Operations Management

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UNIT 1: OPERATIONS MANAGEMENT OVERVIEW

Unit 1: Operations Management Overview

Operations management is a vast topic but can be bundled into a few distinct categories, each of which will be covered in later units. (It should be noted, however, that entire courses could be devoted to each of these topics individually.) Because most people do not work in a formal operations department, we will begin with an overview of operations management itself. The top manager of an operations department is usually called the Director of Operations. Most operations departments will report to a Chief Operating Officer (COO), who reports to the Chief Executive Officer (CEO). The COO is often considered the most important figure in a firm, next to the CEO.

The history of operations management can be traced back to the industrial revolution, when production began to shift from small, local companies to large-scale production firms. One of the most significant contributions to operations management came in the early 20th century, when Henry Ford pioneered the assembly line manufacturing process. This process drastically improved productivity and made automobiles affordable to the masses. Understanding the motivations behind innovations of the past can help us identify factors that may motivate individuals in the future of operations management.

Unit 1 Learning Outcomes

Upon successful completion of this unit, you will be able to:

- define operations and operations management;
- differentiate between manufacturing and service operations;
- describe the role of an operations manager within an organization;
- relate operations to the other functional areas of a business organization; and
- identify and apply the elements of the transformation model to understand the relationship between the inputs, processes, and outputs of an organization.

1.1: Introduction to Operations Management

Read this section. Operations management is the management of the processes that transforms inputs into the goods and services that add value for the customer. By the end of this reading you should be able to explain the role of operations management within an organization and differentiate between strategy and tactics.

OPERATIONS MANAGEMENT

Operations management is the management of processes that transform inputs into goods and services that add value for the customer.

LEARNING OBJECTIVE

- Explain the role of operations management

Key Takeaways

Key Points

- The goal of operations management is to maximize efficiency while producing goods and services that effectively fulfill customer needs.
- Operations is one of the three strategic functions of any organization.
- Operations decisions include decisions that are strategic in nature, meaning that they have long-term consequences and often involve a great deal of expense and resource commitments.

Terms

- **Operations management:** Management of processes that transform inputs into goods and services that add value for the customer.
- **tactic:** A maneuver or action calculated to achieve some end.
- **strategy**: A plan of action intended to accomplish a specific goal.

Examples

- JetBlue airlines is a successful airline that has an organization strategy of providing high-value air transportation service to travelers. JetBlue strives to provide fun, comfortable, and safe air service to popular destinations at a price that middle-income passengers can afford. Given JetBlue's organization strategy, the airline features an operations strategy that focuses on low costs, competent and service-

oriented employees, and reliable aircraft.

- JetBlue locates ("location" is an operations decision area) its main transportation hub in New York City, a city of 19 million people that helps ensure that JetBlue's planes fly at full capacity. In the area of equipment decisions, JetBlue operates only one type of aircraft, the Airbus 320, which has high passenger carrying capacity (to maximize revenue), provides good fuel economy and requires only two pilots (versus three) to operate. Having one type of aircraft reduces training costs for pilots and mechanics, reduces investments in parts inventories, and enables JetBlue to negotiate greater discounts on high-volume purchases from Airbus.

WHAT IS OPERATIONS MANAGEMENT?

Operations management is the management of processes that transform inputs into goods and services that add value for the customer.

The Goal of Operations Management

The goal of operations management is to maximize efficiency while producing goods and services that effectively fulfill customer needs.

Countless operating decisions must be made that have both long- and short-term impacts on the organization's ability to produce goods and services that provide added value to customers. If the organization has made mostly good operating decisions in designing and executing its transformation system to meet the needs of customers, its prospects for long-term survival are greatly enhanced.

For example, if an organization makes furniture, some of the operations management decisions involve the following:

- purchasing wood and fabric,
- hiring and training workers,
- location and layout of the furniture factory,
- purchase cutting tools and other fabrication equipment.

If the organization makes good operations decisions, it will be able to produce affordable, functional, and attractive furniture that customers will purchase at a price that will earn profits for the company.

The Role of Operations Management in the Organization

Operations is one of the three strategic functions of any organization. This means that it is a vital part of accomplishing the organization's strategy and ensuring its long-term survival. The other two areas of strategic importance to the organization are marketing and finance. The operations strategy should support the overall organization strategy. Many companies prepare a 5-year pro-forma to assist in their operation planning. The pro forma uses information from past and current financial statements in an effort to predict future events such as sales, and capital investments.

Strategic Versus Tactical Operations Decisions

Operations decisions include decisions that are strategic in nature, meaning that they have long-term consequences and often involve a great deal of expense and resource commitments.

Strategic operations decisions include the following:

- facility location decisions,
- the type of technologies that the organization will use,
- determining how labor and equipment are organized,
- how much long-term capacity the organization will provide to meet customer demand.

Tactical operations decisions have short to medium term impact on the organization, often involve less commitment of resources, and can be changed more easily than strategic decisions. The following are some tactical decisions:

- workforce scheduling,
- establishing quality assurance procedures,
- contracting with vendors,
- managing inventory.

Strategic and tactical operations decisions determine how well the organization can accomplish its goals. They also provide opportunities for the organization to achieve unique competitive advantages that attract and keep customers.

For example, United Parcel Service (UPS), an international package delivery service, formed a partnership with its customer, Toshiba computers. Toshiba needs to provide a repair service to its laptop computer customers. The old approach of providing this service was cumbersome and time-consuming:

1. UPS picked up the customer computers.
2. UPS delivered the computers to Toshiba.
3. Toshiba repaired the computers.
4. UPS picked up the repaired computers and delivered them back to the customers.

Under this traditional approach, the total time to get a laptop computer repaired was two weeks—a long time for people to be without their laptop! Then they came up with an innovative idea for Toshiba to provide better service to its customers.

UPS hired, trained, and certified its own employees to repair Toshiba laptop computers. The new repair process is much more efficient:

1. UPS picks up computers from Toshiba owners.
2. UPS repairs the computers.
3. UPS delivers the computers back to their owners.

The total time to get a computer repaired is now about two days.

Most Toshiba customers think that Toshiba is doing a great job of repairing their computers, when in fact

Toshiba never touches the computers! The result of this operations innovation is better service to Toshiba customers and a strong and profitable strategic partnership between UPS and its customer, Toshiba.

Blueprint for a commercial operations management solution.

Read this section. Service and manufacturing operations share many similarities. However, there are some important differences. This section provides an overview of those differences.

Service Operations[1]

Although the primary function of both manufacturers and service providers is to satisfy customer needs, there are differences between them.

LEARNING OBJECTIVE

- Differentiate between the goods sector and the service sector

key-takeaways

Key Points

- Service companies provide intangible products.
- Manufactured goods are generally standardized. Services, by contrast, are often customized to satisfy the specific needs of a customer.
- Unlike manufactured goods, many services are bought and consumed at the same time.
- As the U.S. economy has changed from a goods producer to a service provider, the predominance of the manufacturing sector has declined substantially over the last fifty years.

Terms

- **tangible:** touchable; able to be touched or felt; perceptible by the sense of touch; palpable
- **intangible:** incapable of being perceived by the senses; incorporeal

Example

- Examples of service providers include banks and hospitals. Both of these service providers offer customized, high interaction “products” to customers. An automobile company or Pepsi Co. are examples of non-service providers (manufacturers). Their products are tangible, standardized, and offer little to no customization.

THE RISE OF THE SERVICE SECTOR

As the U.S. economy changed from a goods producer to a service provider, the predominance of the manufacturing sector has declined substantially over the last fifty years.

Today, only about 12% of U.S. workers are employed in manufacturing. Most now hold jobs in the service sector, which accounts for 77% of U.S. gross domestic product.

Wal-Mart is now America’s largest employer, followed by McDonald’s, and United Parcel Service (UPS). The fourth-largest employer—General Motors—is a manufacturing company.

1. Boundless: *Business*: "Chapter 10, Section 1, Part 3: Service Operations

Service Providers and Manufacturers: The Differences

Though the primary function of both manufacturers and service providers is to satisfy customer needs, there are several important differences between the two types of operations. Let's focus on three of them:

- Intangibility: Manufacturers produce tangible products—things that can be touched or handled, such as automobiles and appliances. Service companies provide intangible products, such as banking, entertainment, or education.
- Customization: Manufactured goods are generally standardized; one twelve-ounce bottle of Pepsi is the same as any other twelve-ounce bottle of Pepsi. Services, by contrast, are often customized to satisfy the specific needs of a customer. When you go to the barber or the hairdresser, you ask for a haircut that looks good on you because of the shape of your face and the texture of your hair.
- Customer contact: You could spend your entire working life assembling cars in Detroit and never meet a customer who bought a car that you had helped to make. But if you worked as a waitress, you'd interact with customers every day. In fact, their satisfaction with your product would be directly determined in part by the service that you provided. Unlike manufactured goods, many services are bought and consumed at the same time.

Service Operations: Examples

ING Bank demonstrates the strategic importance of the transformation process. ING Bank is a banking company that conducts all banking transactions through theInternet, phone, and mail.

ING maintains no traditional bank facilities, except for the buildings that house the employees that execute remote transactions with ING's customers. This strategyresults in tremendous cost savings and competitive advantage to ING by not having to spend capital resources on land and buildings that traditional banks must spend. Consequently, ING can offer its customers higher interest rates on savings accounts and lower interest rates on loans.

Consider another example, that of a new hospital:

- The leaders of the hospital must decide where to locate the facility so that is it accessible to a large number of potential patients.
- Hospital administrators must evaluate the performance and cost of a wide variety of health equipment.
- Hospital administrators must assess and purchase information technologies to keep patient records, fulfill government regulations, provide accurate and timelycommunications, and track financial performance.
- Doctors, nurses, and staff must be hired.
- Various departments (x-ray, lab, pharmacy, physical therapy, etc.) must be arranged to maximize both efficiency and effectiveness in patient care.

The leaders of a new hospital must make a variety of decisions both to establish the hospital and to keep it running effectively.

Service Operations: Tactical Decisions

Tactical operations decisions have short to medium term impact on the organization, often involve less commitment of resources, and can be changed more easily than strategic decisions.

Tactical decisions include:

- Workforce scheduling
- Establishing quality assurance procedures
- Contracting with vendors
- Managing inventory

In the hospital example, scheduling the workforce to match patient admissions is critical to both providing quality care and controlling costs. Selecting a food service vendor is important to serving both employees and patients. Ensuring that the right drugs and supplies are on hand is achieved by working closely with vendors in the supply chain.

CHAPTER ATTRIBUTION

Boundless: *Business*: Chapter 10, Section 1, Part 1: Operations Management and Part 3: Service Operations

1.2 Manufacturing versus Service Operations

Learning Objectives

- Define operations management, and discuss the role of the operations manager in a manufacturing company.
- Describe the decisions made in planning the production process in a manufacturing company.

Like PowerSki, every organization—whether it produces goods or provides services—sees Job 1 as furnishing customers with quality products. Thus, to compete with other organizations, a company must convert resources (materials, labor, money, information) into goods or services as efficiently as possible. The upper-level manager who directs this transformation process is called an *operations manager*. The job of operations management (OM)Management of the process that transforms resources into products., then, consists of all the activities involved in transforming a product idea into a finished product, as well as those involved in planning and controlling the systems that produce goods and services. In other words, operations managers manage the process that transforms inputs into outputs. Figure 11.1 "The Transformation Process" illustrates this traditional function of operations management.

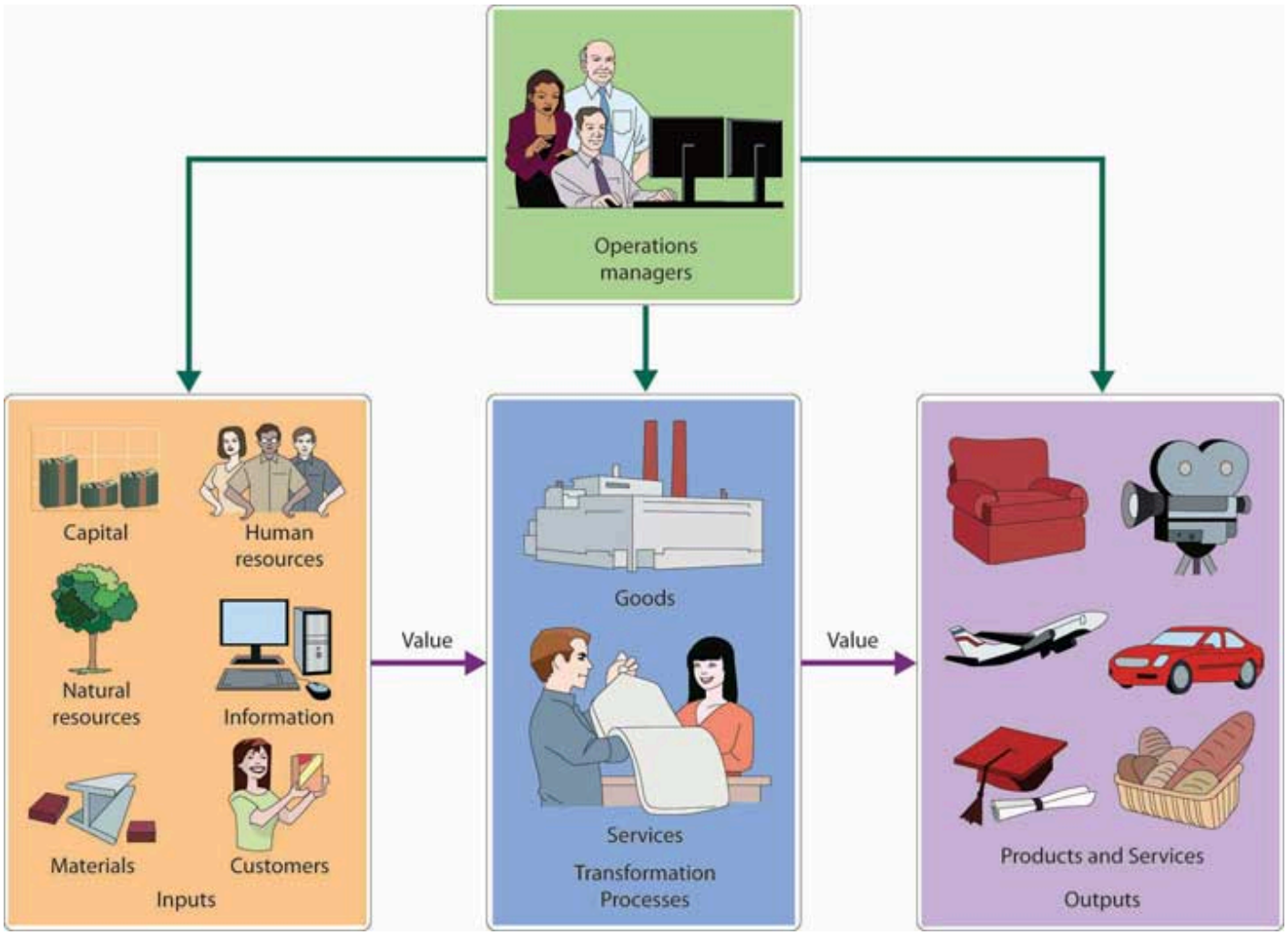

Figure 11.1 The Transformation Process

In the rest of this chapter, we'll discuss the major activities of operations managers. We'll start by describing the role that operations managers play in the various processes designed to produce goods and offer services. Next, we'll look at the production of goods in manufacturing firms; then, we'll describe operations management activities in companies that provide services. We'll wrap up the chapter by explaining the role of operations management in such processes as quality control and outsourcing.

OPERATIONS MANAGEMENT IN MANUFACTURING

Like PowerSki, all manufacturers set out to perform the same basic function: *to transform resources into finished goods*. To perform this function in today's business environment, manufacturers must continually strive to improve operational efficiency. They must fine-tune their production processes to focus on quality, to hold down the costs of materials and labor, and to eliminate all costs that add no value to the finished product. Making the decisions involved in the effort to attain these goals is the job of the operations manager. That person's responsibilities can be grouped as follows:

- *Production planning*. During production planning, managers determine how goods will be produced, where production will take place, and how manufacturing facilities will be laid out.

- *Production control*. Once the production process is under way, managers must continually schedule and monitor the activities that make up that process. They must solicit and respond to feedback and make adjustments where needed. At this stage, they also oversee the purchasing of raw materials and the handling of inventories.
- *Quality control*. Finally, the operations manager is directly involved in efforts to ensure that goods are produced according to specifications and that quality standards are maintained.

Let's take a closer look at each of these responsibilities.

PLANNING THE PRODUCTION PROCESS

The decisions made in the planning stage have long-range implications and are crucial to a firm's success. Before making decisions about the operations process, managers must consider the goals set by marketing managers. Does the company intend to be a low-cost producer and to compete on the basis of price? Or does it plan to focus on quality and go after the high end of the market? Perhaps it wants to build a reputation for reliability. What if it intends to offer a wide range of products? To make things even more complicated, all these decisions involve trade-offs. Upholding a reputation for reliability isn't necessarily compatible with offering a wide range of products. Low cost doesn't normally go hand in hand with high quality.

With these factors in mind, let's look at the specific types of decisions that have to be made in the production planning process. We've divided these decisions into those dealing with production methods, site selection, facility layout, and components and materials management.

PRODUCTION-METHOD DECISIONS

The first step in production planning is deciding which type of production process is best for making the goods that your company intends to manufacture. In reaching this decision, you should answer such questions as the following:

- How much input do I receive from a particular customer before producing my goods?
- Am I making a one-of-a-kind good based solely on customer specifications, or am I producing high-volume standardized goods to be sold later?
- Do I offer customers the option of "customizing" an otherwise standardized good to meet their specific needs?

One way to appreciate the nature of this decision is by comparing three basic types of processes or methods: *make-to-order, mass production*, and *mass customization*. The task of the operations manager is to work with other managers, particularly marketers, to select the process that best serves the needs of the company's customers.

MAKE-TO-ORDER

At one time, most consumer goods, such as furniture and clothing, were made by individuals practicing various crafts. By their very nature, products were *customized* to meet the needs of the buyers who ordered them. This process, which is called a make-to-order strategy, is still commonly used by such businesses as print or sign shops that produce low-volume, high-variety goods according to customer specifications.

MASS PRODUCTION

By the early twentieth century, however, a new concept of producing goods had been introduced: mass production (or make-to-stock strategy) is the practice of producing high volumes of identical goods at a cost low enough to price them for large numbers of customers. Goods are made in anticipation of future demand (based on forecasts) and kept in inventory for later sale. This approach is particularly appropriate for standardized goods ranging from processed foods to electronic appliances.

MASS CUSTOMIZATION

But there's a disadvantage to mass production: customers, as one contemporary advertising slogan puts it, can't "have it their way." They have to accept standardized products as they come off assembly lines. Increasingly, however, customers are looking for products that are designed to accommodate individual tastes or needs but can still be bought at reasonable prices. To meet the demands of these consumers, many companies have turned to an approach called mass customization, which (as the term suggests) combines the advantages of customized products with those of mass production.

This approach requires that a company interact with the customer to find out exactly what the customer wants and then manufacture the good, using efficient production methods to hold down costs. One efficient method is to mass-produce a product up to a certain cut-off point and then to customize it to satisfy different customers.

The list of companies devoting at least a portion of their operations to mass customization is growing steadily. One of the best-known mass customizer is Nike, which has achieved success by allowing customers to configure their own athletic shoes, apparel, and equipment through Nike's iD program. The Web has a lot to do with the growth of mass customization. Levi's, for instance, lets a woman find a pair of perfect fitting jeans by going through an online fitting process that first identifies her "curve" type: *slight* (straight figure), *demi* (evenly proportioned), *bold* (curvy figure, which experiences waist gapping in the back), and supreme (curviest shape, which needs a higher rise in the back). Oakley offers customized sunglasses, goggles, watches, and backpacks, while Mars, Inc. can make M&M's in any color the customer wants (say, school colors) as well as add text and pictures to the candy.
[1]

- [2]
- [3]
- [4]
- [5]

Naturally, mass customization doesn't work for all types of goods. Most people don't care about customized detergents or paper products (although a customized Kleenex tissue box with your picture on it and a statement that says, "go ahead...cry over me!" might come in handy after a relationship breakup with your significant

1. See these websites for examples of customized products:
2. Nike
3. Levi
4. Oakley
5. Mar's M&M's

other.[67]And while many of us like the idea of customized clothes, footwear, or sunglasses from Levi's, Nike, or Oakley, we often aren't willing to pay the higher prices they command.

FACILITIES DECISIONS

After selecting the best production process, operations managers must then decide where the goods will be manufactured, how large the manufacturing facilities will be, and how those facilities will be laid out.

SITE SELECTION

In choosing a location, managers must consider several factors:

- To minimize shipping costs, both for raw materials coming into the plant and for finished goods going out, managers often want to locate plants close to suppliers, customers, or both.
- They generally want to locate in areas with ample numbers of skilled workers.
- They naturally prefer locations where they and their families will enjoy living.
- They want locations where costs for resources and other expenses—land, labor, construction, utilities, and taxes—are low.
- They look for locations with a favorable business climate—one in which, for example, local governments might offer financial incentives (such as tax breaks) to entice them to do business in their locales.

Managers rarely find locations that meet all these criteria. As a rule, they identify the most important criteria and aim at satisfying them. In deciding to locate in San Clemente, California, for instance, PowerSki was able to satisfy three important criteria: (1) proximity to the firm's suppliers, (2) availability of skilled engineers and technicians, and (3) favorable living conditions. These factors were more important than operating in a low-cost region or getting financial incentives from local government. Because PowerSki distributes its products throughout the world, proximity to customers was also unimportant.

CAPACITY PLANNING

Now that you know *where* you're going to locate, you have to decide on the quantity of products that you'll produce. You begin by *forecasting* demand for your product. Forecasting isn't easy. To estimate the number of units that you're likely to sell over a given period, you have to understand the industry that you're in and estimate your likely share of the market by reviewing industry data and conducting other forms of research.

Once you've forecasted the demand for your product, you can calculate the capacityMaximum number of products that a facility can produce over a given period under normal working conditions. requirements of your production facility—the maximum number of goods that it can produce over a given time under normal working conditions. In turn, having calculated your capacity requirements, you're ready to determine how much investment in plant and equipment you'll have to make, as well as the number of labor hours required for the plant to produce at capacity.

Like forecasting, capacity planning is difficult. Unfortunately, failing to balance capacity and projected demand

6.
7. [8])
8. Anita Windisman, "*Personalized Packaging: Kleenex Offers Customizable Tissue Boxes*," One of a Kind Publishing, Inc., January 3, 2008, http://blogs.oneofakindpublishing.com/index.php?/archives/77-Personalized-Packaging-Kleenex-Offers Customizable-Tissue-Boxes.html (accessed November 1, 2011).

can be seriously detrimental to your bottom line. If you set capacity too low (and so produce less than you should), you won't be able to meet demand, and you'll lose sales and customers. If you set capacity too high (and turn out more units than you should), you'll waste resources and inflate operating costs.

Key Takeaways

- The job of **operations management** is to oversee the process of transforming resources into goods and services.
- The role of operations managers in the manufacturing sector includes production planning, production control, and quality control.
- During production planning, managers determine how goods will be produced (production process), where production will take place (site selection), and how manufacturing facilities will be laid out (layout planning).
- In selecting the appropriate production process, managers compare three basic methods: **make-to-order strategy** (goods are made to customer specifications), **mass production** or **make-to-stock strategy** (high volumes of goods are made and held in inventory for later sale), and **mass customization** (high volumes of customized goods are made).
- In choosing the site for a company's manufacturing operations, managers look for locations that minimize shipping costs, have an ample supply of skilled workers, provide a favorable community for workers and their families, offer resources at low cost, and have a favorable business climate.
- Managers estimate the quantity of products to be produced by forecasting demand for their product and then calculating the capacity requirements of the production facility—the maximum number of goods that it can produce over a given period under normal working conditions.

Exercises

- **(AACSB) Analysis**
  Two former surfers invented a material for surfboards that's lighter and stronger than anything manufacturers now use. They have received funding to set up a production facility, and they want you to help them select a location. In addition to your recommendation, identify the factors that you considered in reaching your decision.
- **(AACSB) Analysis**
  Compare and contrast three common types of production processes: make-to-order, make-to-stock, and mass customization. What are the advantages and disadvantages of each? Why are more companies devoting at least a portion of their operations to mass customization? Identify three goods that could probably be adapted to mass customization and three that probably couldn't.

OPERATIONS MANAGEMENT FOR SERVICE PROVIDERS

Learning Objectives

1. List the characteristics that distinguish service operations from manufacturing operations.
2. Describe the decisions made in planning the product delivery process in a service company.
3. Identify the activities undertaken to manage operations in a service organization.

As the U.S. economy has changed from a goods producer to a service provider, the predominance of the manufacturing sector has declined substantially over the last sixty years. Today, only about 9 percent of U.S. workers are employed in manufacturing, in contrast to 30 percent in 1950.[9][10] Most of us now hold jobs in the service sector, which accounts for 77 percent of U.S. gross domestic product.[12][13] Wal-Mart is now America's largest employer, followed by IBM, United Parcel Service (UPS), McDonald's, and Target. Not until we drop down to the seventh-largest employer—Hewlett Packard—do we find a company with even a manufacturing component.[15]

Though the primary function of both manufacturers and service providers is to satisfy customer needs, there are several important differences between the two types of operations. Let's focus on three of them:

- *Intangibility*. Manufacturers produce tangible products—things that can be touched or handled, such as automobiles and appliances. Service companies provide intangible products, such as banking, entertainment, or education.
- *Customization*. Manufactured goods are generally standardized; one twelve-ounce bottle of Pepsi is the same as any other twelve-ounce bottle of Pepsi. Services, by contrast, are often customized to satisfy the specific needs of a customer. When you go to the barber or the hairdresser, you ask for a haircut that looks good on you because of the shape of your face and the texture of your hair. When you go to the dentist, you ask him or her to fill or pull the tooth that's bothering you.
- *Customer contact*. You could spend your entire working life assembling cars in Detroit and never meet a customer who bought a car that you helped to make. But if you were a waitress, you'd interact with customers every day. In fact, their satisfaction with your product would be determined in part by the service that you provided. Unlike manufactured goods, many services are bought and consumed at the same time.

9.
10. [11]
11. "Avoiding an American 'Lost Decade,'" *The Global Language Monitor*, November 3, 2010, http://www.languagemonitor.com/tag/percentage-of-the-non-farm-payroll-in-manufacturing/ (accessed November 2, 2011); William Strauss, "Is U.S. Manufacturing Disappearing?," Federal Reserve Bank of Chicago, August 19, 2010, http://midwest.chicagofedblogs.org/archives/2010/08/bill_strauss_mf.html#footnote2 (accessed November 2, 2011).
12.
13. [14]
14. "International Monetary Fund, World Economic Outlook Database, April 2011: Nominal GDP List of Countries. Data For The Year 2010," International Monetary Fund, http://www.imf.org/external/pubs/ft/weo/2011/01/weodata/index.aspx (accessed November 2, 2011); *Wikipedia*, s.v. "List of Countries by GDP Sector Composition," http://en.wikipedia.org/wiki/List_of_countries_by_GDP_sector_composition (accessed November 2, 2011).
15. [16]
16. "America's Ten Largest Employers," 24/7 Wall Street, April 10, 2011, http://247wallst.com/2011/04/24/americas-ten-largest-employers/#ixzz1ayiE71Sr (accessed November 2, 2011).

Figure 11.10 Here is just one of the over twelve thousand Burger King restaurants across the globe.

Not surprisingly, operational efficiency is just as important in service industries as it is in manufacturing. To get a better idea of the role of operations management in the service sector, we'll look closely at Burger King (BK), home of the Whopper, and the world's second-largest restaurant chain.[1718] BK has grown substantially since selling the first Whopper (for $0.37) almost half a century ago. The instant success of the fire-grilled burger encouraged the Miami founders of the company to expand by selling franchises. Today, there are 12,200 BK company- and independently-owned franchised restaurants in seventy-three countries (seven thousand of which are in the United States), and they employ almost forty thousand people.[2021] More than eleven million customers visit BK each day.[23]

OPERATIONS PLANNING

When starting or expanding operations, businesses in the service sector must make a number of decisions quite similar to those made by manufacturers:

17.
18. [19]
19. "Press Room," Burger King, http://www.bk.com/en/us/company-info/press/index.html (accessed November 2, 2011).
20.
21. [22]
22. SEC, *10K SEC Filings*, Burger King Corporation, August 2010, http://services.corporate-ir.net/SEC.Enhanced/SecCapsule.aspx?c=87140&fid=7105569 (accessed November 3, 2011).
23. [24]
24. "Press Room," Burger King, http://www.bk.com/en/us/company-info/press/index.html (accessed November 2, 2011).

- What services (and perhaps what goods) should they offer?
- How will they provide these services?
- Where will they locate their business, and what will their facilities look like?
- How will they forecast demand for their services?

Let's see how service firms like BK answer questions such as these.[25]

OPERATIONS PROCESSES

Service organizations succeed by providing services that satisfy customers' needs. Companies that provide transportation, such as airlines, have to get customers to their destinations as quickly and safely as possible. Companies that deliver packages, such as FedEx, must pick up, sort, and deliver packages in a timely manner. Colleges must provide quality educations. Companies that provide both services and goods, such as Domino's Pizza, have a dual challenge: they must produce a quality good and deliver it satisfactorily.

Service providers that produce goods can, like manufacturers, adopt either a *make-to-order* or a *make-to-stock* approach to manufacturing them. BK, which encourages patrons to customize burgers and other menu items, uses a make-to-order approach. BK can customize products because it builds sandwiches one at a time rather than batch-process them. Meat patties, for example, go from the grill to a steamer for holding until an order comes in. Then the patty is pulled from the steamer and requested condiments are added. Finally, the completed sandwich chutes to a counter worker, who gives it to the customer. In contrast, many of BK's competitors, including McDonald's, rely on a make-to-stock approach in which a number of sandwiches are made at the same time with the same condiments. If a customer wants, say, a hamburger without onions, he or she has to wait for a new batch of patties to be grilled. The procedure could take up to five minutes, whereas BK can process a special order in thirty seconds.

Like manufacturers, service providers must continuously look for ways to improve operational efficiency. Throughout its sixty-year history, BK has introduced a number of innovations that have helped make the company (as well as the fast-food industry itself) more efficient. BK, for example, was the first to offer drive-through service (which now accounts for 70 percent of its sales.[26]

It was also a BK vice president, David Sell, who came up with the idea of moving the drink station from behind the counter so that customers could take over the time-consuming task of filling cups with ice and beverages. BK was able to cut back one employee per day at every one of its more than eleven thousand restaurants. Material costs also went down because customers usually fill cups with more ice, which is cheaper than a beverage. Moreover, there were savings on supply costs because most customers don't bother with lids, and many don't use straws. On top of everything else, most customers liked the system (for one thing, it allowed them to customize their own drinks by mixing beverages), and as a result, customer satisfaction went up, as well. Overall, the new process was a major success and quickly became the industry standard.

FACILITIES

When starting or expanding a service business, owners and managers must invest a lot of time in selecting a location, determining its size and layout, and forecasting demand. A poor location or a badly designed facility can

25. Information on Burger King was obtained from an interview with David Sell, former vice president of Central, Eastern, and Northern Europe divisions and president of Burger King France and Germany.
26. [27]
27. Bob Krummert, "Burger King: Headed For A Fast-Casual Flameout?," *Restaurant Hospitality*, http://restaurant-hospitality.com/news/burger-king-headed-flameout-1019/ (accessed November 3, 2011).

cost customers, and inaccurate estimates of demand for products can result in poor service, excessive costs, or both.

SITE SELECTION

People in the real estate industry often say that the three most important factors to consider when you're buying a home are location, location, location. The same principle applies when you're trying to locate a service business. To be successful in a service industry, you need to be accessible to your customers. Some service businesses, such as cable-TV providers, package-delivery services, and e-retailers, go to their customers. Many others, however—hotels, restaurants, stores, hospitals, and airports—have to attract customers to their facilities. These businesses must locate where there's a high volume of available customers. Let's see how BK decides where to place a restaurant.

"Through the light and to the right." This is a favorite catchphrase among BK planners who are looking for a promising spot for a new restaurant (at least in the United States). In picking a location, BK planners perform a detailed analysis of demographics and traffic patterns, yet the most important factor is usually *traffic count*—the number of cars or people that pass by a specific location in the course of a day. In the United States, where we travel almost everywhere by car, BK looks for busy intersections, interstate interchanges with easy off and on ramps, or such "primary destinations" as shopping malls, tourist attractions, downtown business areas, or movie theaters. In Europe, where public transportation is much more common, planners focus on subway, train, bus, and trolley stops.

Once planners find a site with an acceptable traffic count, they apply other criteria. It must, for example, be easy for vehicles to enter and exit the site, which must also provide enough parking to handle projected dine-in business. Local zoning must permit standard signage, especially along interstate highways. Finally, expected business must be high enough to justify the cost of the land and building.

SIZE AND LAYOUT

Because manufacturers do business out of plants rarely visited by customers, they base the size and layout of their facilities solely on production needs. In the service sector, however, most businesses must design their facilities with the customer in mind: they must accommodate the needs of their customers while keeping costs as low as possible. Performing this twofold task isn't easy. Let's see how BK has met the challenge.

For its first three decades, almost all BK restaurants were pretty much the same. They all sat on one acre of land (located "through the light and to the right"), had about four thousand square feet of space, and held seating for seventy customers. All kitchens were roughly the same size. As long as land was cheap and sites were readily available, this system worked well enough. By the early 1990s, however, most of the prime sites had been taken, if not by BK itself, then by one of its fast-food competitors or other businesses needing a choice spot, including gas stations and convenience stores. With everyone bidding on the same sites, the cost of a prime acre of land had increased from $100,000 to over $1 million in a few short years.

To continue growing, BK needed to change the way it found and developed its locations. Planners decided that they had to find ways to reduce the size of a typical BK restaurant. For one thing, they could reduce the number of seats, because the business at a typical outlet had shifted over time from 90 percent inside dining and 10 percent drive-through to a 50-50 split. BK customers tended to be in a hurry, and more customers preferred the convenience of drive-through "dining."

David Sell (the same executive who had recommended letting customers fill their own drink cups) proposed to save space by wrapping Whoppers in paper instead of serving them in the cardboard boxes that took up too much space in the back room of every restaurant. So BK switched to a single paper wrapper with the label "Whopper" on one side and "Cheese Whopper" on the other. To show which product was inside, employees just

folded the wrapper in the right direction. Ultimately, BK replaced pallets piled high with boxes with a few boxes full of wrappers.

Ideas like these helped BK trim the size of a restaurant from four thousand square feet to as little as one thousand. In turn, smaller facilities enabled the company to enter markets that were once cost prohibitive. Now BK could locate profitably in airports, food courts, strip malls, center-city areas, and even schools. The company even designed 10-foot-by-10-foot kiosks that could be transported to special events, stadiums, and concerts.

CAPACITY PLANNING

Estimating capacity needs for a service business isn't the same thing as estimating those of a manufacturer. A manufacturer can predict overall demand, produce the product, store it in inventory, and ship it to a customer when it's ordered. Service providers, however, can't store their products for later use: hairdressers can't "inventory" haircuts, hospitals can't "inventory" operations, and amusement parks can't "inventory" roller-coaster rides. Service firms have to build sufficient capacity to satisfy customers' needs on an "as-demanded" basis. Like manufacturers, service providers must consider many variables when estimating demand and capacity:

- How many customers will I have?
- When will they want my services (which days of the week, which times of the day)?
- How long will it take to serve each customer?
- How will external factors, such as weather or holidays, affect the demand for my services?

Forecasting demand is easier for companies like BK, which has a long history of planning facilities, than for brand-new service businesses. BK can predict sales for a new restaurant by combining its knowledge of customer-service patterns at existing restaurants with information collected about each new location, including the number of cars or people passing the proposed site and the effect of nearby competition.

MANAGING OPERATIONS

>Overseeing a service organization puts special demands on managers, especially those running firms, such as hotels, retail stores, and restaurants, that have a high degree of contact with customers. Service firms provide customers with personal attention and must satisfy their needs in a timely manner. This task is complicated by the fact that demand can vary greatly over the course of any given day. Managers, therefore, must pay particular attention to employee work schedules and (in some cases) inventory management. Let's see how BK deals with these problems.

SCHEDULING

In manufacturing, managers focus on scheduling the *activities* needed to transform raw materials into finished goods. In service organizations, they focus on scheduling *workers* so that they're available to handle fluctuating customer demand. Each week, therefore, every BK store manager schedules employees to cover not only the peak periods of breakfast, lunch, and dinner, but also the slower periods in between. If he or she staffs too many people, labor cost per sales dollar will be too high. If there aren't enough employees, customers have to wait in lines. Some get discouraged, and even leave, and many may never come back.

Scheduling is made easier by information provided by a point-of-sale device built into every BK cash register. The register keeps track of every sandwich, beverage, and side order sold by the hour, every hour of the day, every day of the week. Thus, to determine how many people will be needed for next Thursday's lunch hour, the manager

reviews last Thursday's data, using sales revenue and a specific BK formula to determine the appropriate staffing level. Each manager can adjust this forecast to account for other factors, such as current marketing promotions or a local sporting event that will increase customer traffic.

INVENTORY CONTROL

Businesses that provide both goods and services, such as retail stores and auto-repair shops, have the same inventory-control problems as manufacturers: keeping levels too high costs money, while running out of inventory costs sales. Technology, such as the point-of-sale registers used at BK, makes the job easier. BK's system tracks everything sold during a given time and lets each store manager know how much of everything should be kept in inventory. It also makes it possible to count the number of burgers and buns, bags and racks of fries, and boxes of beverage mixes at the beginning or end of each shift. Because there are fixed numbers of supplies—say, beef patties or bags of fries—in each box, employees simply count boxes and multiply. In just a few minutes, the manager knows whether the inventory is correct (and should be able to see if any theft has occurred on the shift).

Key Takeaways

- Though the primary function of both manufacturers and service providers is to satisfy customer needs, there are several important differences between the two types of operations.
- While manufacturers produce tangible, generally standardized products, service firms provide intangible products that are often customized to satisfy specific needs. Unlike manufactured goods, many services are bought and consumed at the same time.
- Operational efficiency is just as important in service industries as it is in manufacturing.
- Operations managers in the service sector make many decisions that are similar to those made by manufacturers: they decide which services to offer, how to provide these services, where to locate their businesses, what their facilities will look like, and what the demand will be for their services.
- Service providers that produce goods can, like manufacturers, adopt either a make-to-order approach (in which products are made to customer satisfaction) or make-to-stock approach (in which products are made for inventory) to manufacturing them.
- Estimating **capacity** needs for a service business is more difficult than for a manufacturer. Service providers can't store their services for later use: services must be delivered on an as-needed basis.
- Overseeing a service organization puts special demands on managers, especially services requiring a high degree of contact with customers.
- Given the importance of personalized service, scheduling workers is more complex in the service industry than in manufacturing. In manufacturing, operations managers focus on scheduling the *activities* needed to produce goods; in service organizations, they focus on scheduling *workers* to ensure that enough people are available to handle fluctuating customer demand.

Exercise

(AACSB) Analysis

Starting a new business can be an exciting adventure. Here's your chance to start a "pretend" business. Select a service business that you'd like to open, and answer these questions. Provide an explanation for each answer:

1. What services (and perhaps goods) will I provide?
2. How will I provide these services?
3. Where will I locate my business?
4. What will the facilities look like (how large will the facilities be and what will the layout look like)?
5. How many customers will I serve each day?
6. When will my customers want my services (which days of the week, which times of the day)?
7. How long will it take to serve each customer?
8. Why will my business succeed? Why will my customers return?

1.3: The Systems View of Operations Management

Read this section. This reading provides an overview of the functional structure common in many organizations. Operations is a function within the organization. It is important to understand the other functional units and how operations fit within the overall structure.

FUNCTIONAL STRUCTURE

An organization with a functional structure is divided based on functional areas, such as IT, finance, or marketing.

Learning Objectives

- Explain the functional structure within the larger context of organizational structures in general

Key Takeaways

- A functional organization is a common type of organizational structure in which the organization is divided into smaller groups based on specialized functional areas, such as IT, finance, or marketing.
- Functional departmentalization arguably allows for greater operational efficiency because employees with shared skills and knowledge are grouped together by function.
- A disadvantage of this type of structure is that the different functional groups may not communicate with one another, potentially decreasing flexibility and innovation. A recent trend aimed at combating this disadvantage is the use of teams that cross traditional departmental lines.

TERMS

- **departmentalization**: The organization of something into groups according to function, geographic location, etc.
- **silo:** In business, a unit or department within which communication and collaboration occurs vertically, with limited cooperation outside the unit.

OVERVIEW OF THE FUNCTIONAL STRUCTURE

An organization can be arranged according to a variety of structures, which determine how the organization will operate and perform. In a functional structure, a common configuration, an organization is divided into smaller groups by areas of specialty (such as IT, finance, operations, and marketing). Some refer to these functional areas as "silos"—entities that are vertical and disconnected from each other. Correspondingly, the company's top management team typically consists of several functional heads (such as the chief financial officer and the chief operating officer). Communication generally occurs within each functional department and is transmitted across departments through the department heads.

Advantages of a Functional Structure

Functional departments arguably permit greater operational efficiency because employees with shared skills and knowledge are grouped together by functions performed. Each group of specialists can therefore operate independently with management acting as the point of cross-communication between functional areas. This arrangement allows for increased specialization.

Disadvantages of a Functional Structure

A disadvantage of this structure is that the different functional groups may not communicate with one another, potentially decreasing flexibility and innovation. Functional structures may also be susceptible to tunnel vision, with each function perceiving the organization only from within the frame of its own operation. Recent trends that aim to combat these disadvantages include the use of teams that cross traditional departmental lines and the promotion of cross-functional communication.

Functional structures appear in a variety of organizations across many industries. They may be most effective within large corporations that produce relatively homogeneous goods. Smaller companies that require more adaptability and creativity may feel confined by the communicative and creative silos functional structures tend to produce.

CHAPTER ATTRIBUTION

Boundless: *Management*: Chapter 2, Section 3, Part 1: Functional Structure"

1.4: The Process View of Organizations

Read this page and explore the transformation process that occurs in operations management. Operations management transforms inputs like labor, widgets, steel, and capital into outputs (goods and services) that provide added value to customers. By the end of this reading, you will be able to analyze the importance of operations management in protecting an organization's competitive advantage.

A STUDY OF PROCESS

Operations management transforms inputs (labor, capital) into outputs (goods and services) that provide added value to customers.

Learning Objective

- Analyze the importance of operations management in protecting an organization's competitive advantage

Key Takeaways

- Operations management transforms inputs (labor, capital, equipment, land, buildings, materials, and information) into outputs (goods and services) that provide added value to customers.
- All organizations must strive to maximize the quality of their transformation processes to meet customer needs.
- Controlling the transformation process makes it difficult for competitors to manufacture products of the same quality as the original producer.

TERMS

- **process**: A series of events to produce a result, especially as contrasted to product.
- **input**: Something fed into a process with the intention of it shaping or affecting the outputs of that process.
- **output**: Production; quantity produced, created, or completed.

EXAMPLES

- The 3M Company is a good example of the strategic importance of transforming inputs into outputs that provide competitive advantage in the marketplace. This company manufactures a top-quality adhesive tape called "Magic Tape. " Magic Tape is used for everyday taping applications, but it offers attractive features that most other tapes do not, including smooth removal from the tape roll, an adhesive that is sticky enough to hold items in place (but not too sticky that it can not be removed and readjusted, if necessary!), and a non-reflective surface. For several decades, 3M has enjoyed a substantial profit margin on its Magic Tape product, because 3M engineers make the manufacturing equipment and design the manufacturing processes that produce Magic Tape. In other words, 3M enjoys a commanding competitive advantage by controlling the transformation processes that turn raw material inputs into the high value-added Magic Tape product. Controlling the transformation process makes it extremely difficult for competitors to produce tape of the same quality as Magic Tape, allowing 3M to reap significant profits from this superior product.
- An opposite example of the strategic implications of the input/output transformation process is 3M's decision in the 1980s to stop manufacturing VHS tape for video players and recorders. In the VHS tape market, 3M had no proprietary manufacturing advantage, as there were many Asian competitors that could produce high-quality, VHS tape at lower cost. Since 3M had no proprietary control over the transformation process for VHS tape that would allow the company to protect its profit margins for this product, it dropped VHS tape from its offerings. The two 3M examples of Magic Tape and VHS tape show how important the transformation process and operations management can be to providing and protecting an organization's competitive advantage.

Operations Management and the Transformation Process

Operations management transforms inputs (labor, capital, equipment, land, buildings, materials and information) into outputs (goods and services) that provide added value to customers.

Figure 1 summarizes the transformation process. The arrow labeled "Transformation System" is the critical element in the model that will determine how well the organization produces goods and services that meet customer needs. It does not matter whether the organization is a for-profit company, a non-profit organization (religious organizations, hospitals, etc.), or a government agency; all organizations must strive to maximize the quality of their transformation processes to meet customer needs.

Example: Strategic Importance of Operations Management

The 3M Company is a good example of the strategic importance of transforming inputs into outputs that provide competitive advantage in the marketplace.

3M manufactures a top-quality adhesive tape called "Magic Tape". Magic Tape is used for everyday taping applications, but it offers attractive features that most other tapes do not, including:

- Smooth removal from the tape roll
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CHAPTER ATTRIBUTION

Boundless: *Business*: "Chapter 10, Section 1, Part 3: A Study of Process"

Unit 1 Activity

ACTIVITY #1

Choose a company that creates a product or offers a service that you are familiar. Using the company website and additional research, list the inputs that the company uses to produce outputs. Define the outputs created. After creating this list, discuss the additional functional units within the organization that are important to the final product. How important do you believe the quality of the operations management is to the final output? Explain your answer.

UNIT 1 ACTIVITY AND GRADING RUBRIC

For this activity, you will apply the concepts of operations management to real world situations. You will use this unit to begin developing an operation management plan by writing a 2-3 page paper on a business concept of your choosing.

Learning Outcome

Explain the role of operations and its relationship with the other functional areas of a business organization.

Specifications:

- 2-3 page paper
- Created in a Word document
- Follows APA, 6th edition formatting
- Includes a Reference page for cited sources

Instructions: For this activity, you will apply the concepts of operations management to real world situations. You will use this unit to begin developing an operation management plan by writing a 2-3 page paper on a business concept of your choosing. You may wish to develop a business such as a retail sales operation, an online service like tutoring, or maybe a personal service such as lawn care or pet grooming as your business. Use the information from Unit 1 to help you identify what aspects are to be covered and explain, in detail, why you made certain choices. In writing your paper, you should research and consider at least 4 scholarly sources (i.e. textbooks, scholarly articles from a peer reviewed journal, etc.) As you write the paper, make sure to address the following topics:

- Will the company be business-to-consumer or business-to-business?
- Will the business manufacture a product, deliver a service, broker information, offer goods for sale, or distribute goods for others?

- Will the business offer one product or service, or a range of products and services?
- Will the company have a bricks-and-mortar presence, or sell strictly over the Web?
- Will the firm be a large company, a medium-sized enterprise, or a small business?
- How will you provide /transport the service or product to the consumer?
- Will there be a need for inventory storage?

UNIT 2: OPERATIONS STRATEGY

Unit 2: Operations Strategy

The most significant aspect of operations management is the process itself. How does Apple take a pile of chips, glass, and plastic, and turn it into an iPhone? Their manufacturer in China is responsible for this process, but Apple is involved every step of the way in order to ensure quality, reliability, and consistency. Process flow structures are the different methods of production deemed appropriate for various manufacturing contexts. Does it make sense for Apple to wait for 1 million orders, then make and ship them? Or should they instead produce iPhones based on current demand and try to balance inventory? These are decisions that the COO must make as each process flow has various costs associated with it.

Additionally, not every operations department is producing a good we can consume. Wall Street traders receive orders from clients and must execute trades on open markets. The order itself may pass through dozens of people before confirmation of the trade is sent back to the client. If you consider that "actual trade" to be the product, you can design an operations process around the goal of executing the trade. The result is a process remarkably similar to production. In this unit, you will learn how operations managers use long-term, strategic planning to manage internal and external influences on the organization's resource base.

Unit 2 Learning Outcomes

Learning Objectives

Upon successful completion of this unit, you will be able to:

- identify the importance of operations strategy for creating corporate, business, and functional level strategy;
- explain the role of the value chain for operations strategy formulation; and
- discuss how operational competencies contribute to the development of a competitive advantage for an organization

2.1: Role of Strategy in Operations Management

CORPORATE SOCIAL RESPONSIBILITY

Learning Objectives

- Define *corporate social responsibility* and explain how organizations are responsible to their stakeholders.

Corporate social responsibility refers to the approach that an organization takes in balancing its responsibilities toward different stakeholders when making legal, economic, ethical, and social decisions. What motivates companies to be "socially responsible" to their various stakeholders? We hope it's because they want to do the right thing, and for many companies, "doing the right thing" is a key motivator. The fact is, it's often hard to figure out what the "right thing" is: What's "right" for one group of stakeholders isn't necessarily just as "right" for another. One thing, however, is certain: Companies today are held to higher standards than ever before. Consumers and other groups consider not only the quality and price of a company's products but also its character. If too many groups see a company as a poor corporate citizen, it will have a harder time attracting qualified employees, finding investors, and selling its products. Good corporate citizens, by contrast, are more successful in all these areas.

Figure 2.6 "The Corporate Citizen" presents a model of corporate responsibility based on a company's relationships with its *stakeholders*. In this model, the focus is on managers—not owners—as the principals involved in all these relationships. Here, owners are the stakeholders who invest risk capital in the firm in expectation of a financial return. Other stakeholders include employees, suppliers, and the communities in which the firm does business. Proponents of this model hold that customers, who provide the firm with revenue, have a special claim on managers' attention. The arrows indicate the two-way nature of corporation-stakeholder relationships: All stakeholders have some claim on the firm's resources and returns, and it's management's job to make decisions that balance these claims.[1]

1. [2]
2. See David P. Baron, *Business and Its Environment*, 4th ed. (Upper Saddle River, NJ: Prentice Hall, 2003), 650–52.

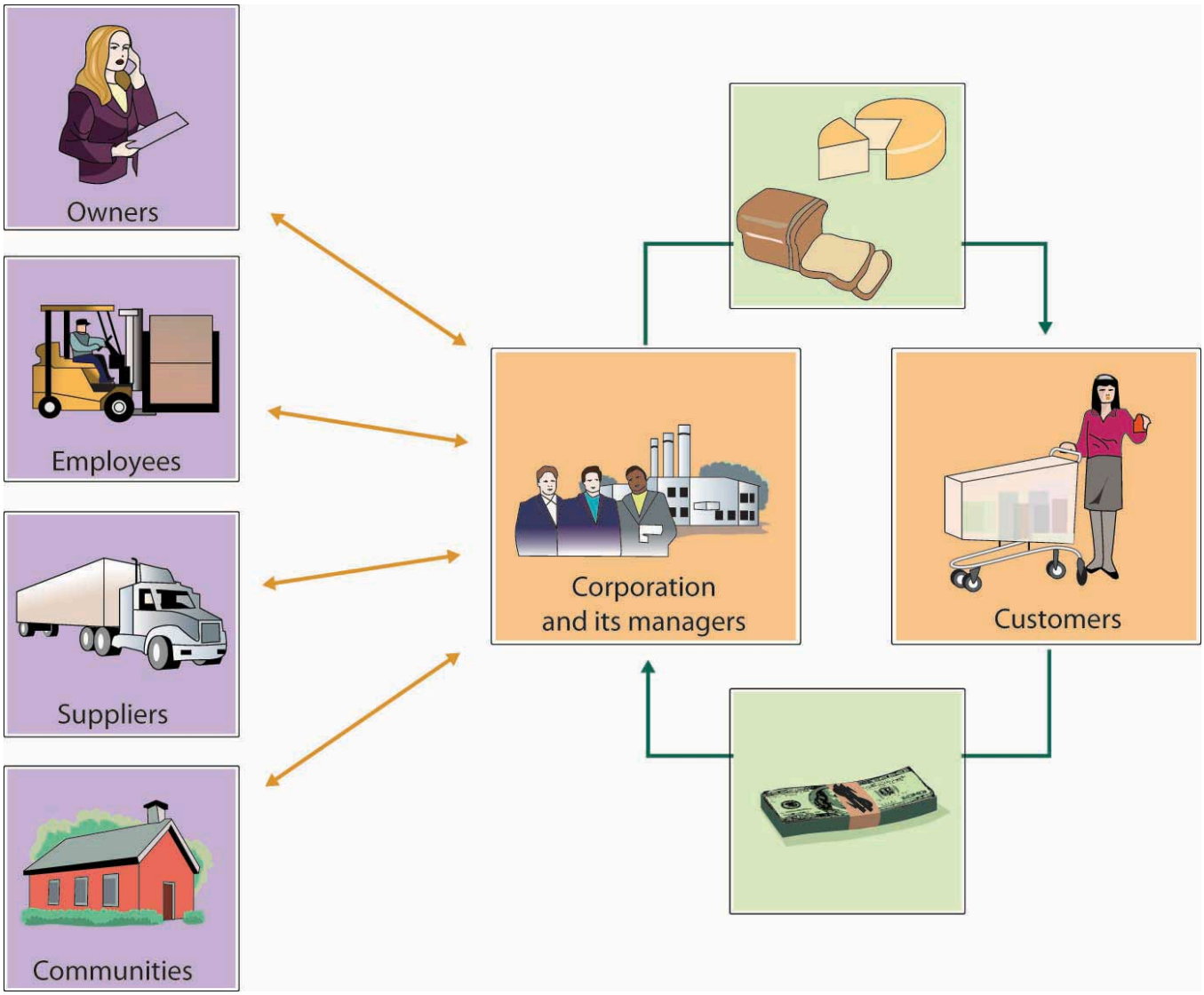


Figure 2.6 The Corporate Citizen Let's look at some of the ways in which companies can be "socially responsible" in considering the claims of various stakeholders.

OWNERS

Owners invest money in companies. In return, the people who run a company have a responsibility to increase the value of owners' investments through profitable operations. Managers also have a responsibility to provide owners (as well as other stakeholders having financial interests, such as creditors and suppliers) with accurate, reliable information about the performance of the business. Clearly, this is one of the areas in which WorldCom managers fell down on the job. Upper-level management purposely deceived shareholders by presenting them with fraudulent financial statements.

FIDUCIARY RESPONSIBILITIES

Finally, managers have a fiduciary responsibility to owners: They're responsible for safeguarding the company's assets and handling its funds in a trustworthy manner. This is a responsibility that was ignored by top executives

at both Adelphia and Tyco, whose associates and families virtually looted company assets. To enforce managers' fiduciary responsibilities for a firm's financial statements and accounting records, the Sarbanes-Oxley Act of 2002 requires CEOs and CFOs to attest to their accuracy. The law also imposes penalties on corporate officers, auditors, board members, and any others who commit fraud.

EMPLOYEES

Companies are responsible for providing employees with safe, healthy places to work—as well as environments that are free from sexual harassment and all types of discrimination. They should also offer appropriate wages and benefits. In the following sections, we'll take a closer look at each of these areas of responsibility.

SAFETY AND HEALTH

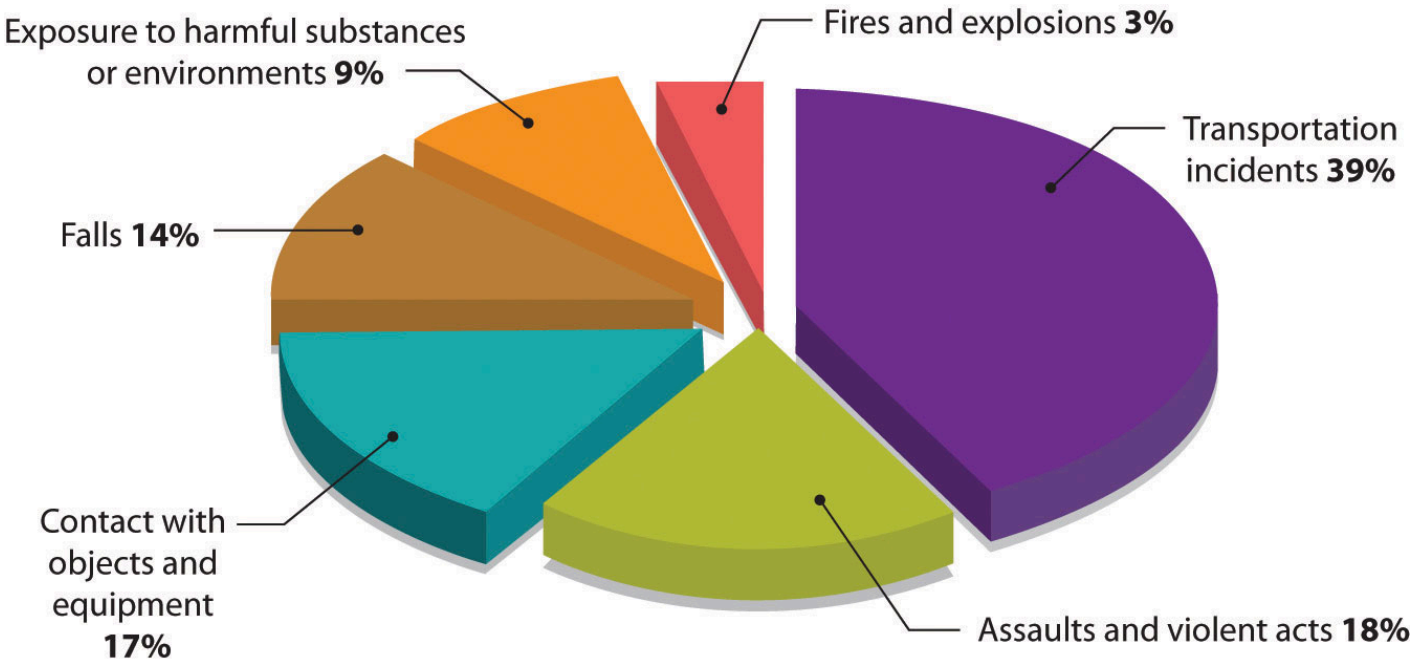


Figure 2.7 Workplace Deaths by Event or Exposure, 2010

Though it seems obvious that companies should guard workers' safety and health, a lot of them simply don't. For over four decades, for example, executives at Johns Manville suppressed evidence that one of its products, asbestos, was responsible for the deadly lung disease developed by many of its workers.[34] The company concealed chest X-rays from stricken workers, and executives decided that it was simply cheaper to pay workers' compensation claims (or let workers die) than to create a safer work environment. A New Jersey court was quite blunt in its judgment: Johns Manville, it held, had made a deliberate, cold-blooded decision to do nothing to protect at-risk workers, in blatant disregard of their rights.[6]

About four in one hundred thousand U.S. workers die in workplace "incidents" each year. The Department of

3.
4. [5]
5. Saul W. Gellerman, "Why 'Good' Managers Make Bad Ethical Choices," *Harvard Business Review on Corporate Ethics* (Boston: Harvard Business School Press, 2003), 49–66.
6. [7]
7. Saul W. Gellerman, "Why 'Good' Managers Make Bad Ethical Choices," *Harvard Business Review on Corporate Ethics* (Boston: Harvard Business School Press, 2003), 53.

Labor categorizes deaths caused by conditions like those at Johns Manville as "exposure to harmful substances or environments." How prevalent is this condition as a cause of workplace deaths? See Figure 2.7 "Workplace Deaths by Event or Exposure, 2010", which breaks down workplace fatalities by cause. Some jobs are more dangerous than others. For a comparative overview based on workplace deaths by occupation, see Figure 2.8 "Workplace Deaths by Industry, 2010".

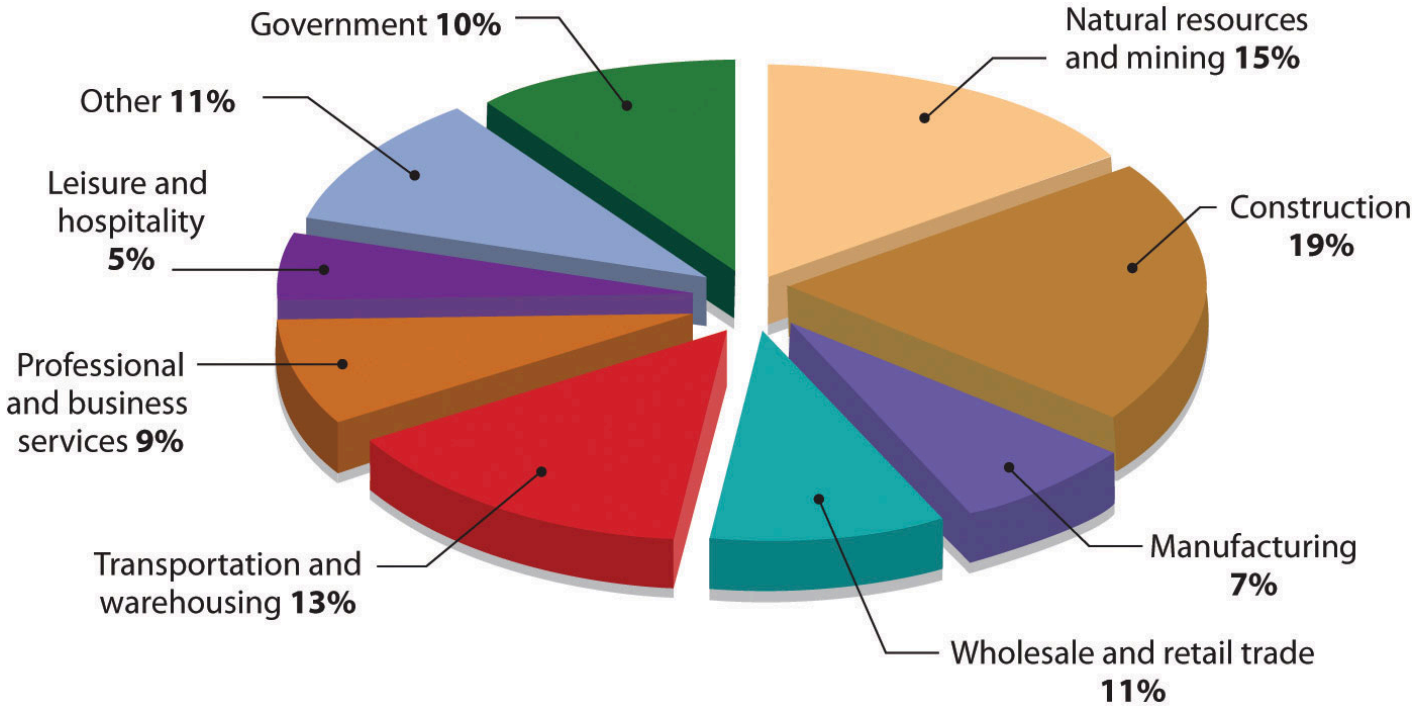


Figure 2.8 Workplace Deaths by Industry, 2010

For most people, fortunately, things are better than they were at Johns Manville. Procter & Gamble (P&G), for example, considers the safety and health of its employees paramount and promotes the attitude that "Nothing we do is worth getting hurt for." With nearly one hundred thousand employees worldwide, P&G uses a measure of worker safety called "total incident rate per employee," which records injuries resulting in loss of consciousness, time lost from work, medical transfer to another job, motion restriction, or medical treatment beyond first aid. The company attributes the low rate of such incidents—less than one incident per hundred employees—to a variety of programs to promote workplace safety.[8]

FREEDOM FROM SEXUAL HARASSMENT

What is *sexual harassment*? The law is quite precise:

- Sexual harassment occurs when an employee makes "unwelcome sexual advances, requests for sexual favors, and other verbal or physical conduct of a sexual nature" to another employee who doesn't welcome the advances.
- It's also sexual harassment when "submission to or rejection of this conduct explicitly or implicitly affects an individual's employment, unreasonably interferes with an individual's work performance or creates an intimidating, hostile or offensive work environment."[10]

8. [9]
9. Procter & Gamble, *2003 Sustainability Report*, http://www.pg.com/content/pdf/01_about_pg/corporate_citizenship/sustainability/reports/sustainability_report_2003.pdf (accessed April 24, 2006).

To prevent sexual harassment—or at least minimize its likelihood—a company should adopt a formal anti-harassment policy describing prohibited conduct, asserting its objections to the behavior, and detailing penalties for violating the policy.[1213] Employers also have an obligation to investigate harassment complaints. Failure to enforce anti-harassment policies can be very costly. In 1998, for example, Mitsubishi paid $34 million to more than three hundred fifty female employees of its Normal, Illinois, plant to settle a sexual harassment case supported by the Equal Employment Opportunity Commission. The EEOC reprimanded the company for permitting an atmosphere of verbal and physical abuse against women, charging that female workers had been subjected to various forms of harassment, ranging from exposure to obscene graffiti and vulgar jokes to fondling and groping.[15]

EQUAL OPPORTUNITY AND DIVERSITY

People must be hired, evaluated, promoted, and rewarded on the basis of merit, not personal characteristics. This, too, is the law—namely, Title VII of the 1964 Civil Rights Act. Like most companies, P&G has a formal policy on hiring and promotion that forbids discrimination based on race, color, religion, gender, age, national origin, citizenship, sexual orientation, or disability. P&G expects all employees to support its commitment to equal employment opportunity and warns that those who violate company policies will face strict disciplinary action, including termination of employment.[17]

EQUAL PAY AND THE WAGE GAP

The Equal Pay Act of 1963 requires equal pay for both men and women in jobs that entail equal skill, equal effort, equal responsibility, or similar working conditions. What has been the effect of the law after forty years? In 1963, women earned, on average, $0.589 for every $1 earned by men. By 2010, that difference—which we call the *wage gap*—has been closed to $0.812 to $1, or approximately 81 percent.[1920] Figure 2.10 "Median Annual Earnings by Gender and Race" provides some interesting numbers on the differences in annual earnings based not only on gender but on race, as well. Figure 2.11 "Median Annual Earnings by Level of Education" throws further light on the wage and unemployment gap when education is taken into consideration.

10. [11]
11. U.S. Equal Employment Opportunity Commission, "Facts about Sexual Harassment," http://www.eeoc.gov/facts/fs-sex.html (accessed January 22, 2012).
12.
13. [14]
14. Joanna Grossman, "Sexual Harassment in the Workplace: Do Employers' Efforts Truly Prevent Harassment, or Just Prevent Liability," *Find Laws Legal Commentary, Writ*, http://writ.news.findlaw.com/grossman/20020507.html (accessed January 22, 2012).
15. [16]
16. Joanna Grossman, "Sexual Harassment in the Workplace: Do Employers' Efforts Truly Prevent Harassment, or Just Prevent Liability," *Find Laws Legal Commentary, Writ*, http://writ.news.findlaw.com/grossman/20020507.html (accessed January 22, 2012).
17. [18]
18. Procter & Gamble, "Respect in the Workplace," *Our Values and Policies*, http://www.pg.com/content/pdf/01_about_pg/01_about_pg_homepage/about_pg_toolbar/download_report/values_and_policies.pdf (accessed January 22, 2012).
19.
20. [21]
21. Mike Aamodt, "Human Resource Statistics," Radford University, http://maamodt.asp.radford.edu/HR%20Statistics/Salary%20by%20Sex%20and%20Race.htm (accessed August 15, 2011).

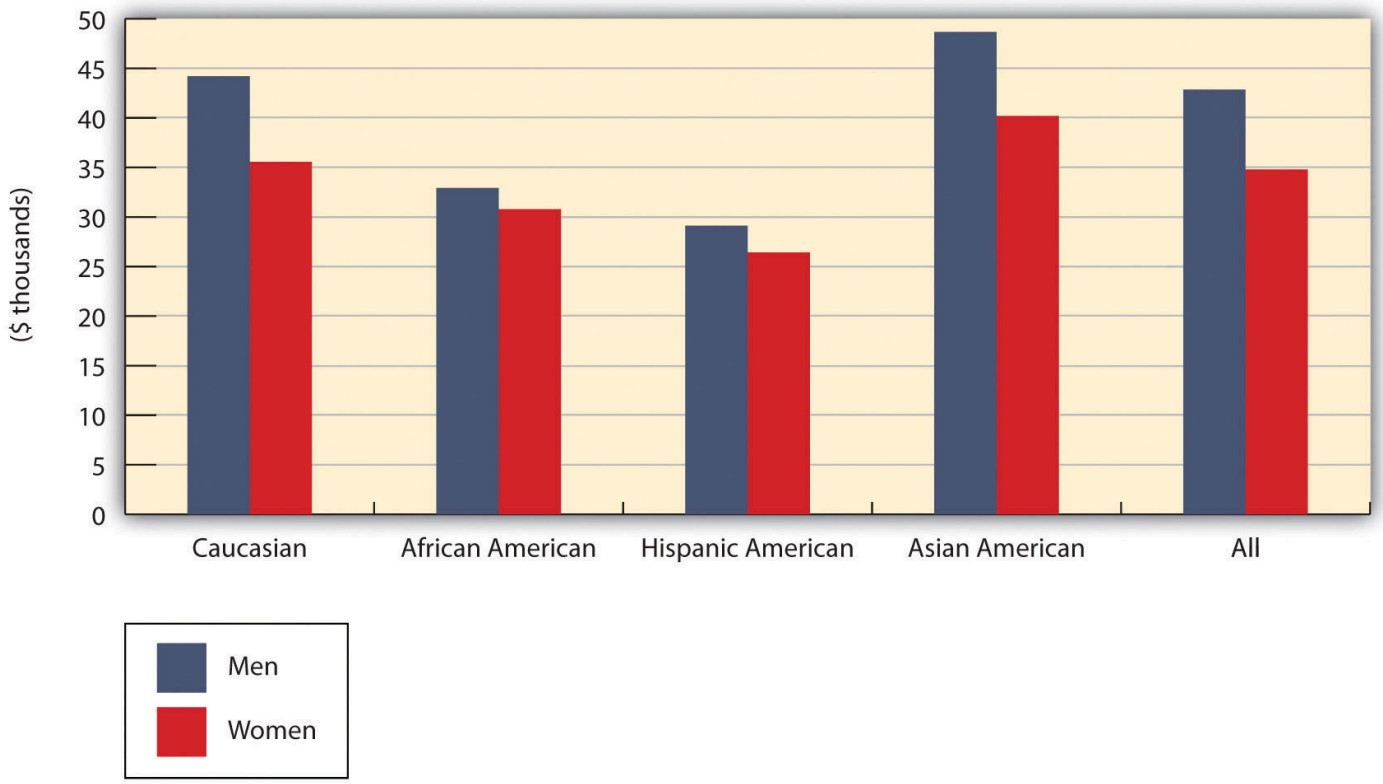


Figure 2.10 Median Annual Earnings by Gender and Race

What accounts for the difference, despite the mandate of federal law? For one thing, the jobs typically held by women tend to pay less than those typically held by men. In addition, men often have better job opportunities. For example, a man newly hired at the same time as a woman will often get a higher-paying assignment at the entry level. Coupled with the fact that the same sort of discrimination applies when it comes to training and promotions, women are usually relegated to a lifetime of lower earnings.

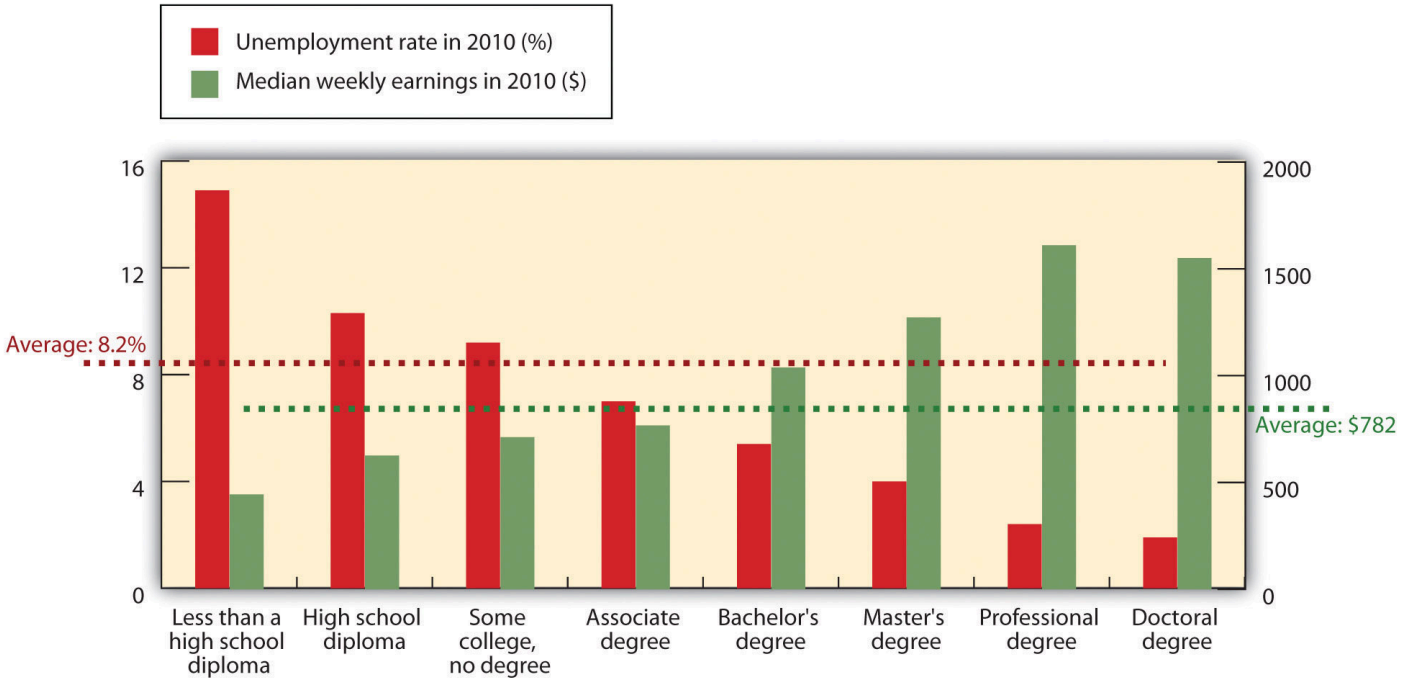


Figure 2.11 Median Annual Earnings by Level of Education *Education pays in higher earnings and lower unemployment rates.* *Note: Data are 2010 annual averages for persons age 25 and over. Earnings are for full-time wage and salary workers.*
Source: Bureau of Labor Statistics, Current Population Survey.

BUILDING DIVERSE WORKFORCES

In addition to complying with equal employment opportunity laws, many companies make special efforts to recruit employees who are underrepresented in the workforce according to sex, race, or some other characteristic. In helping to build more diverse workforces, such initiatives contribute to competitive advantage for two reasons: (1) People from diverse backgrounds bring new talents and fresh perspectives to an organization, typically enhancing creativity in the development of new products. (2) By reflecting more accurately the changing demographics of the marketplace, a diverse workforce improves a company's ability to serve an ethnically diverse population.

WAGES AND BENEFITS

At the very least, employers must obey laws governing minimum wage and overtime pay. A minimum wage is set by the federal government, though states can set their own rates. The current federal rate, for example, is $7.25, while the rate in the state of Washington is $8.67. When there's a difference, the higher rate applies.[2223] By law, employers must also provide certain benefits—social security (which provides retirement benefits), unemployment insurance (which protects against loss of income in case of job loss), and workers' compensation (which covers lost wages and medical costs in case of on-the-job injury). Most large companies pay most of their workers more than minimum wage and offer considerably broader benefits, including medical, dental, and vision care, as well as pension benefits.

22.
23. [24]
24. U.S. Department of Labor, "Minimum Wage Laws in the States," http://www.dol.gov/esa/minwage/america.htm (accessed January 22, 2012).

CUSTOMERS

The purpose of any business is to satisfy customers, who reward businesses by buying their products. Sellers are also responsible—both ethically and legally—for treating customers fairly. The rights of consumers were first articulated by President John F. Kennedy in 1962 when he submitted to Congress a presidential message devoted to consumer issues.[25]

Kennedy identified four consumer rights:

1. *The right to safe products*. A company should sell no product that it suspects of being unsafe for buyers. Thus, producers have an obligation to safety-test products before releasing them for public consumption. The automobile industry, for example, conducts extensive safety testing before introducing new models (though recalls remain common).
2. *The right to be informed about a product*. Sellers should furnish consumers with the product information that they need to make an informed purchase decision. That's why pillows have labels identifying the materials used to make them, for instance.
3. *The right to choose what to buy*. Consumers have a right to decide which products to purchase, and sellers should let them know what their options are. Pharmacists, for example, should tell patients when a prescription can be filled with a cheaper brand-name or generic drug. Telephone companies should explain alternative calling plans.
4. *The right to be heard*. Companies must tell customers how to contact them with complaints or concerns. They should also listen and respond.

Companies share the responsibility for the legal and ethical treatment of consumers with several government agencies: the Federal Trade Commission (FTC), which enforces consumer-protection laws; the Food and Drug Administration (FDA), which oversees the labeling of food products; and the Consumer Product Safety Commission, which enforces laws protecting consumers from the risk of product-related injury.

COMMUNITIES

For obvious reasons, most communities see getting a new business as an asset and view losing one—especially a large employer—as a detriment. After all, the economic impact of business activities on local communities is substantial: They provide jobs, pay taxes, and support local education, health, and recreation programs. Both big and small businesses donate funds to community projects, encourage employees to volunteer their time, and donate equipment and products for a variety of activities. Larger companies can make greater financial contributions. Let's start by taking a quick look at the philanthropic activities of a few U.S. corporations.

FINANCIAL CONTRIBUTIONS

Many large corporations donate a percentage of sales or profits to worthwhile causes. Retailer Target, for example, donates 5 percent of its profits—about $2 million per week—to schools, neighborhoods, and local projects across the country; its store-based grants underwrite programs in early childhood education, the arts, and family-violence prevention.[2728] The late actor Paul Newman donated 100 percent of the profits from "Newman's

25. [26]
26. Henry A. Waxman, House of Representatives, "Remarks on Proposed Consumer Bill of Rights Day, Extension of Remarks," March 15, 1993, http://thomas.loc.gov/cgi-bin/query/z?r103:E15MR30-90 (accessed April 24, 2006), 1–2
27. T
28. [29]

Own" foods (salad dressing, pasta sauce, popcorn, and other products sold in eight countries). His company continues his legacy of donating all profits and distributing them to thousands of organizations, including the Hole in the Wall Gang camps for seriously ill children.[30]

VOLUNTEERISM

Many companies support employee efforts to help local communities. Patagonia, for example, a maker of outdoor gear and clothing, lets employees leave their jobs and work full-time for any environmental group for two months—with full salary and benefits; so far, more than 850 employees have taken advantage of the program.[32]

SUPPORTING SOCIAL CAUSES

Companies and executives often take active roles in initiatives to improve health and social welfare in the United States and elsewhere. Microsoft's former CEO Bill Gates intends to distribute more than $3 billion through the Bill and Melinda Gates Foundation, which funds global health initiatives, particularly vaccine research aimed at preventing infectious diseases, such as polio,[3435] Noting that children from low-income families have twice as many cavities and often miss school because of dental-related diseases, P&G invested $1 million a year to set up "cavity-free zones" for 3.3 million economically disadvantaged children at Boys and Girls Clubs nationwide. In addition to giving away toothbrushes and toothpaste, P&G provided educational programs on dental hygiene. At some locations, the company even maintained clinics providing affordable oral care to poor children and their families.[3839] Proctor & Gamble recently commited to provide more than two billion liters of clean drinking water to adults and children living in poverty in developing countries. The company believes that this initiative will save an estimated ten thousand lives.[41]

Key Takeaways

- **Corporate social responsibility** refers to the approach that an organization takes in balancing its

29. arget Brands Inc., "Target Gives Back over $2 Million a Week to Education, the Arts and Social Services," http://target.com/target_group/community_giving/index.jhtml (accessed August 15, 2011).
30. [31]
31. Jennifer Barrett, "A Secret Recipe for Success: Paul Newman and A. E. Hotchner Dish Up Management Tips from Newman's Own," *Newsweek*, November 3, 2003, http://www.highbeam.com/doc/1G1-109357986.html (accessed January 22, 2012); Paul Newman, "Our Story," Newman's Own Web site, http://www.newmansown.com/ourstory.aspx (accessed August 15, 2011).
32. [33]
33. "Environmental Internships," Patagonia Web site, http://www.patagonia.com/us/patagonia.go?assetid=1963 (accessed August 15, 2011).
34. "
35. [36] in undeveloped countries.[37]
36. 2011 Annual Letter from Bill Gates," Bill and Melinda Gates Foundation, http://www.gatesfoundation.org/annual-letter/2011/Pages/home.aspx (accessed August 15, 2011).
37. Dan Ackman, "Bill Gates Is a Genius and You're Not," *Forbes.com*, July 21, 2004, http://www.forbes.com/2004/07/21/cx_da_0721topnews.html (accessed January 22, 2012)
38.
39. [40]
40. Philip Kotler and Nancy Lee, "Best of Breed," *Stanford Social Innovation Review*, Spring 2004, 21.
41. "[42]
42. Social Responsibility, P&G Children's Safe Drinking Water Program," Proctor & Gamble Web site, http://www.pg.com/en_US/sustainability/social_responsibility/childrens_safe_water.shtml (accessed August 15, 2011).

responsibilities toward different stakeholders when making legal, economic, ethical, and social decisions.

- Companies are socially responsible to their various stakeholders—owners, employees, customers, and the communities in which they conduct business.
- Owners invest money in companies. In return, the people who manage companies have a responsibility to increase the value of owners' investments through profitable operations.
- Managers have a responsibility to provide owners and other stakeholders with accurate, reliable financial information.
- They also have a **fiduciary responsibility** to safeguard the company's assets and handle its funds in a trustworthy manner.
- Companies have a responsibility to guard workers' safety and health and to provide them with a work environment that's free from sexual harassment.
- Businesses should pay appropriate wages and benefits, treat all workers fairly, and provide equal opportunities for all employees.
- Many companies have discovered the benefits of valuing diversity. People with diverse backgrounds bring new talents and fresh perspectives, and improve a company's ability to serve an ethically diverse population.
- Sellers are responsible—both ethically and legally—for treating customers fairly. Consumers have certain rights: to use safe products, to be informed about products, to choose what to buy, and to be heard.
- Companies also have a responsibility to the communities in which they produce and sell their products. The economic impact of businesses on local communities is substantial. Companies have the following functions:

    1. Provide jobs
    2. Pay taxes
    3. Support local education, health, and recreation activities
    4. Donate funds to community projects
    5. Encourage employees to volunteer their time
    6. Donate equipment and products for a variety of activities

EXERCISES

1. Nonprofit organizations (such as your college or university) have social responsibilities to their stakeholders. Identify your school's stakeholders. For each category of stakeholder, indicate the ways in which your school is socially responsible to that group.
2. **(AACSB) Communication**
   Pfizer is one of the largest pharmaceutical companies in the United States. It's in the business of discovering, developing, manufacturing, and marketing prescription drugs. While it's headquartered in New York, it sells products worldwide, and its corporate responsibility initiatives also are global. Go to the Pfizer Web site (http://www.pfizer.com/responsibility/global_health/global_health.jsp) and read about the firm's global corporate-citizenship initiatives (listed on the left sidebar). Write a brief report describing the focus of Pfizer's efforts and identifying a few key programs. In your opinion, why should U.S. companies direct corporate-responsibility efforts at people in countries outside the United States?

Read this section. The strategy pursued by an organization has a distinct impact on the way that the organization chooses to operate. The five steps of strategy are crucial in the design of the operations.

STRATEGIC MANAGEMENT[43]

Strategic management entails five steps: analysis, formation, goal setting, structure, and feedback.
Identify the five general steps that allow businesses to develop a strategic process

Key Takeaways

- Strategic management analyzes the major initiatives, involving resources and performance in external environments, that a company's top management takes on behalf of owners.
- The first three steps in the strategic management process are part of the strategy formulation phase. These include analysis, strategy formulation, and goal setting.
- The final two steps in strategic management constitute implementation. These steps include creating the structure (internal environment) and obtaining feedback from the process.
- By integrating these steps into the strategic management process, upper management can ensure resource allocation and processes align with broader organizational purpose and values.

TERMS

- **implementation**: The process of moving an idea from concept to reality. In business, engineering, and other fields, implementation refers to the building process rather than the design process.
- **objectives**: The goals of an organization.

Strategic management analyzes the major initiatives, involving resources and performance in external environments, that a company's top management takes on behalf of owners. It entails specifying the organization's mission, vision, and objectives, as well as developing policies and plans which allocate resources to drive growth and profitability. Strategy, in short, is the overarching methodology behind the business operations.

FIVE STEPS OF STRATEGIC MANAGEMENT

As strategic management is a large, complex, and ever-evolving endeavor, it is useful to divide it into a series of concrete steps to illustrate the process of strategic management. While many management models pertaining to strategy derivation are in use, most general frameworks include five steps embedded in two general stages:

Formulation

1. *Analysis* – Strategic analysis is a time-consuming process, involving comprehensive market research on the external and competitive environments as well as extensive internal assessments. The process involves conducting Porter's Five Forces, SWOT, PESTEL, and value chain analyses and gathering experts in each industry relating to the strategy.

43. Boundless: Management: "Chapter 12, Section 4, Part 1: Strategic Management"

2. *Strategy Formation* – Following the analysis phase, the organization selects a generic strategy (for example, low-cost, differentiation, etc.) based upon the value-chain implications for core competence and potential competitive advantage. Risk assessments and contingency plans are also developed based upon external forecasting. Brand positioning and image should be solidified.
3. *Goal Setting* – With the defined strategy in mind, management identifies and communicates goals and objectives that correlate to the predicted outcomes, strengths, and opportunities. These objectives include quantitative ways to measure the success or failure of the goals, along with corresponding organizational policy. Goal setting is the final phase before implementation begins.

Implementation

1. *Structure* – The implementation phase begins with the strategy in place, and the business solidifies its organizational structure and leadership (making changes if necessary). Leaders allocate resources to specific projects and enact any necessary strategic partnerships.
2. *Feedback* – During the final stage of strategy, all budgetary figures are submitted for evaluation. Financial ratios should be calculated and performance reviews delivered to relevant personnel and departments. This information will be used to restart the planning process, or reinforce the success of the previous strategy.

7.1 WHO IS RESPONSIBLE FOR STRATEGY DEVELOPMENT?

Boards are being urged to play a more active role in strategy formulation. If evaluating the quality of management's strategic and business plans, including the likelihood of realizing the intended results, is a key board responsibility, so the argument goes, should it not determine for itself whether the company has the capacity to implement and deliver? It is a good but tricky question. How might a board do this? What, for example, should a board do if management presents a bold plan for spinning off or acquiring strategic assets worldwide? Assume that the logic is consistent, that the plan makes sense, that the numbers look good, and that management has a convincing answer for every tough question asked by the board. Has the board met its fiduciary responsibility or should it seek an independent opinion to "audit" the strategic assumptions made by management and its consultants? After all, directors do not have the equivalent time and resources to review the details of strategies presented to them.

A strong argument can be made that if the board feels compelled to retain outside experts to review corporate strategy, it probably has lost confidence in the CEO and should simply fire him or her. Conversely, one can argue that hiring outside consultants is the most cost-effective way for the board to prove its independence and positively challenge top management. Which is it?

In attempts to provide guidance on this issue, numerous "codes of best practice" have been proposed in recent years urging boards to define their responsibilities with respect to strategy development as

- setting the ultimate direction for the corporation;
- reviewing, understanding, assessing, and approving specific strategic directions and initiatives;
- assessing and understanding the issues, forces, and risks that define and drive the company's long-term performance.[44]

As the simple example above demonstrates, however, reality is considerably more complex. Traditionally, boards have become involved in strategy mainly when there were specific reasons for them to do so. The most common

44. Bart (2004), pp. 111–125.

are the retirement of an incumbent CEO, a major investment decision or acquisition proposal, a sudden decline in sales or profits, or an unsolicited takeover bid. In recent years, however, as regulatory and other pressures increased, many boards have sought to become more deeply involved and create an ongoing strategic role, for example, by participating in annual strategy retreats or through the CEO performance evaluation process. Still, in most companies even today boards limit their involvement to approving strategy proposals and to monitoring progress toward strategic goals; very few participate in shaping and developing the company's strategic direction.

There are a number of reasons for this. First, there is a longstanding concern on the part of both executives and directors regarding where to draw the line between having directors involved through contributing ideas about the company's strategic direction and having directors who try to manage the company.[45] Specifically, there is a widely shared belief that strategy formulation is fundamentally a management responsibility and that the role of the board should be confined to making sure that an appropriate strategic planning process is in place and the actual development—and approval—of strategy is left to the CEO. Even those who do favor greater director involvement in strategy say that the degree of involvement should depend on the specific circumstances at hand. A significant acquisition proposal or a new CEO, for example, may indicate the needs for greater board involvement.

Second, in the aftermath of the Enron and other governance scandals, many boards had to focus on internal issues and on digesting the new accounting compliance rules of the landmark Sarbanes-Oxley Act. In a number of companies, this turning inward has had the undesirable side effect that the board's decision making has become so focused on compliance issues that strategic considerations have taken a backseat.

Third, some CEOs simply do not want their boards involved in strategy discussions; they view the board's engagement in developing strategy as interference into their managerial responsibilities and a threat to their sense of personal power. Of course, the downside of this posture is that the board may not fully understand or buy into the organization's strategy and that board talent is underutilized. Taking this approach sometimes backfires on CEOs when formerly disengaged boards become overengaged and then make their CEOs "walk through fire" on tactics.

Fourth, there is the delicate question of how knowledgeable even the most capable directors are to assist with strategy development. Most are quite effective in dealing with short-term financial data. Strategy development, however, also demands a detailed understanding of more future- and long-term oriented issues, such as changing customer preferences, competitive trends, technological developments, and the firm's core competencies. A typical board of directors is poorly designed and ill-equipped for this task. According to a recent McKinsey survey, more than a quarter of directors have, at best, a limited understanding of the current strategy of their companies. Only 11% claim to have a complete understanding. More than half say that they have a limited or no clear sense of their companies' prospects 5 to 10 years down the road. Only 4% say that they fully understand their companies' long-term position. More than half indicate that they have little or no understanding of the 5 to 10 key initiatives that their companies need in order to secure the long-term future.[46]

Finally, while board meetings are conducive to questioning specific strategic assumptions and monitoring progress toward strategic goals, they are not a good forum for the more creative, elaborate, and nonlinear process of crafting strategy. Board discussions tend to focus on the implementation and tactics of an ongoing strategic direction. Revealing serious reservations about the underlying strategic assumptions sometimes not only is seen as distracting and inappropriate but also may be interpreted as a vote of no confidence in the current management.

The bottom line is that carving out a significant role for the board in strategy formulation is extremely difficult. First, as we have seen, there is the nature of the strategy development process itself. Characterizing a board's involvement in strategy on a continuum from "passive" to "active" is a dangerous oversimplification. A passive

45. Lorsch (1995, January–February).
46. [47]
47. Felton and Fritz (2005).

posture assumes that strategic decisions are both separate and sequential, that managers generate options that boards choose from, and that managers then implement the chosen option and boards evaluate the outcomes. An active conception assumes that boards and management formulate strategy in a partnership approach, that management then implements and both groups evaluate. In reality, strategic decisions often evolve through complex, nonlinear, and fragmented processes. What is more, a board can be actively involved in strategy without being involved in its formulation. For example, a board can "shape" strategy through a process of influence over management in which it guides strategic thinking but never actually participates in the development of the strategies themselves.[48]

Second, as noted, certain situations dictate a more influential strategy role for the board than others. For example, at times of crisis, such as a sudden decline in performance, a new CEO, or some other major organizational change, boards tend to become more actively involved in strategy. Other determinants of the degree of board engagement in strategy issues include firm size; the nature of the core business; directors' skills and experience; board size; occupational diversity; board tenure and board member age; board attention to strategic issues; and board processes, such as the use of strategy retreats, prior firm performance, and the relative power between the board and the chief executive officer, particularly in terms of board involvement in monitoring and evaluating this position. External factors include the concentration and level of engagement of the firm's ownership and the degree of environmental uncertainty.[50]

Third, as a consequence of recent governance reforms that focused on making boards more independent, many now lack directors with relevant industry expertise to participate effectively in shaping strategy—much less to reshape it in an increasingly fast-paced business climate. In the current post-scandal governance climate, even as the business landscape is becoming more complex, many boards continue to give priority to compliance-oriented appointments rather than visionary ones.[52]

Finally, there are the ever-present constraints on time and knowledge. To become meaningfully engaged in strategy formulation, boards must become much more efficient, particularly since their time has already been stretched in recent years: The average commitment of a director of a U.S.-listed company increased from 13 hours a month in 2001 to more than twice that today, according to Korn/Ferry.[54] Directors also need to become far more knowledgeable and proactive about grasping the company's current strategic position and challenges more clearly. To understand the long-term health of a company, directors must pay attention not only to its current financials but also to a broader range of indicators: market performance, network positioning, organizational performance, and operational performance. Similarly, a broader appreciation of risk—including credit, market, regulatory, organizational, and operational risk—is vital. Without this knowledge, directors will have only a partial understanding of a company. While boards receive and discuss all sorts of "strategic information," financial measures—probably the least valuable component of a board member's strategic information requirements—still dominate. Even with better information, time constraints may prevent a broader role for the board. Boards typically perform their strategic governance role in the course of a couple of hours at every third board meeting—annually supplemented by a 2-day strategy retreat. A more active role in strategy development requires much more time.

Despite these difficulties, Nadler (2004) argues that companies should try hard to create a meaningful role for their boards in the strategy development process. The key is to create a process in which directors participate in strategic thinking and strategic decision making but do not infringe on the CEO's and senior executive team's

48. [49]
49. de Kluyver and Pearce (2009), chap. 1.
50. [51]
51. Bart (2004).
52. [53]
53. Carey and Patsalos-Fox (2006).
54. [55]
55. Korn/Ferry (2007).

fundamental responsibilities. In such a process, the CEO and management should lead and develop strategic plans with directors' input, while the board approves the strategy and the metrics to assess progress. The direct benefits of such an engagement are many, including a *deeper understanding* by directors of the company and its strategic environment, a *sense of ownership* of the process and the resulting strategy, *better decisions* reflecting the broader array of perspectives, *greater collaboration* between the board and management on other initiatives and decisions, *increased board satisfaction*, and *more effective external advocacy*[5657]

But, as Nadler notes, while the benefits can be significant, broader board participation in strategy development also has costs. First, directors must have a thorough understanding of the company—its capital allocation, debt levels, risks, business unit strategies, and growth opportunities, among many issues—and that takes time and commitment. Importantly, they must engage management on the major challenges facing the company and have a firm grasp on the trade-offs that must be made. A second potential cost is that increased board participation can result in less management control over outcomes. Real participation means influence, and influence means the ability to change outcomes. A well-designed process yields the benefits of participation while limiting the amount of time and potential loss of control.[59]

Building and Managing the Strategic Architecture

OVERVIEW

We now have everything we need to develop and use a complete picture of your organization's performance. This chapter will show you the following:

- **how to assemble a complete strategic architecture of your business** involving performance, resources, flows, and interdependences
- **how to use this architecture** to manage the system, understanding past performance, likely developments, and alternative possibilities
- **how to control performance into the future**

Remember the strategy challenges that we highlighted in Chapter 1. These were:

- *Why* has performance followed the path that it has?
- *Where* is it going if we carry on as we are?
- *How* can we change it for the better?

Now that you understand the way a system of resources works, you are in a position to answer these questions in detail.

BUILDING THE STRATEGIC ARCHITECTURE

Why Has Performance Followed a Particular Path?

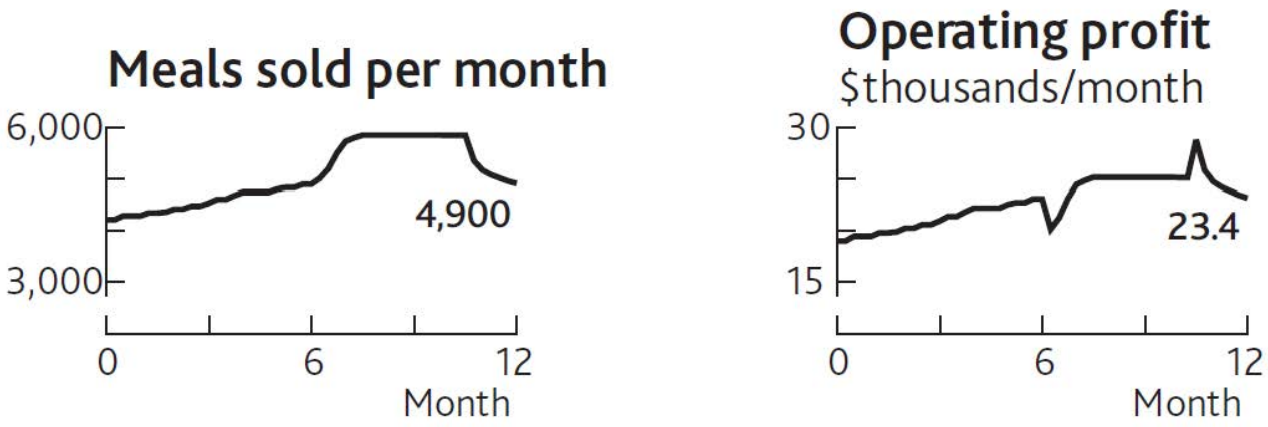
Earlier chapters have given us all the elements we need to develop a complete picture of our business, together with the information that explains why it has performed as it has up to now. These pieces are as follows:

56. .[58]
57.
58. Nadler (2004).
59. [60]
60. Nadler (2004).

- **the time chart of one or more performance measures** (e.g., profits, sales, service levels), with scale and timing
- **the list of likely resources involved** (e.g., customers, clients, staff, products, services, cash, capacity)
- **the chain of immediate causes for that performance**, often with simple arithmetical relationships (e.g., gross margin, revenue, labor costs, customer demand)
- at the head of those causal chains, **the resources driving demand, supply, and performance** (e.g., customers, staff, products, services, cash)
- **the flows of resource** (e.g., customers won and lost per month; staff hired, promoted, or leaving per month; products added or discontinued per year) into, through, and out of the organization's system
- **the immediate causes of these rates of flow**, whether your own decisions or other factors
- **the dependence of each resource flow on existing resources**, either for the same resource or others

To illustrate these stages, let us go back to the performance of your restaurant that you wanted to understand before deciding what to do next. Start by pulling the pieces together.

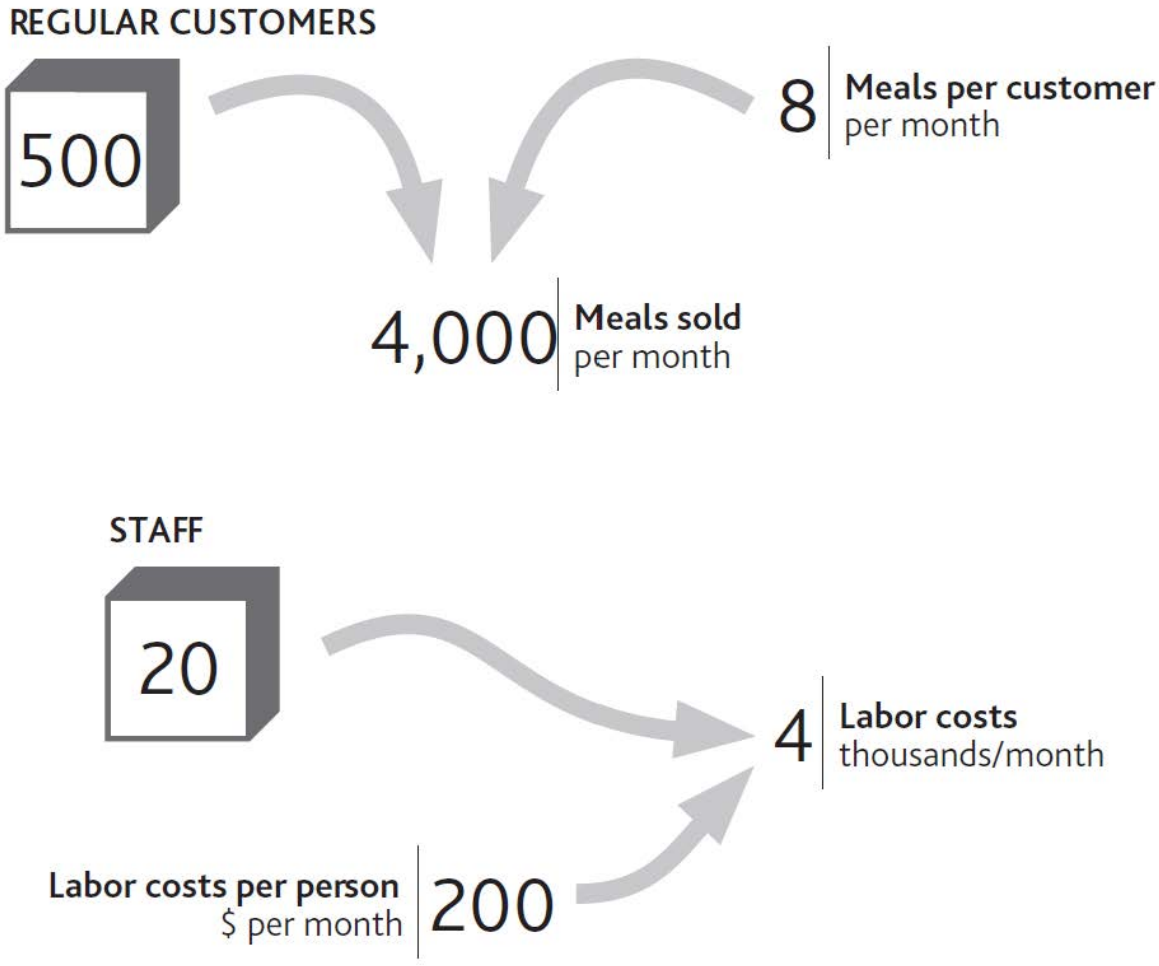
1. The time chart of one or more performance measures, with scale and timing (Figure 1.4 "Restaurant Performance Example").



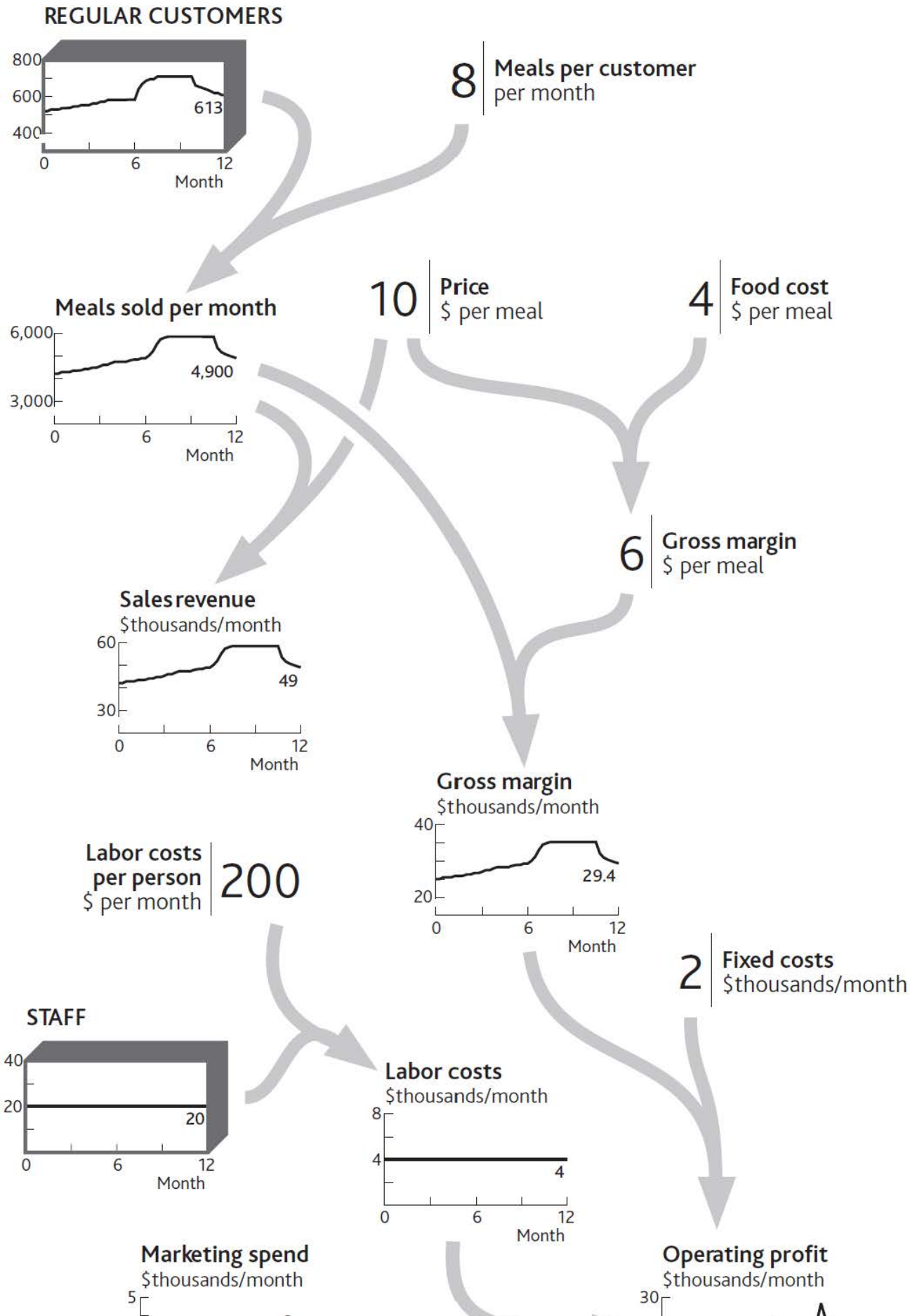
2. The list of likely resources involved. (Note: Not all of these may be needed to tackle a specific challenge. Subsequent stages will identify those that *are* involved.)

Resource	Measure
Regular customers	People
Staff	People
Menu	Items
Capacity	Seats
Cash	$

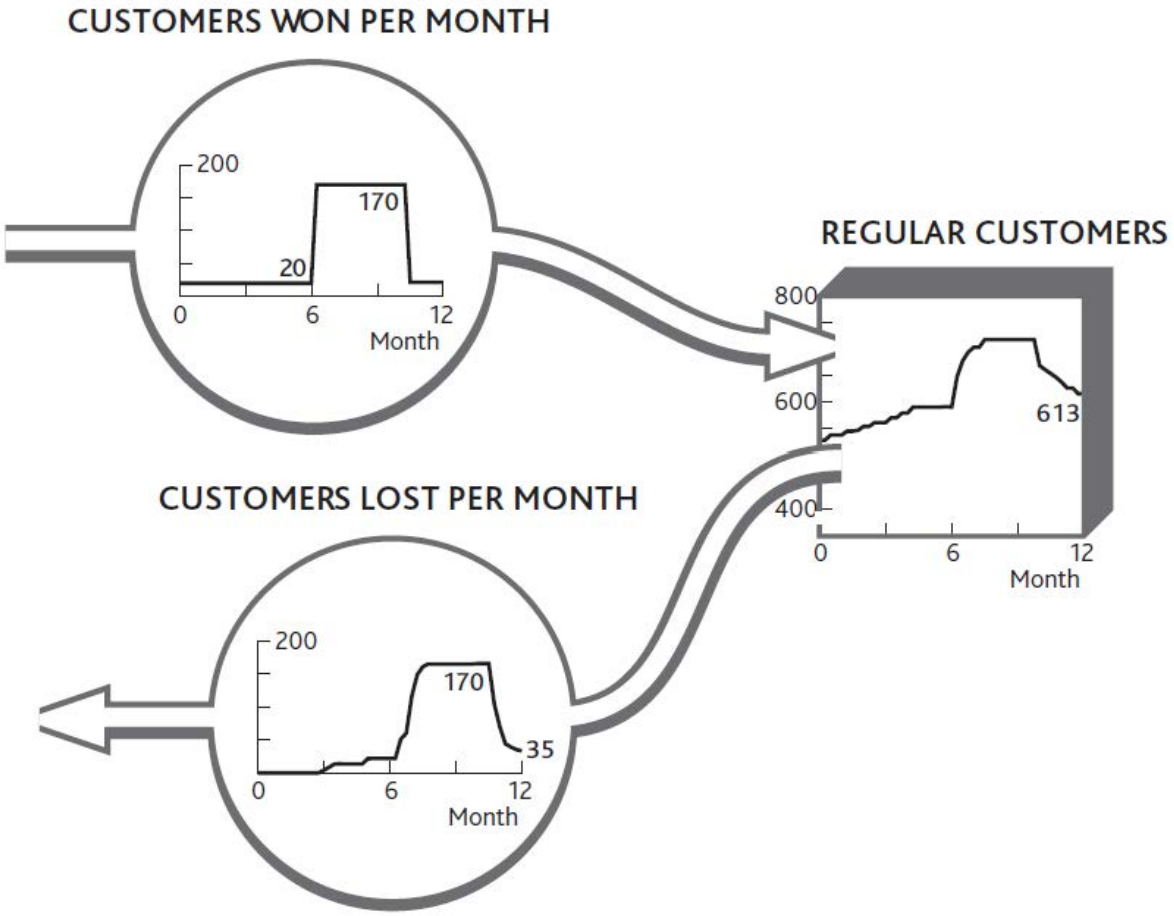
3. The immediate causes of that performance (Figure 2.1 "The Explanation for Restaurant Sales and Labor Costs").



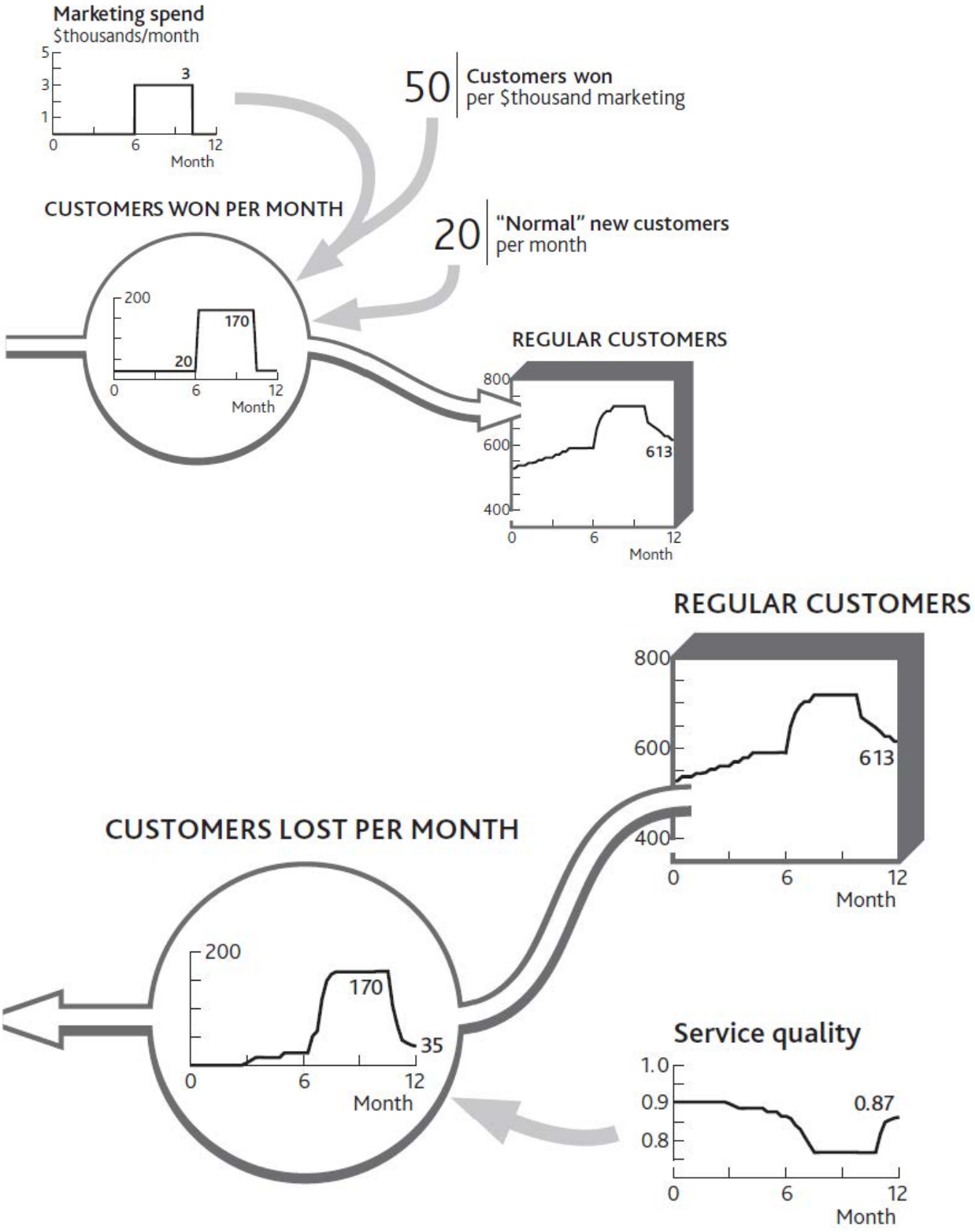
4. The resources driving demand, supply, and performance (Figure 2.2 "Your Restaurant's Resources and Operating Profits").


REGULAR CUSTOMERS
800
600
400
613
0
6
12
Month
8
Meals per customer
per month
Meals sold per month
6,000
3,000
4,900
0
6
12
Month
10
Price
$ per meal
4
Food cost
$ per meal
6
Gross margin
$ per meal
Sales revenue
$thousands/month
60
30
49
0
6
12
Month
Gross margin
$thousands/month
40
20
29.4
0
6
12
Month
Labor costs
per person
$ per month
200
2
Fixed costs
$thousands/month
STAFF
40
20
20
0
6
12
Month
Labor costs
$thousands/month
8
4
4
0
6
12
Month
Marketing spend
$thousands/month
5
Operating profit
$thousands/month
30

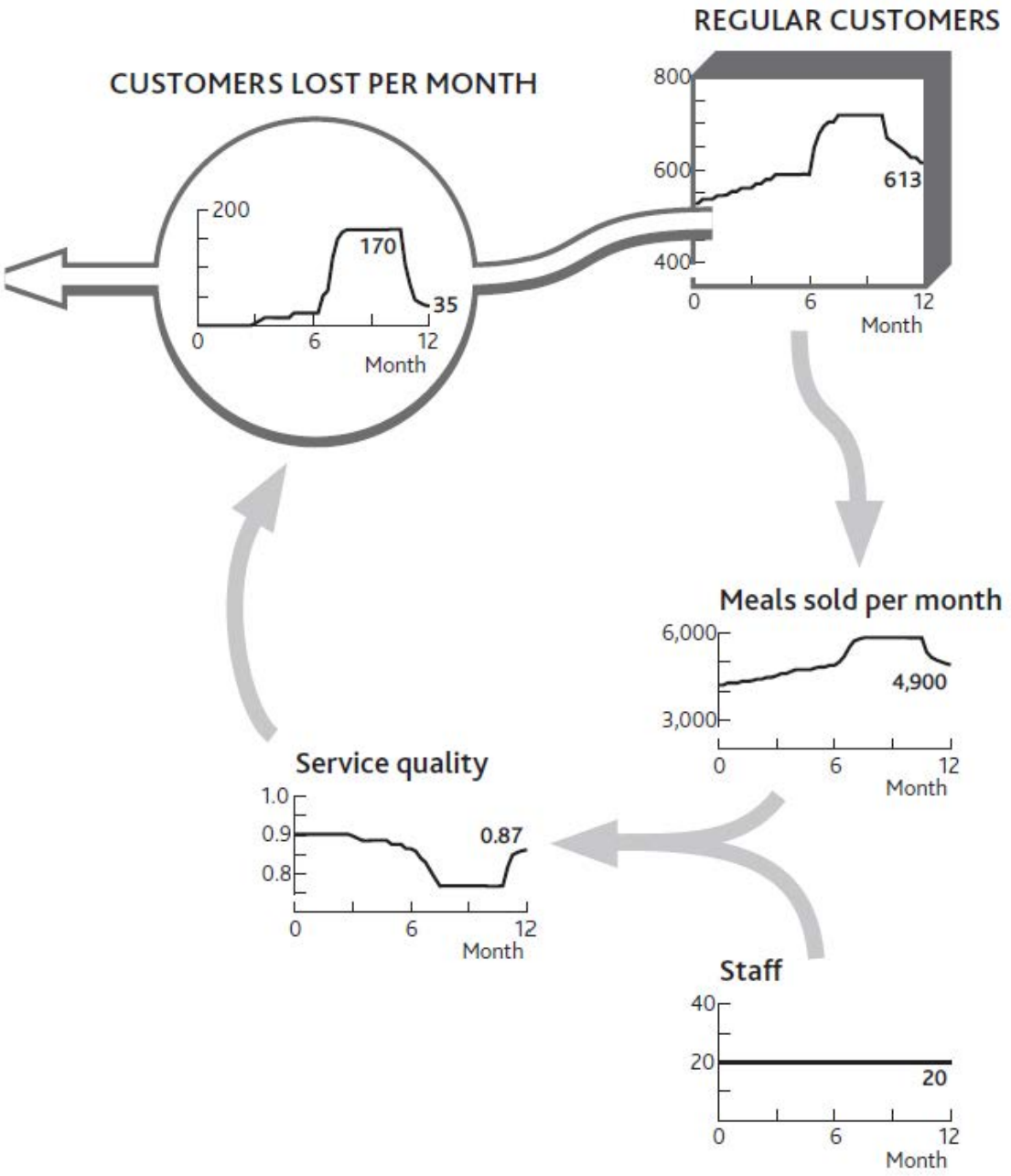
5. The flows of resources into, through, and out of the organization's system (Figure 3.6 "The Separate Flows of Customers Into and Out of Your Regular Customer Group").



6. The immediate causes for these flows to be running at the rate they are (a) why customers are being won (Figure 4.1 "Marketing Decisions Change the Inflow of Customers" shows the "normal" rate at which new customers arrive, plus those won from your marketing spending). (b) why customers are being lost (extended version of Figure 4.8 "The History of Service Quality and Customer Losses").



7. The dependence of each flow on *existing* resource levels (Figure 4.9 "Why Service Quality Suffered Then Recovered").



Doing It Right: Do Not Try to Do Everything

Figure 5.1 "The Strategic Architecture of Your Restaurant, With Data Explaining Recent Performance" is far from a *complete* architecture of your restaurant. It does not, for example, include certain resources, such as the menu or the seating capacity. Nor does it include potentially important factors that could drive changes in performance, such as price or competitors' actions. The best approach is to include as much of the architecture as is necessary to create a plausible explanation of performance over time.

This needs great care!

- First, do not do unnecessary work, such as collecting data on things that are not relevant. Keep the

pictures to a minimum, so you can show people what is happening and why.

- Conversely, check you do not leave out factors that are (or could be) important. This is especially tricky when looking forward rather than just trying to explain the past.
- Finally, when you have an architecture that explains performance, ask whether you have missed anything that may be important to the question you set out to answer.

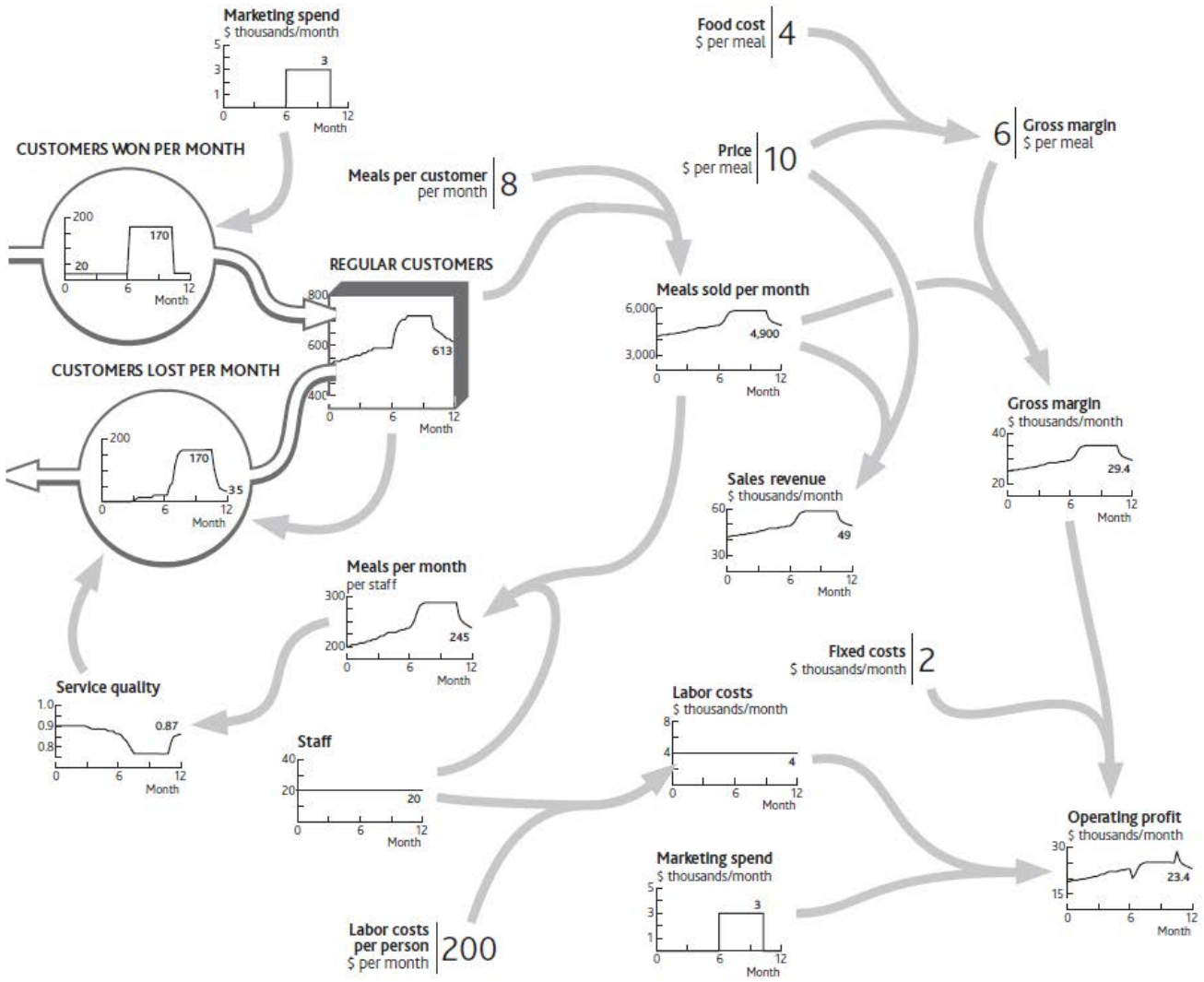


Figure 5.1 The Strategic Architecture of Your Restaurant, With Data Explaining Recent Performance

These elements connect together to provide a complete explanation of recent performance and future challenges (Figure 5.1 "The Strategic Architecture of Your Restaurant, With Data Explaining Recent Performance").

5.2 USING THE ARCHITECTURE

How Have We Come to This Position?

A strategic architectureA tool used to resolve specific issues and guide the performance of an entire strategy.

The strategic architecture should be focused on flow rates. provides a living reference for a firm's structure and behavior. A critical part of top management's job is to understand that structure, ensure that it is well designed, and steer its performance (Keough & Doman, 1992). Diagrams such as Figure 5.1 "The Strategic Architecture of Your Restaurant, With Data Explaining Recent Performance" are a common way of understanding and controlling complex systems. Even if you have never visited a chemicals plant or power station, flown an aircraft, or managed a rail network, you will have seen pictures of "control panels" that give management continuous information on the states of key variables. Their control panels *look like* the system they are managing.

We are trying to achieve the same analog-style diagram for your organization. To make best use of such a picture, you need to have it available and accessible to your whole team, perhaps on a large wallboard in the main meeting room. It may be helpful to have other diagrams in other meeting rooms to show more detail about the architecture of key parts of the system: a diagram of customer segment details in the marketing area, a diagram of people flows in the human resource (HR) department, and so on.

You may not get it right the first time. However, any inaccuracies will become apparent as you learn whether the relationships you have sketched between the connected data provide a good explanation of what is happening. If not, you can readily identify what may be missing or inaccurate and revise the architecture diagram accordingly.

A well-developed strategic architecture is a powerful tool, both to resolve specific issues and to guide the performance of the entire enterprise strategy. To understand this, consider a rather more extensive example than your restaurant: the architecture of a low-fare airline (similar to Ryanair, which is featured in Chapter 2 "Resources: Vital Drivers of Performance"). Figure 5.2 "Growth Slowdown for a Low-Fare Airline" shows the first 2 years of operation, followed by a possible 3-year future, denoted by the dotted portion of the lines.

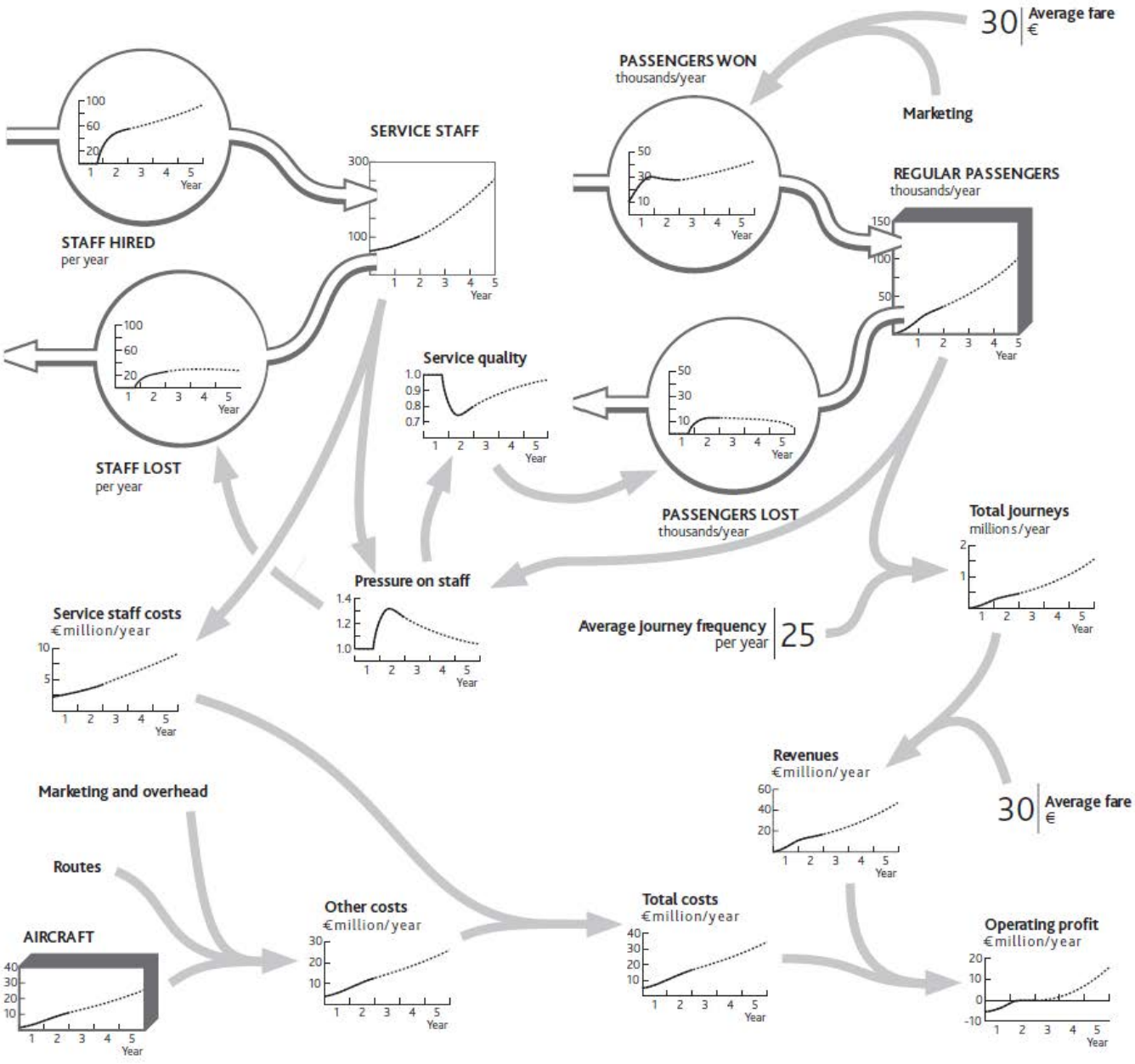


Figure 5.2 Growth Slowdown for a Low-Fare Airline

Doing It Right: Whole Numbers

The chart for aircraft in this example shows a smooth line, even though this resource comes in batches; operating 7.5 planes, as it seems you did at one point in year 2, does not make sense. Strictly, we should have a stepped chart over time for aircraft, with a jump to a new number each time a batch of ordered aircraft is received. But for a strategic view of what is happening you do not need to worry about this picky detail.

It looks complicated, but if you take it in sections, you can see how the stages come together:

- Issues of concern by the end of year 2 are operating profit (bottom right), which seems to have stalled, and total journeys (middle right), where growth has slowed.

- The core resources are aircraft, passengers, and staff (routes, too, but we can add these later).
- The immediate factors driving operating profits can be traced back through revenues to total journeys, and through total costs to staff and other cost drivers (in practice, these would be split further).
- The flows of resources into, through, and out of the organization's system are the gains and losses of passengers, the hiring and loss of staff, and the acquisition of planes. Since buying and selling planes is a simple decision, directly under management control, we do not need to show that on the diagram.
- The problematic flows are the loss of passengers, which appears to be due to a sharp drop in service quality, and the loss of staff, which arose from a steep increase in work pressure.
- The pressure on staff appears to be due to the imbalance between passenger volumes and staff numbers.
- The entire picture explains recent history. Growth in passengers and journeys exceeded the staff's ability to cope, causing them to leave and thus damaging service quality, which in turn increased the loss of passengers.

Valuable insights can arise simply from the team activity involved in developing this picture, as it will typically prompt substantial debate and analysis. Two elements will ensure that insights are accurate and address the correct issues:

- The time charts for core resources, flow drivers, and performance keep discussion focused on the best-known facts of the situation. Do not give up if you do not know precise data; instead, estimate what the facts *might* have been, then use judgment to fill in unknowns. For example, you may not have records of staff attrition rates, but if you know hiring rates and total staff numbers, the history of attrition is easy to calculate.
- You will have quantified how each resource flow depends on the factors driving it. Again, if you do not know for sure what is happening, think through your best explanation and check that it fits with the facts. Do not tolerate unsubstantiated assertions like "Everyone knows staff are leaving because our competitor offers better pay" unless there is factual evidence to back it up.

WHERE IS PERFORMANCE HEADING IF WE GO ON LIKE THIS?

Figure 5.2 "Growth Slowdown for a Low-Fare Airline" goes further than explaining recent history. It sketches out the team's best estimate of where performance is heading into the future. The dashed lines show the estimate that you and your team came up with about the way things are likely to develop if you continue with present policies.

You will continue running a tight operation. This means continuing to hire staff at a steady rate. They may be under pressure, and service quality may not be great, but the business is satisfactory, passengers and journeys are growing, and your company is profitable. You expect that by increasing staff numbers ahead of growth in passengers and journeys, you will gradually bring down the pressure on your staff. In time, service quality will recover enough to slow the loss of passengers and overall growth will pick up.

HOW CAN WE ACT TO IMPROVE FUTURE PERFORMANCE?

The strategic architecture you develop will enable your team to evaluate a range of possible future strategies—the final stage of the process. You again need an organized approach:

- Start with the points in the business architecture where step 6 showed the challenge to lie: where flows are not running as you would like.
- Focus on the links into that part of the architecture that management can influence. For the airline in Figure 5.2 "Growth Slowdown for a Low-Fare Airline", these would be price changes, marketing, and hiring.
- Estimate the scale of policy revision and the likely scale and timing of its results. For example, if you cut fares by 10%, how much would the passenger win rate change? If you double the hiring rate, how quickly will staff numbers rise to your target level?
- Follow the consequences of these policy changes. If you cut fares and bring in more passengers, how much will this change total journeys and pressure on staff? How much impact will *this* have on passenger losses and staff turnover? If you boost hiring, how much will *that* change pressure on staff, and what impact will *that* have on passenger losses and staff turnover?
- Anticipate any issues that might arise from altering the part of the system where the current problem is focused. Cutting your fares will clearly cut revenue per journey, and increasing staff will increase costs, both resulting in a short-term *drop* in profits. How long will it take before the improved resource flows you stimulated work through to generate revenues and profit improvements that overcome this short-term penalty?
- Finally, work through how any performance outcomes might evolve over time because of the proposed changes. The cut in fares might very quickly bring in more passengers and boost revenues and profits, although the *further* consequence would be increased workloads for staff, faster passenger losses, and hence a later decrease in passengers, journeys, revenues, and profits. Alternatively, increasing hiring should reduce the pressure staff are under, reduce turnover, improve service quality, and cut passenger losses, thus increasing total passengers even if there is no change in passenger win rates. More passengers means more journeys and revenues, which will more than pay for the higher staff costs.

Let us work through an example. One of your colleagues believes that poor service quality is unacceptable: It risks building up a poor reputation among potential passengers, which could hurt future growth. This colleague feels you should immediately hire enough staff to remove the overload.

Together, your team works through what might happen (Figure 5.3 "Relieving Staff Pressure to Improve Service", heavy dotted lines). One risk in the proposed solution is that these newcomers will not know what they are doing at first, so they will be deployed on simple tasks, and hiring rates can be reduced for a while so they can acquire more skill. Your colleague feels that this simple step will immediately relieve some of the pressure and give your people the ability to improve service quality quickly—especially if you tell them that this is your plan!

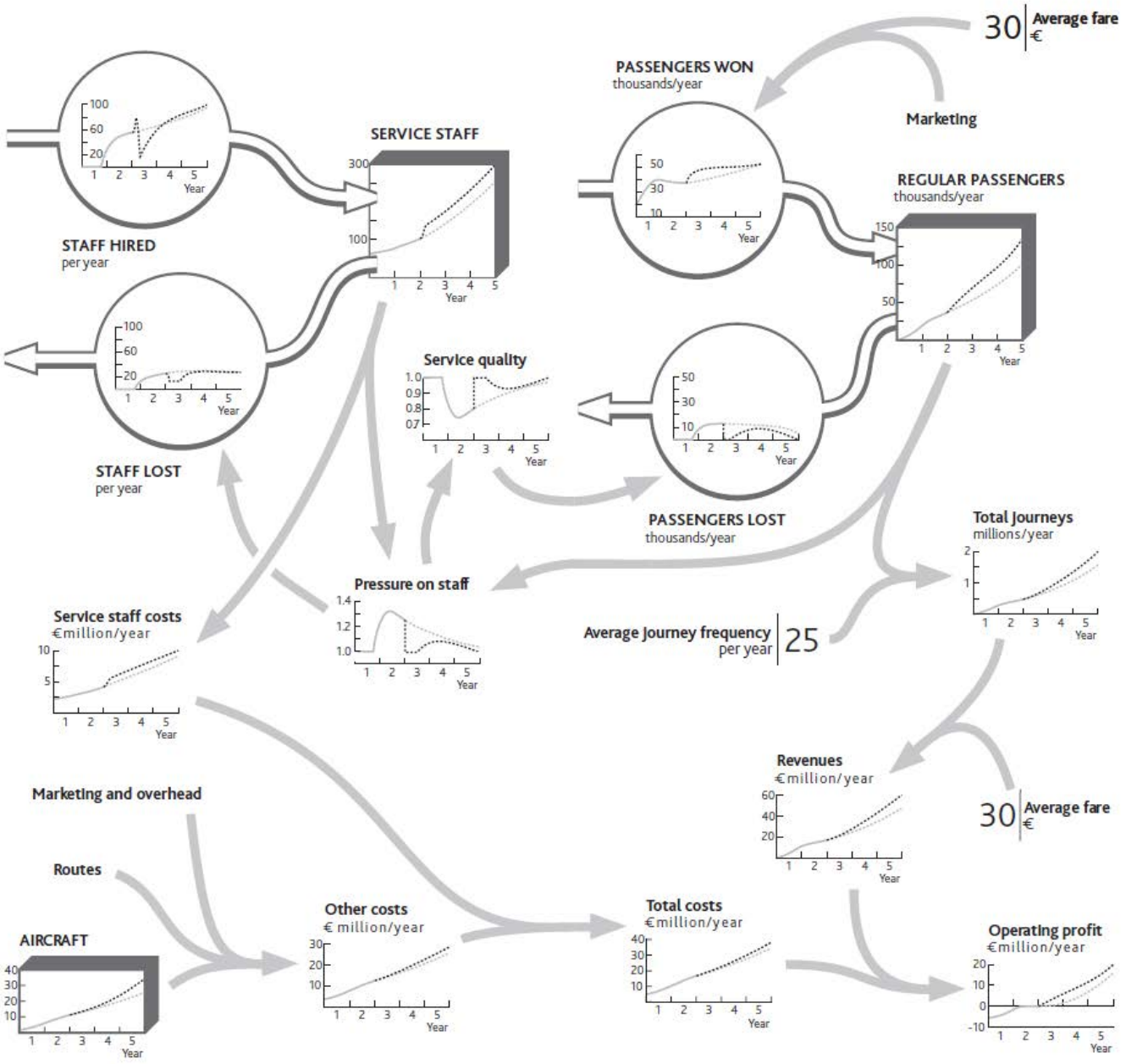


Figure 5.3 Relieving Staff Pressure to Improve Service

You are reasonably confident that the improvements to workload and quality will materialize, so you estimate that passenger growth will accelerate once more, provided you continue adding routes and aircraft. You feel there is a small risk that this will again put staff under pressure some time during year 3. You resolve to keep track of this issue and revisit the hiring policy if it looks as though the problem is recurring.

5.3 TAKE CONTROL: LOOKING FOR FIXES

The airline's one-off hiring effort is just one example of a management response to improve performance. There are other common types of response, and it is important to look for and evaluate these in the right order, otherwise you risk undermining one fix by missing unintended consequences:

Minimize Leakages in the Resource System

Many organizations focus on cost-effectively acquiring resources and building them but pay much less attention to keeping them. However, there is little advantage in trying to increase the stock of resources in the system if the organization simply loses them again. Too often, customers are won, only to be lost again by poor products or service; staff are hired and trained, only to leave again for any of a host of reasons; new brands are established, only to become uncompetitive as the excitement of the launch fades; distribution agreements are set up, but stall when the company proves unable to sustain the relationship. Of course, there may be situations where the organization has good reason to reduce resources deliberately: for example, cutting back on sales efforts as you progress toward fully exploiting a market opportunity.

Improve Resource Acquisition and Development

Once you have ensured there are no leaks in your bath, you can think about filling it!

- Examine each resource inflow, ensuring that other necessary resources, mechanisms, and policies are in place to enable growth. Is the marketing budget sufficient to reach potential customers to make the desired win rate feasible? Is the product's functionality adequate to win customers and are the production, delivery, and installation resources in place to turn orders into completed sales? Is the hiring and training capacity in place to bring in staff at the rate required and make them productive quickly?
- Apply the same principle to ensure that existing resources, mechanisms, and policies are in place to allow resource *development* to occur: turning prototype products into marketable goods, developing sufficient numbers of experienced people, and so on.

Eliminate Self-Imposed Limits

The development of one resource can be hampered by inadequacies in other resources. The team should therefore examine the strategic architecture, focusing on each resource in turn and ascertaining whether its own growth may cause imbalances that restrict its further progress. A valuable question to trigger insight is, "If we are successful in winning these customers (or finding these staff, or launching these products), what are all the things that could go wrong or get in the way?"

Look for Reinforcing Mechanisms to Drive Growth

Only after steps 1 through 3 have been completed should you turn to the tempting task of finding reinforcing mechanisms to drive growth. By this point it should be safe to look for ways in which existing resources can be leveraged to drive their own growth or that of others. Can you, for example, leverage existing customers and your resulting reputation to drive faster acquisition of *further* new customers or to increase your ability to hire the best people?

Evaluate Step Solutions to Shift the System to a New State

In cases where resource limits and imbalances are serious, it may be impractical or take too long to grow, develop, or reduce the necessary resources. Instead, step changes may be appropriate. These may be limited to actions in a single part of the business or affect many resources simultaneously:

- **Action** may be needed to bring a **single resource into line** with the rest of the system, either as it is or as it is planned to become. Signing up a large new dealership can provide rapid access to a new customer base; licensing products from other firms can quickly fill out a weak product range; and taking on contractors can rapidly relieve staff pressure. Beware, though: Such actions may themselves place new demands on the organization, so make sure they can be absorbed.
- **Larger actions** may be required to take the business to a whole new level, with better balance and stronger growth potential. Acquisition is one of the clearest examples of such a shift for the whole organization and featured strongly, for example, in the growth of Blockbuster Inc. in its drive to become the dominant movie rental business in the United States and other countries. Each acquisition brought a bucket full of new stores, new customers, and new staff, which were assimilated into the established Blockbuster system. On the other hand, rationalization of several parts of a system may be necessary to bring an ineffective organization back to a core of activity that can be sustained into the future. This may entail rationalizing the product range, removing poor-quality customers, reducing capacity, and cutting staff, all in a coherent move over a short period.

Although step solutions are hardly a new approach to improving an organization's performance, a sound architecture of the situation will provide important safeguards for their implementation. Above all, the rest of the system needs to able to absorb the new or increased resource. It may be necessary to develop complementary resources, or at least start them on an increasing trajectory so that they quickly become able to cope with the influx. Without such precautions, the very solution itself may trigger some new resource losses that undermine your hoped-for improvement.

It is common, for example, for staff to resign after new people arrive. Losses may also arise among other resource categories: For example, inward licensing of new products may cause product development staff to become disillusioned and resign, and the opening of new direct customer relationships may cause dealers to defect to rivals.

5.4 MAINTAIN CONTROL: MANAGING THE SYSTEM

A clear picture of the organization's overall performance and underlying strategic architecture provides valuable insights into how decisions should be guided. The first observation is that using financial outcomes to guide decisions is likely to be hopeless. Clearly, the *immediate* consequences must make sense: You do not want to spend what you cannot afford, or price your product so high as to kill current sales or so low as to destroy margin. But this is not *strategic* control.

A simple principle guides how strategic decisions should be viewed: Strategic management **is all about flow rates!**

To appreciate the implications of this view, think about how our airline team might set a rule of thumb for its marketing spending. Some of the possibilities from which to choose include:

- Marketing spending should not exceed a set fraction of revenue.
- If profits dip too low, cut marketing by a fraction.
- Check that marketing does not exceed a specified cost per passenger journey sold.
- Spend more on marketing if planes are not full.
- Spend more on marketing if regular customers are being lost.

However, marketing *directly* affects just two main items: the frequency with which existing passengers travel with your airline and the rate at which new passengers are won. Marketing is not the *only* factor driving these values,

but these values are the only significant things being driven by marketing! These, then, should be the focus of the decision rule for marketing *because they are closely coupled to the decision variable*.

The further you move away from this principle, the more likely it becomes that your decision rule will cause serious problems. It is astonishing, for example, how many organizations stick to "percent of sales" ratios to decide their spending on everything from research and development (R&D) to marketing, training, and maintenance. Just think how this would work for your restaurant:

- Labor cost must not exceed 15% of sales.
- So, if sales fall for some reason, you cut staff.
- So service quality drops, and sales decline.
- So you cut staff again to keep within your 15%!

You become trapped in a cycle of decline. This makes no sense, and in practice, managers usually avoid such foolish consequences. But why *start* with a decision guide that makes no sense in the first place? Pressure from investors who may not understand the structure of the strategic architecture often does not help.

So which performance metrics guide decisions best? Many organizations now use some form of balanced scorecard: an integrated approach to performance measurement and management (Kaplan & Norton, 1996). This recognizes that financial factors alone provide inadequate targets and incentives and so adds measures relating to

- **customers**: satisfaction, retention, market share, and share of business;
- **internal performance**: quality, response times, cost, and new product introductions;
- **learning and growth**: employee satisfaction and availability of information systems.

Only if these additional factors are in good shape will the firm deliver strong financial performance. The balanced scorecard offers important advances over traditional reporting approaches in recognizing the interconnectedness within the business and the importance of measuring and managing "soft" issues. Increasing training of staff about products, for example, will improve sales effectiveness, which in turn will improve sales and margins.

There are limits, though, to the control that a balanced scorecard can achieve if it is not designed to take account of the dynamic interactions that run through the organization's architecture. There are two particularly common failings:

1. What may be good for an indicator under one condition may be bad under other situations. A common example is the winning of new business when the organization cannot cope with what it already has.
2. The optimum balance between different parts of the architecture often shifts substantially as situations develop. Early in the growth of a business, service capacity may need to be a rather minor part of the organization's total activity, but later it can come to dominate as business builds up. Similarly, you may want to keep staff turnover very low when trying to build capability in a rapidly developing organization, but some rate of staff losses may be positively helpful when growth slows in order to make room for new people to develop.

Doing It Right: Avoiding Disappointment With Strategic Architecture

Management techniques often fail or fall from favor not because they are wrong, but because they are not used properly. Superficial work, done in the hope of a quick fix, is a common culprit. The extensive effort required by many otherwise sound methods is often not sustained. As senior managers instruct their people to undertake one

initiative after another, none is carried to fruition before the next is begun. Initiative overload is a common cause of poorly implemented strategies.

Strategy dynamics—the basis of the approach in this book—will not work either if badly applied. It is a powerful but demanding approach that needs to be done professionally and thoroughly if accurate findings and good managerial responses are to be obtained. However, it is not typically more time-consuming or analysis-intensive than many planning processes that organizations put themselves through. Indeed, it often eliminates much activity, data processing, and analysis that would otherwise have been carried out.

Who should do this work? *You and your team*. Continuing management of today's dynamically complex organizations in today's dynamically complex markets and environments is not intuitively easy. For this reason, beware of consultants. Though many excellent professionals can carry out all kinds of demanding analysis and give exceedingly sound advice, few have had a thorough education or training in dynamic analysis. This is a tricky skill, and amateurs will usually get it wrong. Moreover, the need to review your performance dynamics will never go away. You cannot subcontract strategic leadership and you cannot subcontract strategic understanding.

Action Checklist: Building and Managing the Strategic Architecture

The action checklist for this topic was already outlined, so in summary:

- Follow the steps explained in Section 5.1 "Building the Strategic Architecture" to develop the strategic architecture of your organization or for an issue it is facing.
- Using that architecture, follow steps 1 to 5 in Section 5.3 "Take Control: Looking for Fixes" to identify how to enable improved and sustainable performance.

Note that this short book can only provide a summary of how this approach works for some simple business examples. For more extensive guidance on more complex situations, see Warren (2008) and http://www.strategydynamics.com.

CHAPTER 8 STRATEGIC PLANNING AND TEN–TEN PLANNING

To be strategic is to have plans of action that provide directions for operating in an uncertain world. In this section, our focus is on developing strategic plans to compete in a world characterized by monopolistic competition. Notice that the emphasis is on plans of action and not on a single plan. There is no single plan or single planning approach that can deal with the complexity of contemporary markets. What is needed is a continuous process for churning out new plans, for differentiated products and services, in order to compete in a dynamic environment. This chapter presents a brief overview of the various approaches to strategic planning and provides an overview of the planning literature. There is a lot of material to slog through, but each approach to planning has something to offer. This overview will set the stage for presenting the Ten–Ten planning process in the next chapter. The next chapter will integrate the various planning approaches and present a simplified, yet robust approach to planning called the Ten–Ten planning process. The key benefit of the Ten–Ten planning process is that it can be used for developing business plans in a very short time span.

8.1 PLANNING CONCEPTS

There are two generic planning strategies that a business can pursue.[1] It can strive to be efficient, it can differentiate, or both. In other words, a firm can focus on delivering Midas versions of products, Hermes versions of products, or both. A firm that employs a strategy of efficiency strives to be the low-cost producer and compete on the basis of charging less than the other competitors. In contrast, a firm that is competing on the basis of product differentiation can charge premium prices. If charging premium prices yields larger-than-average profits, the market will, of course, attract attentions. Competitors will enter the market with a slightly different product, perhaps even a better product, at a lower price and ultimately drive down the premium prices. The firm will then have to embark on further cost-cutting initiatives, improve their product in order to hold on to market share and survive, or do both. The market is relentless and it demands a two-pronged approach of developing differentiated products and services and cutting costs.

The first mantra of the entrepreneur is “differentiate through innovation or perish” or in simpler terms “differentiate or die.” The second mantra of the entrepreneur is “strive to reduce costs.” The first mantra is accomplished by focusing on Midas versions of products using extravagant engineering and design. Differentiation is not only the engine driving business success under monopolistic competition, but it is also buttressed by attempting to improve costs and product design through frugal engineering. The second mantra is accomplished by focusing on Hermes versions of products using frugal engineering.

As noted earlier, over 99% of the approximately 23 million businesses compete in markets that are characterized by monopolistic competition. That is there are many buyers, many sellers, market entry and exit is easy, and the products are closely related but not identical. There are the two approaches for differentiating products. The first uses marketing and advertising to develop a brand. The second approach is to engage in product development through some sort of research and development (R&D) process and to develop goods and services with updated features. Both approaches are necessary parts of the differentiation process. Marketing and advertising can help illustrate the features and can sometimes delay encroachment by the competition. But in the long run (probably less than a year), successful differentiation depends on product development and R&D.

8.2 THE PLANNING PROCESS

Planning can be accomplished in a variety of ways. Figure 8.1 “The Planning Process (Adapted from May)” presents

1. Michael Porter originally identified three generic strategies. He noted that a business can also focus on a market that is not very competitive. Most people consider this to be a special case of the other two strategies. See Porter (1980).

a typical model of the strategic planning process.[2] The mantra is an often-repeated phrase that provides the basis for the existence of the company. It is a slogan, a watchword, a byword, or a motto that breathes life into the firm's existence. The mantra is not a replacement for the mission statement. The mission It describes what the company does, why it exists, and how it satisfes customer needs. statement is an overall view of the business at an abstract level. It describes what the company does and why it exists and how it satisfies customer needs. The mission statement can also include a statement reflecting whether the company will focus on product differentiation and niche markets, focus on being price-competitive, or focus on both. The mantra and the mission are rarely static but ever-changing and emerging throughout the life of the firm.

The essence of the planning process consists of looking-inside and looking-outside analysis. Analysis involves both introspection and extrospection. The *internal* and *external* organization environments are examined using a number of analytical approaches, several of which are included in Table 8.1 "Orientations of Strategic Planning Approaches". These techniques will be covered in the next section. There is a lot of confusion related to identifying goals and objectives. Many view the terms goals and objectives to be interchangeable. Goals are more abstract and broader than objectives. Objectives are generally more detailed. The important point that will be discussed in the next chapter is to identify the goals and objectives that will help support the mantra, the mission, and the value proposition over a certain time frame. The tactics are the activities the organization will use over the next 3 months to a year to reach their goals and objectives. The tactics can include timetables and schedules related to the goals and objectives. The key to the model in Figure 8.1 "The Planning Process (Adapted from May)" is that this is not a linear process. Sometimes a new mission emerges after analysis has been completed. Mission statements that change, reflect an organization that can adapt to dynamic environments.

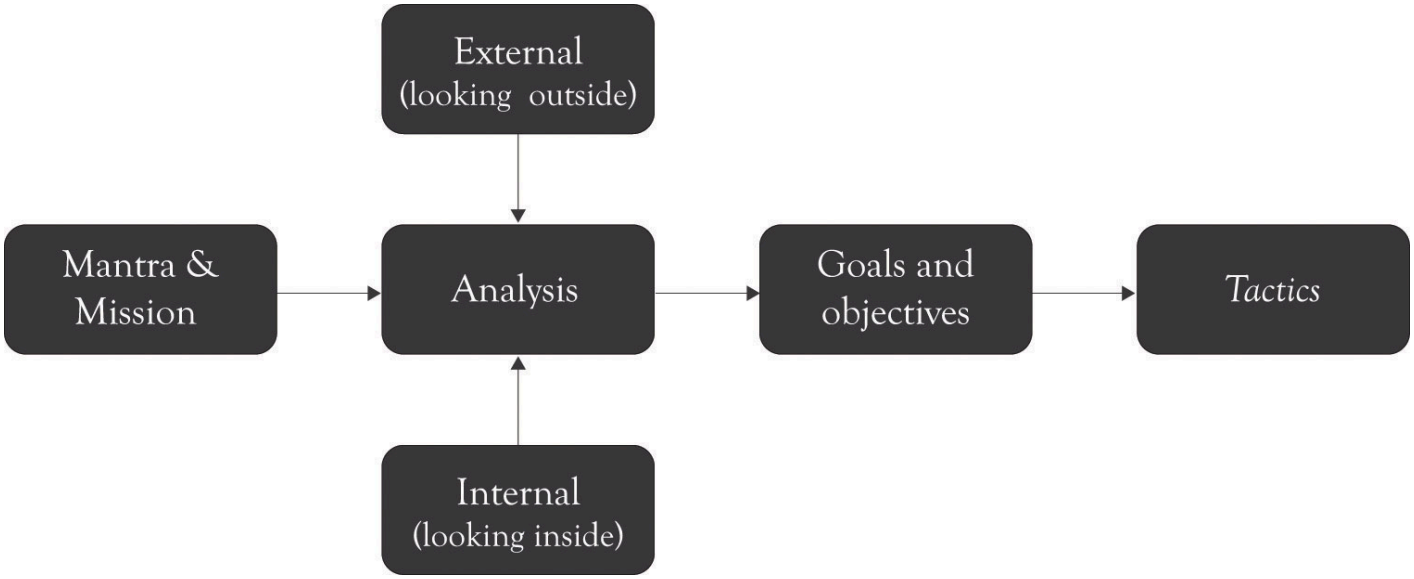


Figure 8.1 The Planning Process (Adapted from May)

Table 8.1 Orientations of Strategic Planning Approaches

2. Adapted from May (2010).

Inter organizational focus	External competitive environments focus	Time to execute	
Value and supply chain analysis	High	Low	Moderate
Porter's five force model	Low	High	Long
Resource-based framework	High	Moderate	Long
Strategy maps	High	Moderate	Long
Creating Blue Ocean markets using the strategy canvas	Moderate to high	Moderate to high	Short
SWOT analysis	Moderate to high	Moderate to high	Short

We will revisit the definitions in the next chapter and illustrate how the planning process can be streamlined and made more efficient and facilitate the development of business plans in a very short time span using the Ten–Ten planning process.

8.3 ANALYTICAL APPROACHES FOR STRATEGIC PLANNING

There are a number of analytical approaches that can be used to develop a process for churning out new plans for differentiation. We will review several of the more popular strategic planning approaches because they all provide insights into the differentiation process. A discussion of planning concepts can be at times boring; however, such discussion is also crucial for developing good plans.

The approaches to be discussed include value chain and supply chain analysis, Porter's five-force model, the resource-based framework, the use of Strategy Maps, creating Blue Ocean markets using the Strategy Canvas, and SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis. As illustrated in Table 8.1 "Orientations of Strategic Planning Approaches", each of the approaches can be classified as having an internal organizational focus (looking inside) or an external environmental focus (looking outside). Several of the strategic analysis approaches are better for understanding the organization and others are better suited for understanding the competitive environment. This table illustrates that there is no "best" approach for conducting strategic analysis and that a combination of approaches is necessary for completing an examination of the inner workings of an organization as well as the organizational context. Each of the strategic analysis tools will be covered in this chapter.

Value Chain and Supply Chain Analysis

Value chain analysisA framework developed by Michael Porter that divides the company into primary and secondary activities related to delivering a product or service. is a framework developed by Michael Porter that divides the company into primary and secondary activities related to delivering a product or service.[3] The primary activities include inbound logistics, operations, sales and marketing, and outbound logistics. The secondary activities are supporting activities and include the firm infrastructure, human resources, information technology, and procurement. Figure 8.2 "The Value Chain (Adapted from Porter)" illustrates the components of the value chain.

A closely related concept is the supply chain. A supply chain is defined as the connected activities related to the creation of a product or service up through the delivery of the product to the customer. It includes upstream suppliers as well as downstream activities such as wholesalers and distribution warehouses. Figure 8.3 "Supply Chain" illustrates the supply chain.

In general, the terms value chain and supply chain can be used interchangeably; although the value chain is rooted in the strategic planning literature, the supply chain is linked to the work in the operations management

3. Porter (1985).

area. The key concept is that products and services have to be created and eventually delivered to consumers and the in-between activities can be referred to as the supply chain or the value chain.

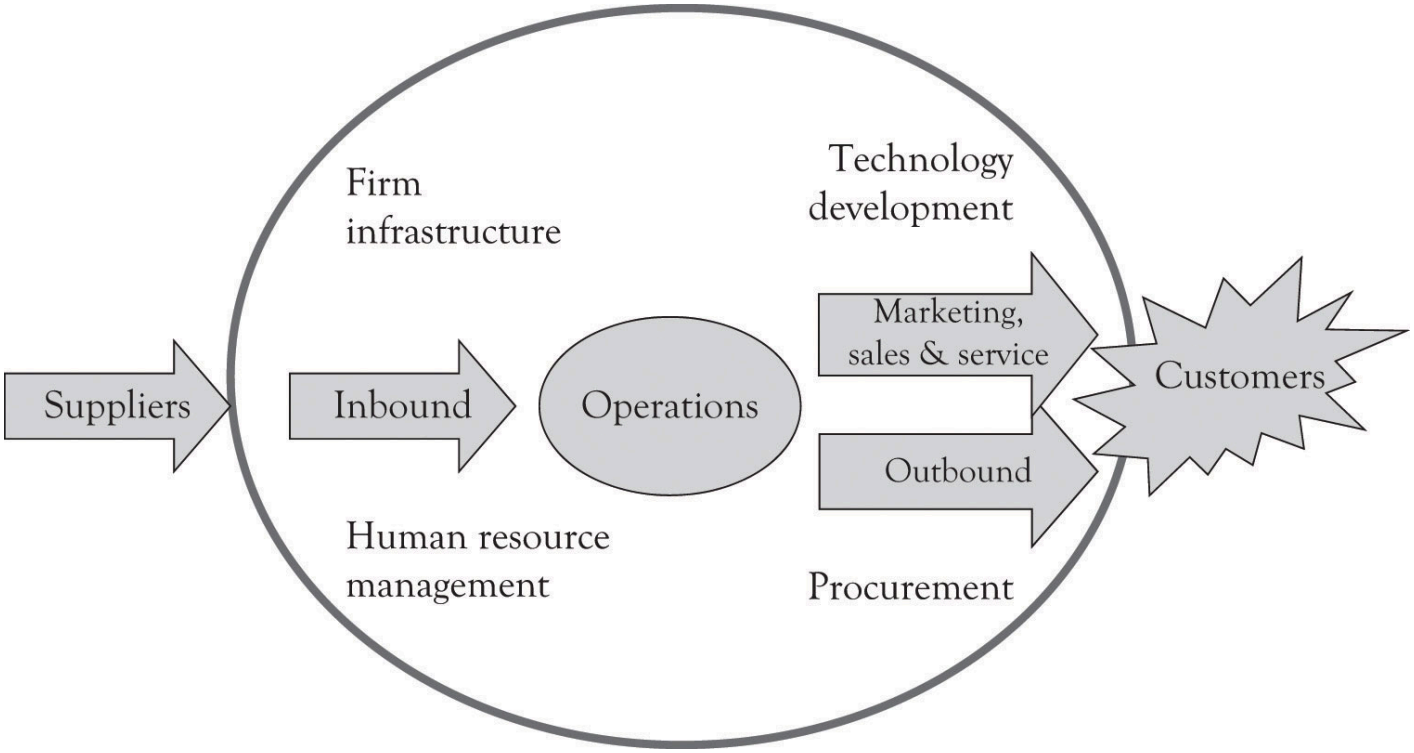


Figure 8.2 The Value Chain (Adapted from Porter)

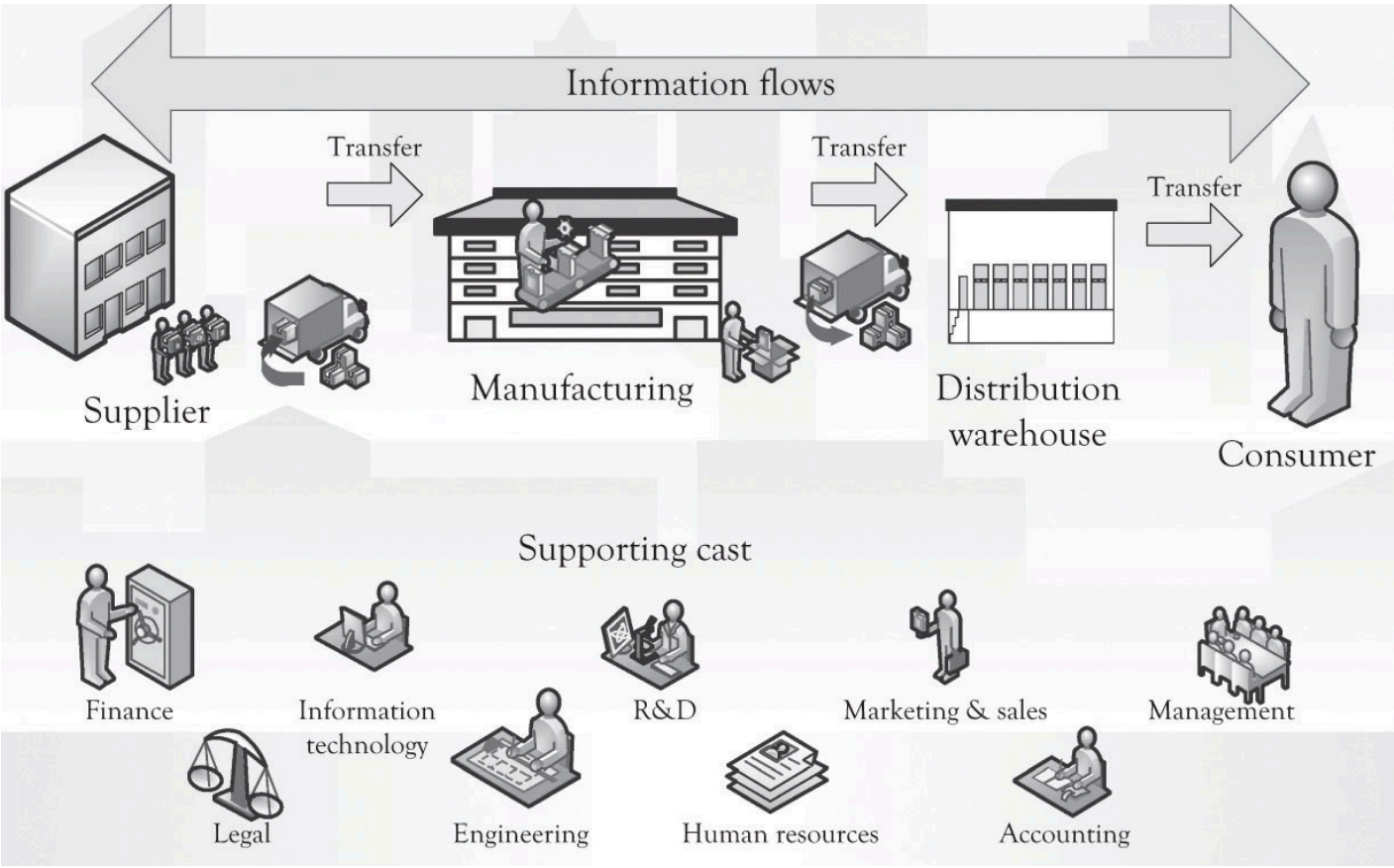


Figure 8.3 Supply Chain

The supply chain is an important visual tool because it can be used to understand where to look for processes that can be reengineered. That is, improvements can be made in connecting, coordinating, and controlling activities across linkages. It can also be used to determine what kind of information should be gathered to improve communications throughout the value chain and where value chain performance could be improved. For example, the firm can investigate where information technology can be marshaled to support the supply chain activity and where technology can be used to automate tasks. The goal, of course, is to reduce transaction costs up and down the supply chain.[4] Transaction costs refer to the effort that goes into choosing, organizing, negotiating, and entering into agreements for products and services.[5] Transaction costs come in a variety of flavors and there is significant overlap among the various costs.

- Search costs: In general, these costs are related to gathering information on a product or service, including the costs associated with locating a product and offering a product for sale.
- Discovery costs: These costs are involved in locating an acceptable price for a product.
- Decision costs: These costs are associated with making a decision on what product to purchase. These include personal cognitive effort and organizational decision processes related to selecting a product or service.
- Negotiation costs: These costs are related to agreeing to the terms of a contract including the price, what will be delivered, how much, and when.
- Acquisition costs: These costs are involved in transporting, receiving, infrastructure development, and

4. Coase (1937).
5. Williamson (1985).

managing the product in inventory.

- Enforcement costs: These are the costs that the parties in the contract incur in order to enforce the terms of the contract.
- Settlement costsThese are the costs related to paying and getting paid for a product or service.: These are the costs related to paying and getting paid for a product or service.
- Social costsCosts that are not necessarily picked up by buyers and sellers. Examples include pollution costs, health costs, privacy costs, and bankruptcy costs.: These include costs that are not necessarily picked up by the buyers and the sellers. Examples include pollution costs, health costs, privacy costs, and bankruptcy costs.

Porter's Five-Force Model

Michael Porter has also developed a technique for assessing the desirability of competing in a particular industry and how a firm can compete in that industry.[6] Porter's five-force framework considers the buyers, the sellers, the suppliers, the current competition, and the threat of competition from substitute products. The key idea is that a firm can be more profitable by understanding how the five forces influence the competitive environment, as will be explained next.

Threat of new entrants. This is the degree to which entry into an industry is easy to accomplish. If it is easy to enter an industry and start competing, then there is a threat of new entrants. If an industry has high fixed costs, such as in the case of semiconductor manufacturing, auto manufacturing, or operating systems construction, then there is a low threat of entry. This is in contrast to the situation where entry is easy and relatively inexpensive such as found in online retail stores, home maintenance businesses, and restaurants.

Entry into a market can of course be precluded because of the scarcity of expertise and resources. For example, in the late 1990s, there were very few individuals with expertise in Enterprise Resource Planning systems and in COBOL to handle the Y2K date problem. Numerous firms turned toward India and Singapore to find employees with skills in these areas.[7] Resource scarcity can also limit entry into a market. Examples of industries where resource scarcity is critical include diamond mining, where DeBeers owns a substantial amount of the diamond resources, and oil production where Exxon has access to oil production and installed refining capability.

Threat of substitute products. Substitute products are a constant threat in contemporary commerce. If another product can be substituted for a product in the industry under consideration, then there is a threat of substitute products. It is sometimes impossible to know where your competition will come from. For example, video and audio content can be delivered via satellite, wireless, coax cable, cat 5, and fiber optics. The content can in turn be delivered to a variety of devices including mobile phones, televisions, iPODs/MP3 players, game consoles, DVRs, and computers. A similar situation exists for transportation. You can travel via electric car, bus, and air or in the future, by way of a personal jet craft or some type of Segway device. Indeed content delivery can be a substitute for transportation. As video and audio becomes more robust and easy to use, it may be possible to be there without actually being there. Families will soon get together by linking-up and interacting with their plasma and LCD screens using a high bandwidth carrier to communicate video and audio feeds of a birthday party or anniversary. This has already occurred in businesses with the emergence of virtual meetings. This brings up another issue. People set aside a certain amount of dollars for entertainment. However, although technology is not a perfect substitute for entertainment outside of the home, it can be a substitute for spending on entertainment. Thus, a console or a game might threaten the launching of a new movie during the holidays or vice versa.

Bargaining power of buyers. If individuals, companies, or groups of companies can influence the price and the features required in a product or service, then the buyers have the bargaining power. This often occurs when

6. Porter (2008).
7. This is in part the reason that outsourcing and off-shoring started to increase so dramatically.

there are few buyers or when the buyer is large. The auto companies have bargaining power over the component manufactures. The same goes for Dell's component suppliers and Wal-Mart's suppliers. When a buyer is large and switching costs are small, then the buyer has the bargaining power. Wal-Mart is in such a position with its suppliers. Dell, however, has less buyer power because it cannot simply switch the component suppliers because desktops systems are built around integrated components and the performance of the system can be adversely impacted when components are not integrated.

Bargaining power of suppliers. If a company supplying a product or service can dictate the terms of the transaction, then the supplier has the bargaining power. The bargaining power of suppliers can be derived from many factors including the scarcity of the resource or technology, the number of suppliers, the characteristics and features of the technology, whether the technology is proprietary, and even the brand image. Intel and Microsoft have some bargaining power over Dell, but the hard drive, dram, motherboard, and monitor manufacturers have less bargaining power. The power supply and case manufacturers have even less bargaining power with Dell. The game console and global positioning system (GPS) manufactures have some power over Wal-Mart when they introduce a new model, but a holiday candle manufacturer has much less power. In many ways, the bargaining power is related to the threat of new entrants and the threat of substitute products or services. The key issue surrounding the bargaining power of suppliers is the availability of other sources of the products and services. If alternative or second sourcing is available, then the bargaining power of the supplier is lessened.

Rivalry among existing competitors. This is the degree to which there is competition among the firms. When there are several competitors and the products they are selling are fairly standard or readily obtainable and the competitors cannot easily leave the industry, then the rivalry will be intense. Examples of intense rivalries include breakfast cereals, flash memory, dram and electronics industries, housing construction, online and offline retailing, and the airline industry. Intense rivalries among competitors are again driven by the threat of new entrants and the threat of substitute products and services. In this context, product differentiation is essential in order to reduce the ruinous effect of perfect competition. This is the reason that the producers of GPS systems are constantly refining and adding features to their product line. Airlines, breakfast cereal producers, and the housing industry are constantly looking for ways to differentiate their offerings and at the same time reduce costs.

The Five-Force Model in Practice

The five-force model can be used as the basis for conducting an industry analysis. The goal of an industry analysis is to understand the dynamics of competition and to ascertain how the five forces influence profitability. The following steps are used for conducting an industry analysis:

- Develop a brief description of the target industry
- Identify the competitors, buyers, suppliers, potential entrants, and potential substitutes
- Determine the strength and weaknesses of the forces
- Identify any recent changes in the dynamics of the forces
- Determine the potential for short- and long-term profitability
- Ascertain who in the industry is positioned to be profitable
- Determine where the organization should invest.

Porter's five-force model provides an overarching view of the competitive environment and is extremely helpful for understanding the competitive environment. It does, however, have several deficiencies. First of all, it takes a long time to conduct a full-blown exposé of the five forces because many devotees to the approach tend to overanalyze the industry and the competition. This in turn leads to organizational fatigue. Overanalysis is related

to the second deficiency. The ideas are very abstract and broad, and the technique requires consulting expertise in order to be applied effectively. Finally, it takes too long to implement for small organizations. For the entrepreneur working under extreme pressure, under the umbrella of monopolistic competition, there is very little time to attend to apply the approach effectively. Even though Porter's ideas are very powerful, they do not resonate with the entrepreneur because they are abstract and difficult to apply.

Resource-based Framework

The resource-based view, also referred to as RBV, is very popular with academics. The intellectual foundations for the RBV approach are many, but the work by Prahalad and Hamel on core competencies[8] and the work by Barney[9] on the link between resources and sustained competitive advantage established a strong foundation. The basic idea of RBV is that some organizations are more competitive because they have access to unique resources or special capabilities and competencies. Resources can be tangible or intangible and include raw materials, land, brand, knowledge and expertise of people, reputation with customers and suppliers, plants, equipments, patents, trademarks, copyrights, and funds. A capability or competence is the ability of a firm to turn its resources into customer value and profits. Capabilities or competencies can be manufacturing prowess, order fulfillment and delivery, customer service, marketing, finance and accounting, management expertise and leadership, and in essence any proficiency or prowess in the supply chain and value chain.

Porter's five force model, and the accompanying industry analysis, tends to focus on locating a firm in an attractive industry and then taking steps to achieve competitive advantage over rival firms. In contrast, the RBV approach suggests focusing on competitive arenas where the firm has unique resources and competencies. For example, if you own property with rich productive topsoil, if your workers are diligent, and if your daughter is an excellent agronomist, you will probably be a successful farmer. The key to being successful in the context of RBV is that the resources and competencies are hard to imitate and help to establish a strong basis for competitive advantage. In essence, the status of the internal resources and competencies will assist in pursuing a particular strategic direction. Amazon has a core competency in selling online and it simply kept pursing that competency by selling construction tools, electronics, audio books, eBooks, and developing partnerships with brick and mortar vendors. Most of Google's successful ventures are related to its core competency of *search*. Joan's foray into the jewelry box business discussed earlier was linked to her excellent craftsman skills. Joan had a core competency in jewelry box design and fine woodworking.

Core competencies are the very critical skills that define an organization. For Google, it is their search capability, for Amazon it is their ability to sell online, and for Joan it is her prowess at jewelry box design and her knowledge of the marketplace. In the case of Joan, her knowledge and skills can probably be imitated and replicated in a shorter time frame than the competencies developed by Amazon and Google. But of course, Joan's jewelry box business is more agile and can change direction much faster than Amazon and Google. Eventually, all capabilities and competencies (even Amazon and Google's) can be imitated, replicated, and improved. Even scarce resources and monopolies can succumb to the onslaught of new technology, time, and market forces. There are substitutes for oil, diamonds, and operating systems.

The RBV is a powerful idea for understanding strategic direction, but it has several deficiencies. First of all, it is very broad in scope and hard to implement as part of a concrete business plan. Delineating the unique capabilities, competencies, and resources and then using this information in strategic planning are time-consuming. In addition, there is little guidance on how to build competencies. Indeed, some theorists believe that core competencies cannot be built but simply emerge. For additional discussion on RBV, see Henry[10] and Grant.[11]

8. Prahalad and Hamel (1990).
9. Barney (1991).
10. Henry (2007).
11. Grant (2007).

Later on, we will discuss how this approach can be effectively integrated with SWOT analysis and, in the next chapter, we will discuss how this approach can be integrated with the Ten–Ten planning process.

Strategy Maps

A strategy map is a visual diagram that represents a causal structure of an organizational strategy. The strategy map is an outgrowth of the balanced scorecard approach developed by Robert Kaplan and David Norton.[12] The purpose of the balanced scorecard is to develop a series of measurable performance indicators that are linked and aligned with organizational missions and objectives. Measurement at the operational and tactical levels is a key part of the balanced scorecard approach and essential for developing and benchmarking best practices. Measurement can be used to identify where management should redirect its attention and also to identify whether best practices are already in place.

There are four primary areas where performance indicators can be used. They are the financial performance indicators, customer performance indicators, performance indicators related to internal organizational processes, and performance indicators related to the ability of the organization and employees to innovate and learn. The strategy map is an overview of the causal relationships related to the four perspectives. Figure 8.4 "Example of a Strategy Map for a Railroad" is an example of a strategy map for a railroad. You are encouraged to use Google's image search using the keyword strategy map for additional examples.

In general, the balanced scorecard/strategy maps approach is more suitable for older larger organizations with a lot of time for developing and executing a strategic plan. Kaplan and Norton point out that a strategy map presents an integrated overview of the outcome measures and the performance drivers of outcomes using cause-and-effect relationships. The strategy map can serve as a strategic measurement system and strategic control system that align departmental and personal goals with overall strategy.[13] There are, however, problems in assumptions and the time it takes to implement the approach.[14] The first problem is that the approach is too hierarchical and not particularly suitable for dynamic and complex environments. Some researchers also question the causal relationships among the variables. For example, are there causal links related to enhancing cost control leading to increases in the rate of competitiveness, which in turn are leading to improvements in customer satisfaction?[15] In essence, does cost control always lead to customer satisfaction through competitiveness? One hopes that this is the case, but it is not easy to verify from both research and practice perspectives.

12. Cf. Kaplan and Norton (1996, January–February, 2003b) and visit http://www.balancedscorecard.org/BSCResources/AbouttheBalancedScorecard/tabid/55/Default.aspx
13. Nørreklit (2000).
14. Nørreklit (2000).
15. Nørreklit (2000).

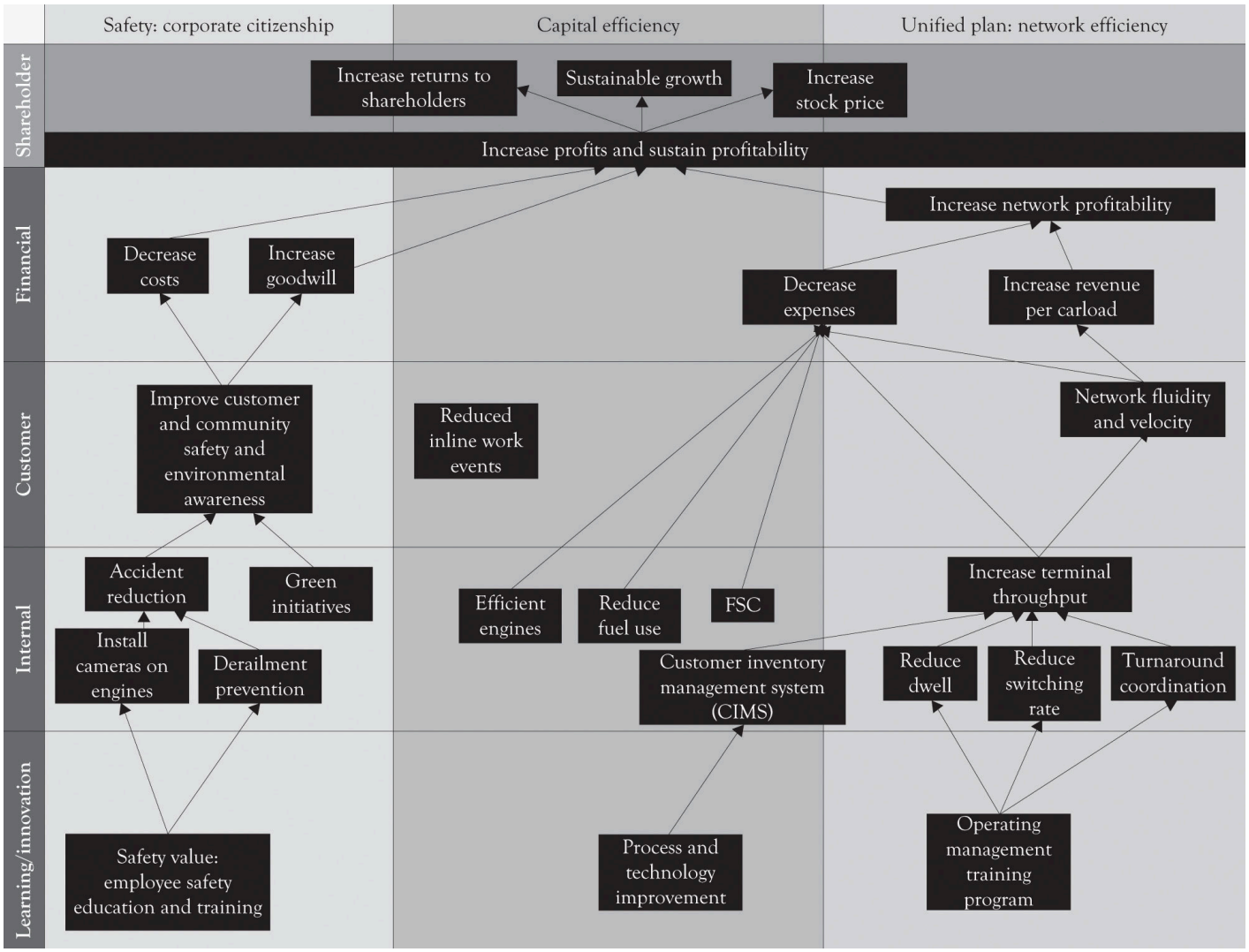


Figure 8.4 Example of a Strategy Map for a Railroad

From the public sector, permission of Wikimedia Commons License Agreement, http://commons.wikimedia.org/wiki/File:StrategyMap.jpg.

The major problem from an entrepreneurial perspective is that the balanced scorecard approach using strategy maps approach is very complex and difficult to implement. In general, strategy maps and the balanced scorecard approach are more applicable to relatively mature companies and are not conducive to new venture development. New ventures, whether they are intrapreneurial or entrepreneurial, need a more adaptive and agile approach. A customer orientation, with an attention to securing and reducing the cash burn rate, a focus on executing the plan by attending to developing internal processes, and focusing on R&D and learning are the most important takeaways from the balanced scorecard/strategy maps approach.

Creating Blue Ocean Markets Using the Strategy Canvas

As noted throughout the earlier chapters we believe that the Blue Ocean concept is an important contribution to the strategic planning literature.[16] The idea is very similar to the so-called killer-app concept and lateral marketing approach. The goal of the Blue Ocean approach is to identify uncontested market spaces for profit and growth

16. Kim and Mauborgne (2005).

rather than compete in traditional Red Ocean market spaces where there is a tendency to focus on either cost-cutting or differentiation. Table 8.2 "Red Versus Blue Ocean Strategy" illustrates how the concepts developed in the book with Midas, Atlas, and Hermes products relate to the Blue Ocean concepts. This process of developing a Blue Ocean market is facilitated by developing the Strategy Canvas and by using the FAD template as an input into the Strategy Canvas.

This is in contrast to the competitive strategy where a large and growing already-served market is identified and the entering firm tries to find a way to compete. Several research projects have been conducted on the efficacy of the Blue Ocean approach, and the results suggest that organizations pursuing Blue Ocean markets can in some instances be successful. A Blue Ocean strategy that is focused on intense innovation and on product differentiation and brand creation has been found to be profitable.[17] The Blue Ocean approach apparently helps to insulate a firm from intense competition. In many instances, Blue Oceans are not completely blue, but rather have patches of red. The net effect is that it is sometimes necessary to find a niche in a large market and then use Porter's five-forces model to assess the desirability of competing in a particular industry and how a firm can compete in that industry. The key idea is that a firm can be more profitable by understanding how the five forces influence the competitive environment. The most important part of the Blue Ocean approach is to assist in identifying strategic opportunities for product differentiation using the Strategy Canvas. This was discussed in an earlier chapter where we used the FAD template to develop a Strategic Canvas for the Nintendo Wii.

Table 8.2 Red Versus Blue Ocean Strategy

Red Ocean	Blue Ocean
The major goal is to beat the competition in an already established market space.	The major goal is to make the competition irrelevant and superfluous by developing a new product or service in a new market space.
Compete on the existing demand curve in the existing market space. Growth is slow.	Compete and capture a new uncontested demand curve in a new market space. Growth is above average.
Develop either Midas, Atlas or Hermes products and services.	Develop and introduce Midas, Altas and Hermes products and services.
Focused on product differentiation or being a low cost producer.	Focused on product differentiation and also being a low cost producer.
Focused on cost cutting, outsourcing, brand management and advertising.	Focused on research, product design and learning.

SWOT Analysis

The genesis of the SWOT approach to strategic planning is usually attributed to Albert S. Humphrey during his tenure with the Stanford Research Institute.[18] Even though the SWOT technique can trace its roots to the 1960s, it is still an important and useful tool that is constantly evolving and improving to deal with the ever-increasing complexity of contemporary markets.

The objective of a SWOT analysis is to facilitate the development of a strategy in starting a new venture or large-scale project, completing a large-scale project and diagnosing deficiencies in an existing organization by taking its temperature in a particular environmental context. A SWOT diagram consists of four quadrants (see Figure 8.5 "SWOT Diagram"). The upper two quadrants relate the internal strengths and weaknesses of the organization. The bottom two quadrants relate to the external organizational environment in terms of the opportunities and threats faced by the organization in the marketplace.

17. Burke, Stel, and Thurik (2009).
18. Before he died in 2005, Humphrey wrote a brief history of SWOT development. He indicated that it was initiated in 1960 because long-range planning approaches were not working properly. The research team interviewed 1,100 organizations and had 5,000 executives complete a 250-item questionnaire. The approach was originally called SOFT (Satisfactory, Opportunity, Fault, and Threat) but after subsequent adaptations by a number of consultants and academics, it evolved into SWOT. There are devotees of SWOT that believe it originated at Harvard Business School under the guise of Albert Smith, Roland Christensen, and Kenneth Andrew. See Humphrey (2005); Panagiotou (2003).

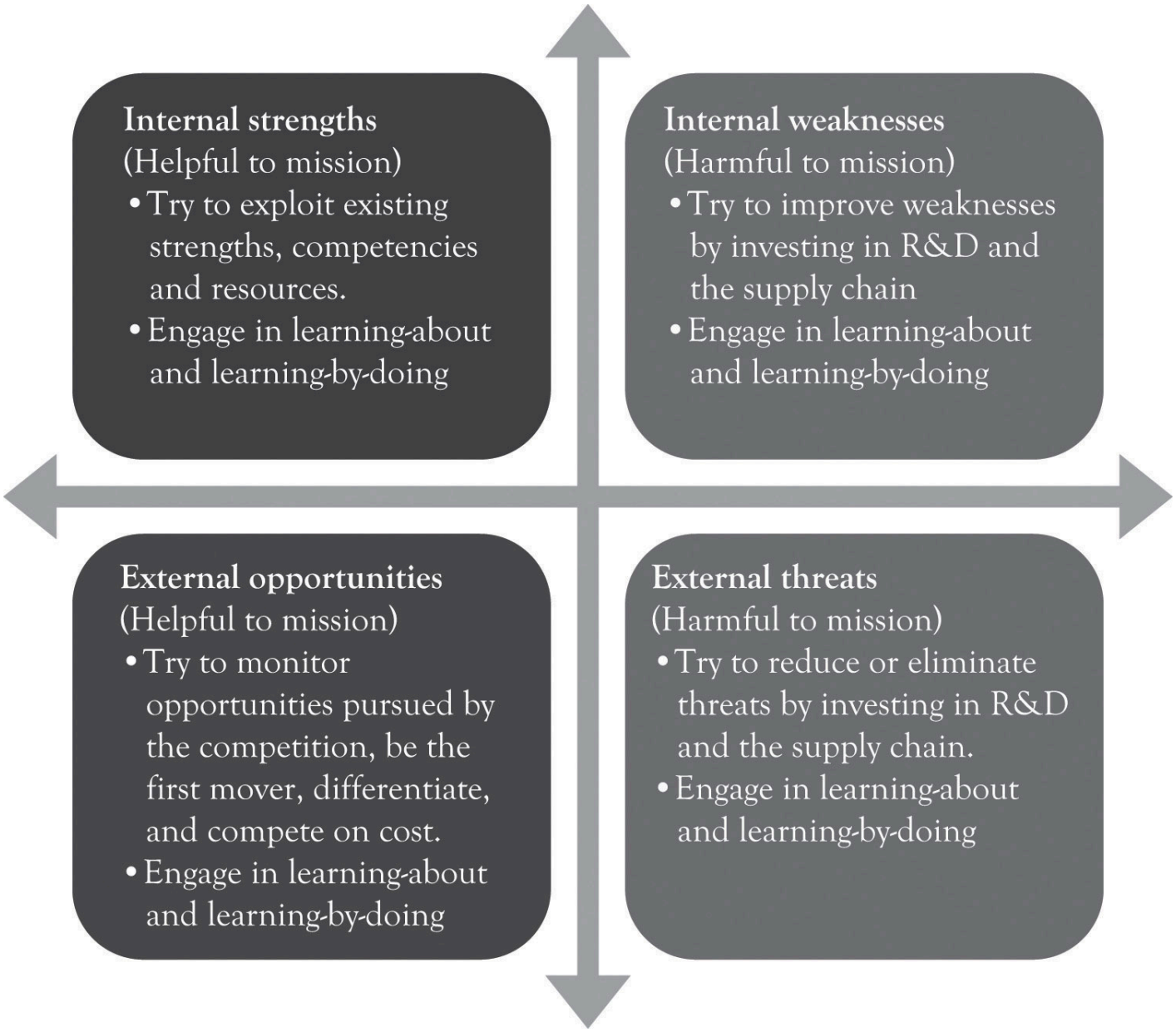


Figure 8.5 SWOT Diagram

One of the benefits of SWOT is that it can be used to analyze the organization as well as the organizational environment in order to identify areas of competitiveness and areas that need attention. It is a very useful tool for looking inside and looking outside to identify the state of the organization and the competitive environment. In an ideal situation, it draws on organizational constituencies and scans the external environment for opportunities and threats. Several examples of how SWOT can be used to analyze the strategic context are presented below.

Example 1: iPhone 4

Figure 8.6 "iPhone 4 SWOT Analysis" illustrates a SWOT analysis for Apple's iPhone 4. Substitute products are the greatest threat; however, Apple has been able to counterbalance such encroachment by paying attention to product differentiation through research and product development and, of course, the coolness index.

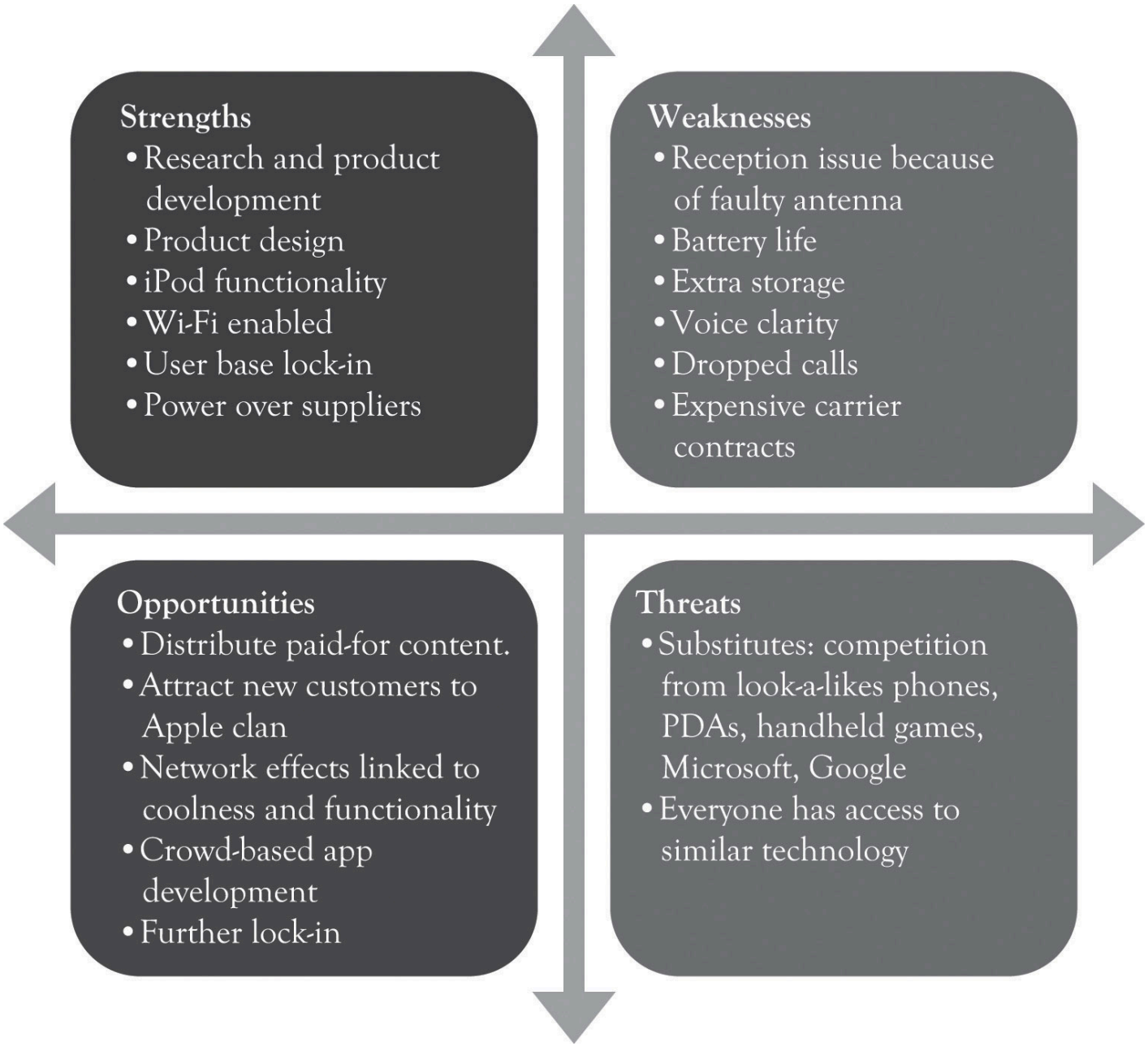


Figure 8.6 iPhone 4 SWOT Analysis

Example 2: Dell's Entrance Into the Chinese Computer Market

Dell decided to enter the Chinese PC market in the 1990s. They faced many impediments to entering such a complex environment. Figure 8.7 "SWOT Analysis for Dell Entering China" illustrates a hypothetical SWOT analysis for Dell as they embark into the Chinese PC market. The Dell supply chain is top-notch as well as their strong commitment to R&D. They have numerous business process patents as well as product patents. One of the earlier knocks on Dell was that the Chinese culture was not conducive to Dell's golden rules of disdaining inventory, always selling directly, and always listening to the customer. They have subsequently begun to listen to the customer and have started to sell through retail outlets.

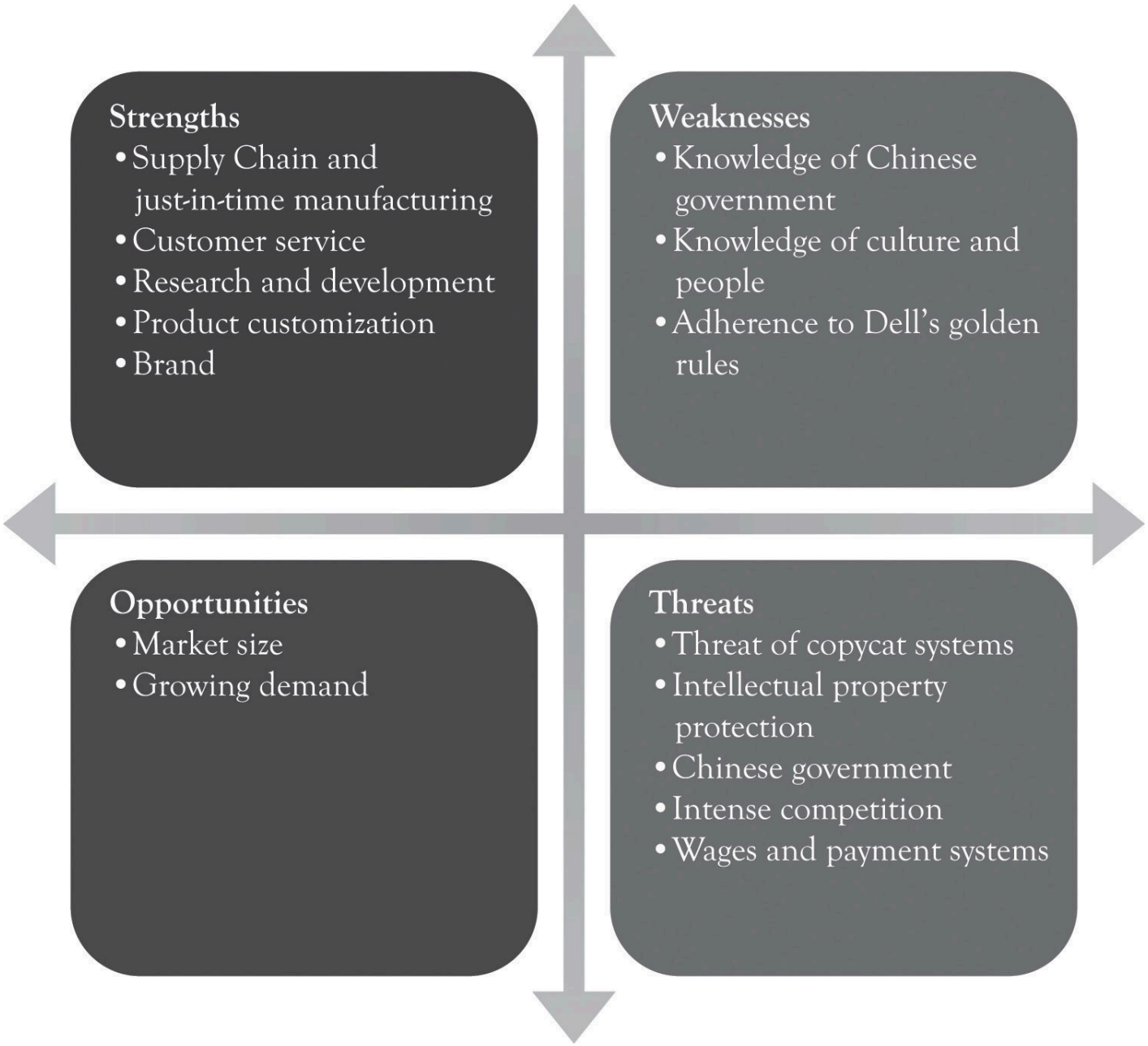


Figure 8.7 SWOT Analysis for Dell Entering China

Integrated SWOT Analysis

Even though a SWOT analysis is fairly easy to understand and apply, it is not necessarily easy to develop a good one. One of the primary criticisms of SWOT is that it leads to a large laundry list of strengths, weaknesses, opportunities, and threat factors. It is also criticized because it lacks direction and focus. The net effect is that strategic planners are not sure what variables are important or where to start in the process. This is particularly relevant in a world characterized by strong domestic and global competition where risk and uncertainty are driven by the winds of technological change, political turmoil, and governmental actions.[19]

The quick SWOT approach alleviates the deficiencies of traditional SWOT analysis by drawing on the other

19. Panagiotou (2003).

analytical approaches looking at strategy presented earlier. It takes the key variables in value and supply chain analysis, the five-force model, the resource-based framework, and the technology-based strategy approach and uses them to drive the SWOT process. The critical variables or drivers that influence the SWOT are listed below:

- Internal Organizational Drivers
    - Supply and value chain performance
    - Core competencies and organizational resources
    - Emerging technology
- External Organizational Drivers
    - Threat of substitute products
    - Threat of new entrants
    - Bargaining power of buyers
    - Bargaining power of suppliers
    - Local and world economy, culture, and government influence

Some of the variables influence both the internal and external organizational environment. For example, the supply chain boundary affects the internal environment, but it is also part of the external environment and involves logistics and financial institutions. Similarly, the onslaught of new technologies also influences the internal as well as the external environment. Figure 8.8 “Key Drivers for Quick SWOT Analysis” illustrates the SWOT template along with the key variables that should drive the SWOT analysis.

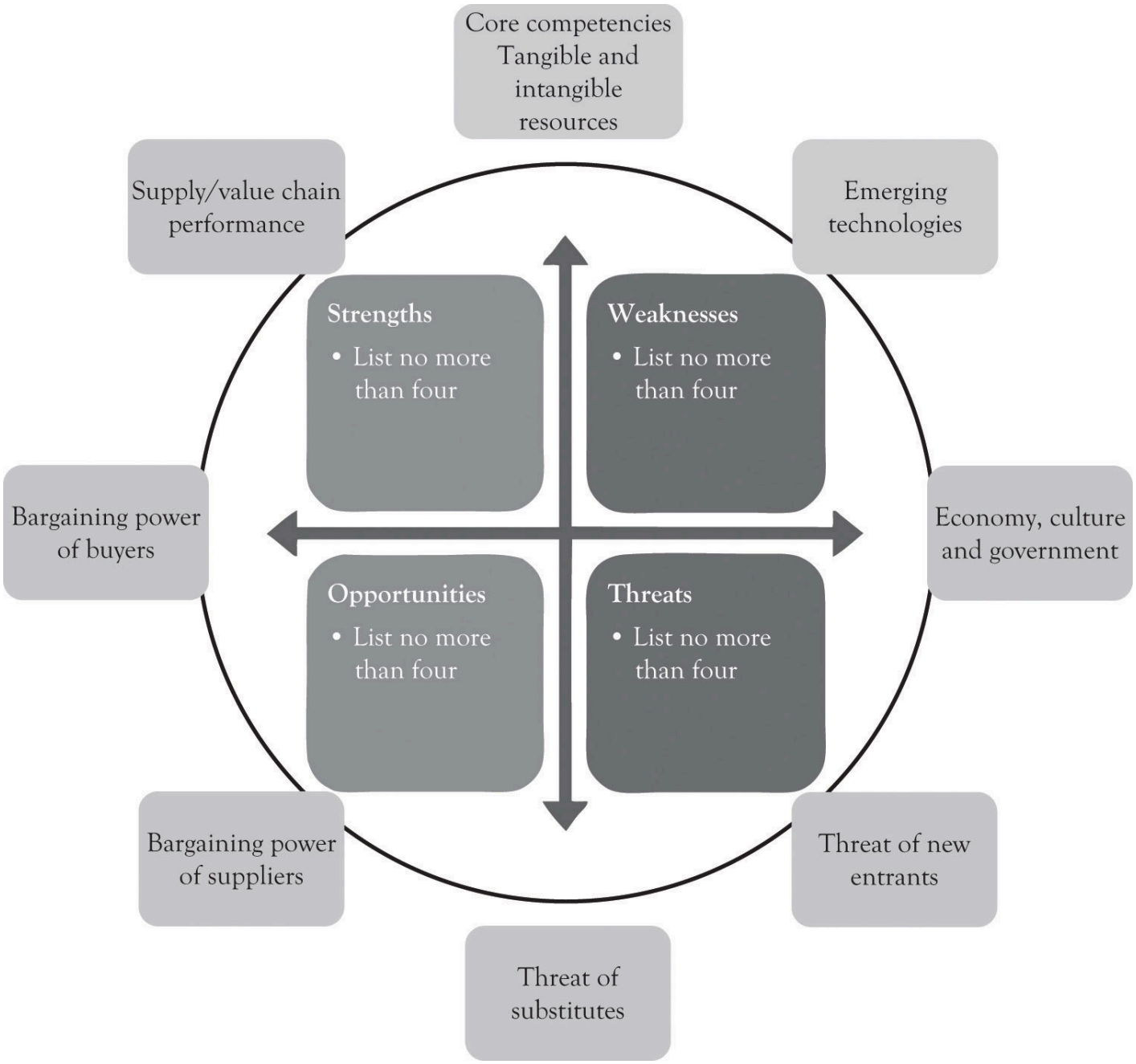


Figure 8.8 Key Drivers for Quick SWOT Analysis

THE QUICK SWOT SUPPORTED WITH STRATEGY CANVAS

A SWOT analysis should be conducted very quickly as illustrated below:

1. Conduct a brief external industry analysis.
    - Identify the competitors, buyers, suppliers, potential entrants, and potential substitutes.
    - Understand the industry supply chain and how it works.

2. Conduct a brief internal organizational analysis.
    - Identify organizational capabilities/competencies related to manufacturing prowess, order fulfillment and delivery, customer service, marketing, finance, accounting, R&D, employees, and management. This is essentially the internal supply and value chains.
3. Use a strategy canvas to identify how you can add or subtract features for product differentiation. The idea is to identify new opportunities and perhaps Blue Ocean markets.
4. Develop a 4 × 4 SWOT diagram using the template. Try to limit the number of factors in each quadrant to four factors.
5. Start the process over after 4 months.

The next chapter will provide a simple template as part of the Ten–Ten planning process for conducting an organizational and industry analysis that incorporates the quick SWOT approach.

MONOPOLISTIC COMPETITION AND SWOT

Monopolistic competition involves many buyers and many sellers offering slightly different competitive products. Producers are always searching for markets with potential. In such an environment, there are several strengths that are critical for survival. Figure 8.9 "Competing Under Monopolistic Competition Requires Strength in At Least Two Areas" illustrates the idea that if there are substitute products or emerging technology threats, then you need to have 2 out of 3 critical strengths. The critical strengths are research and product development, a high performance supply chain, and a strong brand. The optimum situation is to be strong in all three areas, but this is not very common. If any of these three are placed in the critical weakness category, the organization is definitely at risk. It should also be noted that an organization could be strong in all three critical strengths and still fail. Survival is still linked to long-term profitability. Many of the very successful companies are 3 for 3 and have above-average performance in R&D and a strong brand and excellent supply chain.

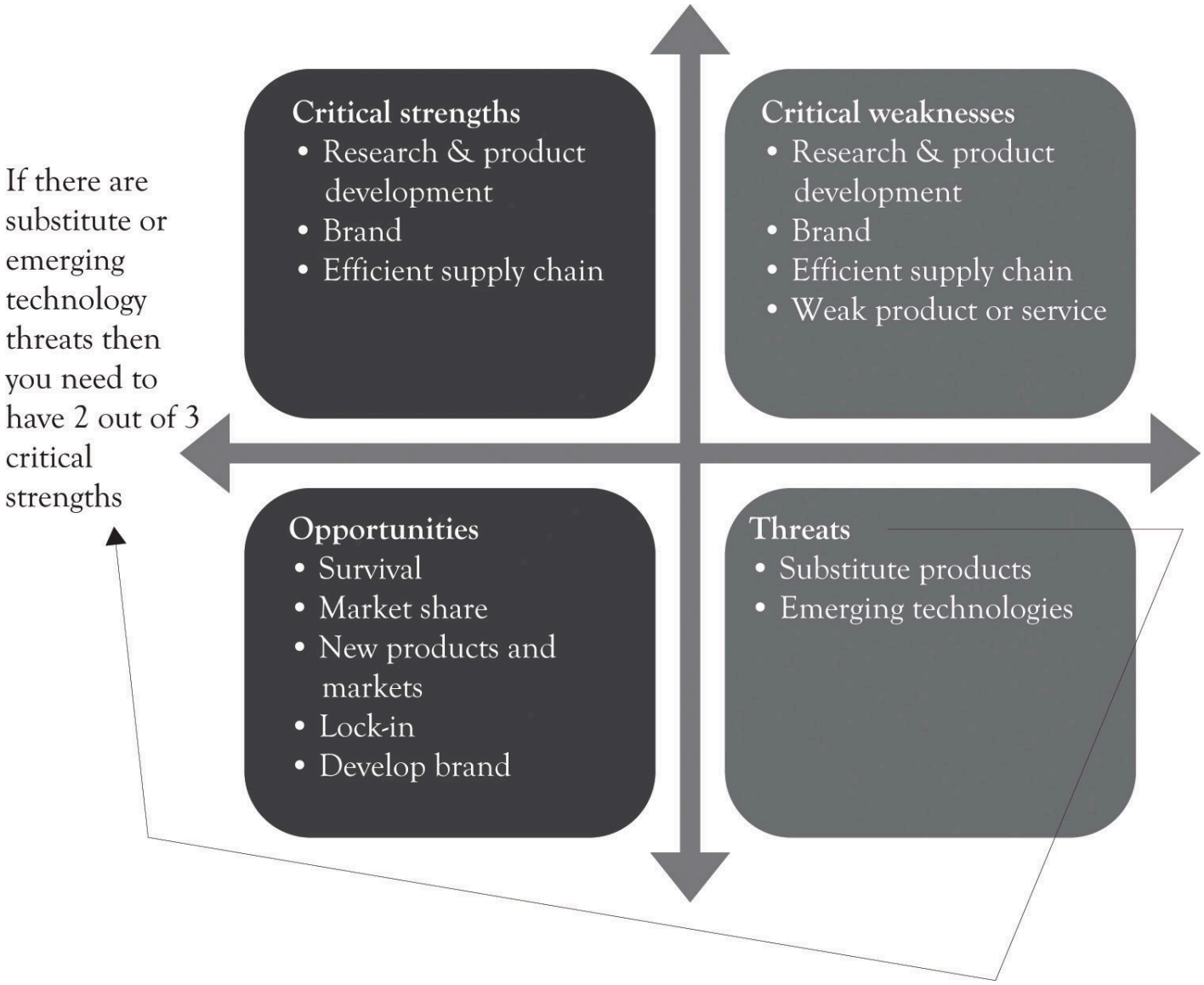


Figure 8.9 Competing Under Monopolistic Competition Requires Strength in At Least Two Areas

8.4 CONCLUSION

In this chapter, we have reviewed many popular approaches for strategic planning. The key points are the following:

- The two basic strategies for business planning include product differentiation and striving to be the low-cost producer.
- Product differentiation can be accomplished by focusing on Midas versions of products using extravagant engineering and design. Being the low-cost producer can be accomplished by focusing on Hermes versions of products using frugal engineering and design.
- Planning approaches can be classified as having an internal organizational focus (looking inside) or an external or environmental focus (looking outside).

- The development of an abbreviated SWOT analysis that is supported with a strategy analysis can be used to integrate the key attributes of the various strategic planning approaches.
- The planning process never ends. With continuous pressure from market and competition, firms are suggested to develop new strategy and planning from time to time.

This chapter reviewed the various analytic approaches for strategic planning. There is no single business plan that can be used to deal with the complexity of monopolistic competition nor is there a single planning approach that will take the organization down the right path. A revised analysis tool, called quick SWOT analysis, was introduced that combines the various strategic planning approaches.

This chapter also sets the stage for the Ten–Ten planning process, a simplified yet robust approach to planning. The next chapter will present two templates for developing a business plan. The first template is the Organizational and Industry Analysis template and it incorporates the quick SWOT approach along with concepts from value chain analysis, the resource-based approach, Blue Ocean market analysis, and the other strategic analysis approaches discussed in this chapter. This information is then used to fill in the Business Plan Overview template. The use of the two templates is part of the Ten–Ten planning process. The approach can be used to produce one plan and also to churn out new plans in order to compete in dynamic environments characterized by monopolistic competition.

2.2: Operations Competitive Priorities

2.4 KEY FRAMEWORK: THE FIVE FORCES OF INDUSTRY COMPETITIVE ADVANTAGE

Learning Objectives

- Diagram the five forces of competitive advantage.
- Apply the framework to an industry, assessing the competitive landscape and the role of technology in influencing the relative power of buyers, suppliers, competitors, and alternatives.

Professor and strategy consultant Gary Hamel once wrote in a *Fortune* cover story that "the dirty little secret of the strategy industry is that it doesn't have any theory of strategy creation."[1] While there is no silver bullet for strategy creation, strategic frameworks help managers describe the competitive environment a firm is facing. Frameworks can also be used as brainstorming tools to generate new ideas for responding to industry competition. If you have a model for thinking about competition, it's easier to understand what's happening and to think creatively about possible solutions.

One of the most popular frameworks for examining a firm's competitive environment is Porter's five forces, also known as the *Industry and Competitive Analysis*. As Porter puts it, "analyzing [these] forces illuminates an industry's fundamental attractiveness, exposes the underlying drivers of average industry profitability, and provides insight into how profitability will evolve in the future." The five forces this framework considers are (1) the intensity of rivalry among existing competitors, (2) the threat of new entrants, (3) the threat of substitute goods or services, (4) the bargaining power of buyers, and (5) the bargaining power of suppliers.

New technologies can create jarring shocks in an industry. Consider how the rise of the Internet has impacted the five forces for music retailers. Traditional music retailers like Tower and Virgin found that customers were seeking music online. These firms scrambled to invest in the new channel out of what is perceived to be a necessity. Their *intensity of rivalry* increases because they not only compete based on the geography of where brick-and-mortar stores are physically located, they now compete online as well. Investments online are expensive and uncertain, prompting some firms to partner with *new entrants* such as Amazon. Free from brick-and-mortar stores, Amazon, the dominant new entrant, has a highly scalable cost structure. And in many ways the online buying experience is superior to what customers saw in stores. Customers can hear samples of almost all tracks, selection is seemingly limitless (the *long tail* phenomenon and data is leveraged using *collaborative filtering* software to make product recommendations and assist in music discovery. Tough competition, but it gets worse because CD sales aren't the only way to consume music. The process of buying a plastic disc now faces *substitutes* as digital music files become available on commercial music sites. Who needs the physical atoms of a CD filled with

1. G. Hamel, "Killer Strategies that Make Shareholders Rich," *Fortune*, June 23, 1997.

ones and zeros when you can buy the bits one song at a time? Or don't buy anything and subscribe to a limitless library instead.

From a sound quality perspective, the *substitute good* of digital tracks purchased online is almost always inferior to their CD counterparts. To transfer songs quickly and hold more songs on a digital music player, tracks are encoded in a smaller file size than what you'd get on a CD, and this smaller file contains lower playback fidelity. But the additional tech-based market shock brought on by digital music players (particularly the iPod) has changed listening habits. The convenience of carrying thousands of songs trumps what most consider just a slight quality degradation. ITunes is now responsible for selling more music than any other firm, online or off. Most alarming to the industry is the other widely adopted substitute for CD purchases—theft. Illegal music "sharing" services abound, even after years of record industry crackdowns. And while exact figures on real losses from online piracy are in dispute, the music industry has seen album sales drop by 45 percent in less than a decade.[2] All this choice gives consumers (buyers) *bargaining power*. They demand cheaper prices and greater convenience. The *bargaining power of suppliers*—the music labels and artists—also increases. At the start of the Internet revolution, retailers could pressure labels to limit sales through competing channels. Now, with many of the major music retail chains in bankruptcy, labels have a freer hand to experiment, while bands large and small have new ways to reach fans, sometimes in ways that entirely bypass the traditional music labels.

While it can be useful to look at changes in one industry as a model for potential change in another, it's important to realize that the changes that impact one industry do not necessarily impact other industries in the same way. For example, it is often suggested that the Internet increases bargaining power of buyers and lowers the bargaining power of suppliers. This suggestion is true for some industries like auto sales and jewelry where the products are commodities and the price transparency of the Internet counteracts a previous information asymmetry where customers often didn't know enough information about a product to bargain effectively. But it's not true across the board.

In cases where network effects are strong or a seller's goods are highly differentiated, the Internet can strengthen supplier bargaining power. The customer base of an antique dealer used to be limited by how many likely purchasers lived within driving distance of a store. Now with eBay, the dealer can take a rare good to a global audience and have a much larger customer base bid up the price. Switching costs also weaken buyer bargaining power. Wells Fargo has found that customers who use online bill pay (where switching costs are high) are 70 percent less likely to leave the bank than those who don't, suggesting that these switching costs help cement customers to the company even when rivals offer more compelling rates or services.

Tech plays a significant role in shaping and reshaping these five forces, but it's not the only significant force that can create an industry shock. Government deregulation or intervention, political shock, and social and demographic changes can all play a role in altering the competitive landscape. Because we live in an age of constant and relentless change, mangers need to continually visit strategic frameworks to consider any market-impacting shifts. Predicting the future is difficult, but ignoring change can be catastrophic.

Key Takeaways

- Industry competition and attractiveness can be described by considering the following five forces: (1) the intensity of rivalry among existing competitors, (2) the potential for new entrants to challenge incumbents, (3) the threat posed by substitute products or services, (4) the power of buyers, and (5) the power of suppliers.
- In markets where commodity products are sold, the Internet can increase buyer power by increasing price transparency.

2. [3]

3. K. Barnes, "Music Sales Boom, but Album Sales Fizzle for '08," *USA Today*, January 4, 2009.

- The more differentiated and valuable an offering, the more the Internet shifts bargaining power to sellers. Highly differentiated sellers that can advertise their products to a wider customer base can demand higher prices.
- A strategist must constantly refer to models that describe events impacting their industry, particularly as new technologies emerge.

Questions and Exercises

1. What are Porter's "five forces"?
2. Use the five forces model to illustrate competition in the newspaper industry. Are some competitors better positioned to withstand this environment than others? Why or why not? What role do technology and resources for competitive advantage play in shaping industry competition?
3. What is price transparency? What is information asymmetry? How does the Internet relate to these two concepts? How does the Internet shift bargaining power among the five forces?
4. How has the rise of the Internet impacted each of the five forces for music retailers?
5. In what ways is the online music buying experience superior to that of buying in stores?
6. What is the *substitute* for music CDs? What is the comparative sound quality of the substitute? Why would a listener accept an inferior product?
7. Based on Porter's five forces, is this a good time to enter the retail music industry? Why or why not?
8. What is the cost to the music industry of music theft? Cite your source.
9. Discuss the concepts of price transparency and information asymmetry as they apply to the diamond industry as a result of the entry of BlueNile. Name another industry where the Internet has had a similar impact.
10. Under what conditions can the Internet strengthen supplier bargaining power? Give an example.
11. What is the effect of switching costs on buyer bargaining power? Give an example.
12. How does the Internet impact bargaining power for providers of rare or highly differentiated goods? Why?

2.2 POWERFUL RESOURCES

Learning Objectives

1. Understand that technology is often critical to enabling competitive advantage, and provide examples of firms that have used technology to organize for sustained competitive advantage.
2. Understand the value chain concept and be able to examine and compare how various firms organize to bring products and services to market.
3. Recognize the role technology can play in crafting an imitation-resistant value chain, as well as when

technology choice may render potentially strategic assets less effective.

4. Define the following concepts: brand, scale, data and switching cost assets, differentiation, network effects, and distribution channels.
5. Understand and provide examples of how technology can be used to create or strengthen the resources mentioned above.

Management has no magic bullets. There is no exhaustive list of key resources that firms can look to in order to build a sustainable business. And recognizing a resource doesn't mean a firm will be able to acquire it or exploit it forever. But being aware of major sources of competitive advantage can help managers recognize an organization's opportunities and vulnerabilities, and can help them brainstorm winning strategies. And these assets rarely exist in isolation. Oftentimes, a firm with an effective strategic position can create an arsenal of assets that reinforce one another, creating advantages that are particualrly difficult for rivals to successfully challenge.

IMITATION-RESISTANT VALUE CHAINS

While many of the resources below are considered in isolation, the strength of any advantage can be far more significant if firms are able to leverage several of these resources in a way that makes each stronger and makes the firm's way of doing business more difficult for rivals to match. Firms that craft an imitation-resistant value chain have developed a way of doing business that others will struggle to replicate, and in nearly every successful effort of this kind, technology plays a key enabling role. The *value chain* is the set of interrelated activities that bring products or services to market (see below). When we compare FreshDirect's value chain to traditional rivals, there are differences across every element. But most importantly, the elements in FreshDirect's value chain work together to create and reinforce competitive advantages that others cannot easily copy. Incumbents trying to copy the firm would be *straddled* across two business models, unable to reap the full advantages of either. And late-moving pure-play rivals will struggle, as FreshDirect's lead time allows the firm to develop brand, scale, data, and other advantages that newcomers lack (see below for more on these resources).

KEY FRAMEWORK: THE VALUE CHAIN

The value chain is the "set of activities through which a product or service is created and delivered to customers."[45] There are five primary components of the value chain and four supporting components. The primary components are as follows:

- *Inbound logistics*—getting needed materials and other inputs into the firm from suppliers
- *Operations*—turning inputs into products or services
- *Outbound logistics*—delivering products or services to consumers, distribution centers, retailers, or other partners
- *Marketing and sales*—customer engagement, pricing, promotion, and transaction
- *Support*—service, maintenance, and customer support

4.
5. [6]
6. M. Porter, "Strategy and the Internet," *Harvard Business Review* 79, no. 3 (March 2001): 62–78.

The secondary components are the following:

- *Firm infrastructure*—functions that support the whole firm, including general management, planning, IS, and finance
- *Human resource management*—recruiting, hiring, training, and development
- *Technology / research and development*—new product and process design
- *Procurement*—sourcing and purchasing functions

While the value chain is typically depicted as it's displayed in the figure below, goods and information don't necessarily flow in a line from one function to another. For example, an order taken by the marketing function can trigger an inbound logistics function to get components from a supplier, operations functions (to build a product if it's not available), or outbound logistics functions (to ship a product when it's available). Similarly, information from service support can be fed back to advise research and development (R&D) in the design of future products.

When a firm has an imitation-resistant value chain—one that's tough for rivals to copy in a way that yields similar benefits—then a firm may have a critical competitive asset. From a strategic perspective, managers can use the value chain framework to consider a firm's differences and distinctiveness compared to rivals. If a firm's value chain can't be copied by competitors without engaging in painful trade-offs, or if the firm's value chain helps to create and strengthen other strategic assets over time, it can be a key source for competitive advantage. Many of the examples used in this book, including FreshDirect, Amazon, Zara, Netflix, and eBay, illustrate this point.

An analysis of a firm's value chain can also reveal operational weaknesses, and technology is often of great benefit to improving the speed and quality of execution. Firms can often buy software to improve things, and tools such as *supply chain management* (SCM; linking inbound and outbound logistics with operations), *customer relationship management* (CRM; supporting sales, marketing, and in some cases R&D), and *enterprise resource planning* software (ERP; software implemented in modules to automate the entire value chain), can have a big impact on more efficiently integrating the activities within the firm, as well as with its suppliers and customers. But remember, these software tools can be purchased by competitors, too. While valuable, such software may not yield lasting competitive advantage if it can be easily matched by competitors as well.

There's potential danger here. If a firm adopts software that changes a unique process into a generic one, it may have co-opted a key source of competitive advantage particularly if other firms can buy the same stuff. This isn't a problem with something like accounting software. Accounting processes are standardized and accounting isn't a source of competitive advantage, so most firms buy rather than build their own accounting software. But using packaged, third-party SCM, CRM, and ERP software typically requires adopting a very specific way of doing things, using software and methods that can be purchased and adopted by others. During its period of PC-industry dominance, Dell stopped deployment of the logistics and manufacturing modules of a packaged ERP implementation when it realized that the software would require the firm to make changes to its unique and highly successful operating model and that many of the firm's unique supply chain advantages would change to the point where the firm was doing the same thing using the same software as its competitors. By contrast, Apple had no problem adopting third-party ERP software because the firm competes on product uniqueness rather than operational differences.

Dell's Struggles: Nothing Lasts Forever

Michael Dell enjoyed an extended run that took him from assembling PCs in his dorm room as an undergraduate at the University of Texas at Austin to heading the largest PC firm on the planet. For years Dell's superefficient, vertically integrated manufacturing and direct-to-consumer model combined to help the firm earn seven times

more profit on its own systems when compared with comparably configured rival PCs.[78] And since Dell PCs were usually cheaper, too, the firm could often start a price war and still have better overall margins than rivals.

It was a brilliant model that for years proved resistant to imitation. While Dell sold direct to consumers, rivals had to share a cut of sales with the less efficient retail chains responsible for the majority of their sales. Dell's rivals struggled in moving toward direct sales because any retailer sensing its suppliers were competing with it through a direct-sales effort could easily chose another supplier that sold a nearly identical product. It wasn't that HP, IBM, Sony, and so many others didn't see the advantage of Dell's model—these firms were wedded to models that made it difficult for them to imitate their rival.

But then Dell's killer model, one that had become a staple case study in business schools worldwide, began to lose steam. Nearly two decades of observing Dell had allowed the contract manufacturers serving Dell's rivals to improve manufacturing efficiency.[1011] Component suppliers located near contract manufacturers, and assembly times fell dramatically. And as the cost of computing fell, the price advantage Dell enjoyed over rivals also shrank in absolute terms. That meant savings from buying a Dell weren't as big as they once were. On top of that, the direct-to-consumer model also suffered when sales of notebook PCs outpaced the more commoditized desktop market. Notebooks can be considered to be more differentiated than desktops, and customers often want to compare products in person—lift them, type on keyboards, and view screens—before making a purchase decision.

In time, these shifts created an opportunity for rivals to knock Dell from its ranking as the world's number one PC manufacturer. Dell has even abandoned its direct-only business model and now also sells products through third-party brick-and-mortar retailers. Dell's struggles as computers, customers, and the product mix changed all underscore the importance of continually assessing a firm's strategic position among changing market conditions. There is no guarantee that today's winning strategy will dominate forever.

BRAND

A firm's brand is the symbolic embodiment of all the information connected with a product or service, and a strong brand can also be an exceptionally powerful resource for competitive advantage. Consumers use brands to *lower search costs*, so having a strong brand is particularly vital for firms hoping to be the first online stop for consumers. Want to buy a book online? Auction a product? Search for information? Which firm would you visit first? Almost certainly Amazon, eBay, or Google. But how do you build a strong brand? It's *not* just about advertising and promotion. First and foremost, customer experience counts. A strong brand *proxies quality* and *inspires trust*, so if consumers can't rely on a firm to deliver as promised, they'll go elsewhere. As an upside, tech can play a critical role in rapidly and cost-effectively strengthening a brand. If a firm performs well, consumers can often be enlisted to promote a product or service (so-called viral marketing). Consider that while scores of dot-coms burned through money on Super Bowl ads and other costly promotional efforts, Google, Hotmail, Skype, eBay, Facebook, LinkedIn, Twitter, YouTube, and so many other dominant online properties built multimillion member followings before committing any significant spending to advertising.

Early customer accolades for a novel service often mean that positive press (a kind of free advertising) will also likely follow. But show up late and you may end up paying much more to counter an incumbent's place in the consumer psyche. In recent years, Amazon has spent no money on television advertising, while rivals Buy.com and Overstock.com spent millions. Google, another strong brand, has become a verb, and the cost to challenge

7.
8. [9]
9. B. Breen, "Living in Dell Time," *Fast Company*, December 19, 2007, http://www.fastcompany.com/magazine/88/dell.html.
10.
11. [12]
12. T. Friscia, K. O'Marah, D. Hofman, and J. Souza, "The AMR Research Supply Chain Top 25 for 2009," *AMR Research*, May 28, 2009, http://www.amrresearch.com/Content/View.aspx?compURI=tcm:7-43469.

it is astonishingly high. Yahoo! and Microsoft's Bing each spent $100 million on Google-challenging branding campaigns, but the early results of these efforts seemed to do little to grow share at Google's expense.[1314] Branding is difficult, but if done well, even complex tech products can establish themselves as killer brands. Consider that Intel has taken an ingredient product that most people don't understand, the microprocessor, and built a quality-conveying name recognized by computer users worldwide.

SCALE

Many firms gain advantages as they grow in size. Advantages related to a firm's size are referred to as scale advantages. Businesses benefit from economies of scale when the cost of an investment can be spread across increasing units of production or in serving a growing customer base. Firms that benefit from scale economies as they grow are sometimes referred to as being *scalable*. Many Internet and tech-leveraging businesses are highly scalable since, as firms grow to serve more customers with their existing infrastructure investment, profit margins improve dramatically.

Consider that in just one year, the Internet firm BlueNile sold as many diamond rings with just 115 employees and one Web site as a traditional jewelry retailer would sell through 116 stores.[16] And with lower operating costs, BlueNile can sell at prices that brick-and-mortar stores can't match, thereby attracting more customers and further fueling its scale advantages. Profit margins improve as the cost to run the firm's single Web site and operate its one warehouse is spread across increasing jewelry sales.

A growing firm may also gain *bargaining power with its suppliers or buyers*. Apple's dominance of smartphone and tablet markets has allowed the firm to lock up 60 percent of the world's supply of advanced touch-screen displays, and to do so with better pricing than would be available to smaller rivals.[1819] Similarly, for years eBay could raise auction fees because of the firm's market dominance. Auction sellers who left eBay lost pricing power since fewer bidders on smaller, rival services meant lower prices.

The scale of technology investment required to run a business can also act as a barrier to entry, discouraging new, smaller competitors. Intel's size allows the firm to pioneer cutting-edge manufacturing techniques and invest $7 billion on next-generation plants.[2122] And although Google was started by two Stanford students with borrowed computer equipment running in a dorm room, the firm today runs on an estimated 1.4 million servers.[2425] The investments being made by Intel and Google would be cost-prohibitive for almost any newcomer to justify.

SWITCHING COSTS AND DATA

Switching costs exist when consumers incur an expense to move from one product or service to another. Tech firms often benefit from strong switching costs that cement customers to their firms. Users invest their time

13.
14. [15]
15. J. Edwards, "JWT's $100 Million Campaign for Microsoft's Bing Is Failing," *BNET*, July 16, 2009.
16. [17]
17. T. Mullaney, "Jewelry Heist," *BusinessWeek*, May 10, 2004.
18.
19. [20]
20. S. Yin, "Report: Apple Controls 60% of Touchscreen Supply," *PCMag.com*, February 17, 2011.
21.
22. [23]
23. J. Flatley, "Intel Invests $7 Billion in Stateside 32nm Manufacturing," *Engadget*, February 10, 2009.
24.
25. [26]
26. R. Katz, "Tech Titans Building Boom," *IEEE Spectrum* 46, no. 2 (February 1, 2009): 40–43.

learning a product, entering data into a system, creating files, and buying supporting programs or manuals. These investments may make them reluctant to switch to a rival's effort.

Similarly, firms that seem dominant but that don't have high switching costs can be rapidly trumped by strong rivals. Netscape once controlled more than 80 percent of the market share in Web browsers, but when Microsoft began bundling Internet Explorer with the Windows operating system and (through an alliance) with America Online (AOL), Netscape's market share plummeted. Customers migrated with a mouse click as part of an upgrade or installation. Learning a new browser was a breeze, and with the Web's open standards, most customers noticed no difference when visiting their favorite Web sites with their new browser.

Sources of Switching Costs

- Learning costs: Switching technologies may require an investment in learning a new interface and commands.
- Information and data: Users may have to reenter data, convert files or databases, or may even lose earlier contributions on incompatible systems.
- Financial commitment: Can include investments in new equipment, the cost to acquire any new software, consulting, or expertise, and the devaluation of any investment in prior technologies no longer used.
- Contractual commitments: Breaking contracts can lead to compensatory damages and harm an organization's reputation as a reliable partner.
- Search costs: Finding and evaluating a new alternative costs time and money.
- Loyalty programs: Switching can cause customers to lose out on program benefits. Think frequent purchaser programs that offer "miles" or "points" (all enabled and driven by software).[27]

It is critical for challengers to realize that in order to win customers away from a rival, a new entrant must not only demonstrate to consumers that an offering provides more value than the incumbent, they have to ensure that their value added exceeds the incumbent's value *plus* any perceived customer switching costs. If it's going to cost you and be inconvenient, there's no way you're going to leave unless the benefits are overwhelming.

Data can be a particularly strong switching cost for firms leveraging technology. A customer who enters her profile into Facebook, movie preferences into Netflix, or grocery list into FreshDirect may be unwilling to try rivals—even if these firms are cheaper—if moving to the new firm means she'll lose information feeds, recommendations, and time savings provided by the firms that already know her well. Fueled by scale over time, firms that have more customers and have been in business longer can gather more data, and many can use this data to improve their value chain by offering more accurate demand forecasting or product recommendations.

Competing on Tech Alone Is Tough: Gmail versus Rivals

Switching e-mail services can be a real a pain. You've got to convince your contacts to update their address books, hope that any message-forwarding from your old service to your new one remains active and works properly, and regularly check the old service to be sure nothing is caught in junk folder purgatory. Not fun. So when Google entered the market for free e-mail, challenging established rivals Yahoo! and Microsoft Hotmail, it knew it needed to offer an overwhelming advantage to lure away customers who had used these other services for years. Google's offering? A mailbox with vastly more storage than its competitors. With 250 to 500 times the capacity of rivals,

27. [28]

28. Adapted from C. Shapiro and H. Varian, "Locked In, Not Locked Out," *Industry Standard*, November 2–9, 1998.

Gmail users were liberated from the infamous "mailbox full" error, and could send photos, songs, slideshows, and other rich media files as attachments.

A neat innovation, but one based on technology that incumbents could easily copy. Once Yahoo! and Microsoft saw that customers valued the increased capacity, they quickly increased their own mailbox size, holding on to customers who might otherwise have fled to Google. Four years after Gmail was introduced, the service still had less than half the users of each of its two biggest rivals.

DIFFERENTIATION

Commodities are products or services that are nearly identically offered from multiple vendors. Consumers buying commodities are highly price-focused since they have so many similar choices. In order to break the commodity trap, many firms leverage technology to *differentiate* their goods and services. Dell gained attention from customers not only because of its low prices, but also because it was one of the first PC vendors to build computers based on customer choice. Want a bigger hard drive? Don't need the fast graphics card? Dell will oblige.

Data is not only a switching cost, it also plays a critical role in differentiation. Each time a visitor returns to Amazon, the firm uses browsing records, purchase patterns, and product ratings to present a custom home page featuring products that the firm hopes the visitor will like. Customers value the experience they receive at Amazon so much that the firm received the highest score ever recorded on the University of Michigan's American Customer Satisfaction Index (ACSI). The score was not just the highest performance of any online firm, it was the highest ranking that any service firm in any industry had ever received.

Capital One has also used data to differentiate its offerings. The firm mines data and runs experiments to create risk models on potential customers. Because of this, the credit card firm aggressively pursued a set of customers that other lenders considered too risky based on simplistic credit scoring. Technology determined that a subset of underserved customers was not properly identified by conventional techniques and was actually a good bet. Finding profitable new markets that others ignored allowed Capital One to grow its EPS (earnings per share) 20 percent a year for seven years, a feat matched by less than 1 percent of public firms.[29]

NETWORK EFFECTS

Facebook is by far the most dominant social network worldwide. Microsoft Windows has a 90 percent market share in operating systems. EBay has an 80 percent share of online auctions. Why are these firms so dominant? Largely due to the concept of network effects. Network effects (sometimes called *network externalities* or *Metcalfe's Law*) exist when a product or service becomes more valuable as more people use it. If you're the first person with a Facebook account, then Facebook isn't very valuable. But with each additional user, there's one more person to communicate with. A firm with a big network of users might also see value added by third parties. Apple's iOS devices (the iPhone, iPod touch, and iPad) and Google's Android dominate rivals from Microsoft and HP in part because Apple and Google have tens of thousands more apps that run on and enhance these devices, and most of these apps are provided by firms other than Apple and Google. Third-party add-on products, books, magazines, or even skilled labor are all attracted to networks of the largest number of users, making dominant products even more valuable.

Switching costs also play a role in determining the strength of network effects. Tech user investments often go far beyond simply the cost of acquiring a technology. Users spend time learning a product; they buy add-ons, create files, and enter preferences. Because no one wants to be stranded with an abandoned product and lose this additional investment, users may choose a technically inferior product simply because the product has a larger user base and is perceived as having a greater chance of being offered in the future. The virtuous cycle of network

29. [30]

30. T. Davenport and J. Harris, *Competing on Analytics: The New Science of Winning* (Boston: Harvard Business School Press, 2007).

effects[31] doesn't apply to all tech products, and it can be a particularly strong asset for firms that can control and leverage a leading standard (think Apple's iPhone and iPad with their closed systems versus the once-dominant but now rarely used Netscape browser, which was almost entirely based on open standards), but in some cases where network effects are significant, they can create winners so dominant that firms with these advantages enjoy a near-monopoly hold on a market.

DISTRIBUTION CHANNELS

If no one sees your product, then it won't even get considered by consumers. So distribution channels—the path through which products or services get to customers—can be critical to a firm's success. Again, technology opens up opportunities for new ways to reach customers.

Users can be recruited to create new distribution channels for your products and services (usually for a cut of the take). You may have visited Web sites that promote books sold on Amazon.com. Web site operators do this because Amazon gives them a percentage of all purchases that come in through these links. Amazon now has over 1 million of these "associates" (the term the firm uses for its affiliates), yet it only pays them if a promotion gains a sale. Google similarly receives some 30 percent of its ad revenue not from search ads, but from advertisements distributed within third-party sites ranging from lowly blogs to the *New York Times*.[32]

In recent years, Google and Microsoft have engaged in bidding wars, trying to lock up distribution deals that would bundle software tools, advertising, or search capabilities with key partner offerings. Deals with partners such as Dell, Nokia, and Verizon Wireless have been valued at up to $1 billion each.[34]

The ability to distribute products by bundling them with existing offerings is a key Microsoft advantage. But beware—sometimes these distribution channels can provide firms with such an edge that international regulators have stepped in to try to provide a more level playing field. Microsoft was forced by European regulators to unbundle the Windows Media Player, for fear that it provided the firm with too great an advantage when competing with the likes of RealPlayer and Apple's QuickTime.

WHAT ABOUT PATENTS?

Intellectual property protection can be granted in the form of a patent for those innovations deemed to be useful, novel, and nonobvious. In the United States, technology and (more controversially) even business models can be patented, typically for periods of twenty years from the date of patent application. Firms that receive patents have some degree of protection from copycats that try to identically mimic their products and methods.

The patent system is often considered to be unfairly stacked against start-ups. U.S. litigation costs in a single patent case average about $5 million,[3637] and a few months of patent litigation can be enough to sink an early stage firm. Large firms can also be victims. So-called patent trolls hold intellectual property not with the goal of bringing novel innovations to market but instead in hopes that they can sue or extort large settlements from

31. A virtuous adoption cycle occurs when network effects exist that make a product or service more attractive (increases benefits, reduces costs) as the adopter base grows.
32. [33]
33. Google Fourth Quarter 2008 Earnings Summary, http://investor.google.com/earnings.html.
34. [35]
35. N. Wingfield, "Microsoft Wins Key Search Deals," *Wall Street Journal*, January 8, 2009; P. Clarke, "Report: Microsoft to Pay Nokia $1 Billion for Support," *EETimes*, March 8, 2011.
36.
37. [38]
38. B. Feld, "Why the Decks Are Stacked against Software Startups in Patent Litigation," *Technology Review*, April 12, 2009.

others. BlackBerry maker Research in Motion's $612 million settlement with the little-known holding company NTP is often highlighted as an example of the pain trolls can inflict.[39]

Even if an innovation is patentable, that doesn't mean that a firm has bulletproof protection. Some patents have been nullified by the courts upon later review (usually because of a successful challenge to the uniqueness of the innovation). Software patents are also widely granted, but notoriously difficult to defend. In many cases, coders at competing firms can write substitute algorithms that aren't the same, but accomplish similar tasks. For example, although Google's PageRank search algorithms are fast and efficient, Microsoft, Yahoo! and others now offer their own noninfringing search that presents results with an accuracy that many would consider on par with PageRank. Patents do protect tech-enabled operations innovations at firms like Netflix and Caesars Entertainment Corporation (formerly known as Harrah's), and design innovations like the iPod click wheel. But in a study of the factors that were critical in enabling firms to profit from their innovations, Carnegie Mellon professor Wes Cohen found that patents were only the fifth most important factor. Secrecy, lead time, sales skills, and manufacturing all ranked higher.[41]

Key Takeaways

- Technology can play a key role in creating and reinforcing assets for sustainable advantage by enabling an imitation-resistant value chain; strengthening a firm's brand; collecting useful data and establishing switching costs; creating a network effect; creating or enhancing a firm's scale advantage; enabling product or service differentiation; and offering an opportunity to leverage unique distribution channels.
- The value chain can be used to map a firm's efficiency and to benchmark it against rivals, revealing opportunities to use technology to improve processes and procedures. When a firm is resistant to imitation, a superior value chain may yield sustainable competitive advantage.
- Firms may consider adopting packaged software or outsourcing value chain tasks that are not critical to a firm's competitive advantage. A firm should be wary of adopting software packages or outsourcing portions of its value chain that are proprietary and a source of competitive advantage.
- Patents are not necessarily a sure-fire path to exploiting an innovation. Many technologies and business methods can be copied, so managers should think about creating assets like the ones previously discussed if they wish to create truly sustainable advantage.
- Nothing lasts forever, and shifting technologies and market conditions can render once strong assets as obsolete.

Questions and Exercises

1. Define and diagram the value chain.
2. Discuss the elements of FreshDirect's value chain and the technologies that FreshDirect uses to give the firm a competitive advantage. Why is FreshDirect resistant to imitation from incumbent firms? What advantages does FreshDirect have that insulate the firm from serious competition from start-ups copying its model?

39. [40]
40. T. Wu, "Weapons of Business Destruction," *Slate*, February 6, 2006; R. Kelley, "BlackBerry Maker, NTP Ink $612 Million Settlement," *CNN Money*, March 3, 2006.
41. [42]
42. T. Mullaney and S. Ante, "InfoWars," *BusinessWeek*, June 5, 2000.

3. Which firm should adopt third-party software to automate its supply chain—Dell or Apple? Why? Identify another firm that might be at risk if it adopted generic enterprise software. Why do you think this is risky and what would you recommend as an alternative?
4. Identify two firms in the same industry that have different value chains. Why do you think these firms have different value chains? What role do you think technology plays in the way that each firm competes? Do these differences enable strategic positioning? Why or why not?
5. How can information technology help a firm build a brand inexpensively?
6. Describe BlueNile's advantages over a traditional jewelry chain. Can conventional jewelers successfully copy BlueNile? Why or why not?
7. What are switching costs? What role does technology play in strengthening a firm's switching costs?
8. In most markets worldwide, Google dominates search. Why hasn't Google shown similar dominance in e-mail, as well?
9. Should Lands' End fear losing customers to rivals that copy its custom clothing initiative? Why or why not?
10. How can technology be a distribution channel? Name a firm that has tried to leverage its technology as a distribution channel.
11. Do you think it is possible to use information technology to achieve competitive advantage? If so, how? If not, why not?
12. What are network effects? Name a product or service that has been able to leverage network effects to its advantage.
13. For well over a decade, Dell earned above average industry profits. But lately the firm has begun to struggle. What changed?
14. What are the potential sources of switching costs if you decide to switch cell phone service providers? Cell phones? Operating systems? PayTV service?
15. Why is an innovation based on technology alone often subjected to intense competition?
16. Can you think of firms that have successfully created competitive advantage even though other firms provide essentially the same thing? What factors enable this success?
17. What role did network effects play in your choice of an instant messaging client? Of an operating system? Of a social network? Of a word processor? Why do so many firms choose to standardize on Microsoft Windows?
18. What can a firm do to prepare for the *inevitable* expiration of a patent (patents typically expire after twenty years)? Think in terms of the utilization of other assets and the development of advantages through employment of technology.

Unit 2 Activity and Assessment

UNIT 2 DISCUSSION

#1
Use the company you chose for the discussion board activity in Unit 1 to complete this question. Use Porter's Five Forces to explore the competitive advantage that this company has in the industry. How does the current Five Forces analysis help explain the current competitive advantage in the industry? How is the value chain used to increase competitive advantage? If it is not used effectively, what adjustments to the current value chain would you suggest to increase the competitiveness of the company?

UNIT 2 ACTIVITY

For this activity, you will write a 2-3 page paper on the development of an operation management plan that focuses on your business concept that you developed for the Unit 1 Activity.

Learning Objective
Analyze operation processes from a variety of perspectives such as productivity, workflow, and quality.

Specifications:

- 2-3 page paper
- Created in a Word document
- Follows APA, 6th edition formatting
- Includes a Reference page for cited sources

Instructions: For this activity, you will write a 2-3 page paper on the development of an operation management plan that focuses on your business concept that you developed for the Unit 1 Activity. A minimum of four scholarly resources should be used in order to support your plan, citing your sources in APA format. Make sure to include a References
section that also lists the sources used in APA format. As you write your paper, you should address the following questions and topics:

1. Purchasing procedures**:** Identify the necessary input (raw materials necessary to generate the output, or product). Who will or can you buy the raw materials from? If you are providing a service, what supplies will you need to begin and where will they be purchased from?

2. What accounting and/or purchasing system(s) will you need to accomplish buying either a product line or a service-based business?
3. Quality control procedures: Identify what quality control measures you will use in order to make sure the product or service meets consumer standards.

For example, if your business concept was to open a bed and breakfast, to answer question 1, you will want to estimate how many rooms you will need; how many guests [on average] you intend to host; and where you will obtain your groceries, paper items, soap, and other guest necessities? Will you shop at a grocery store, use a shopping club like Costco or Sam's Club, or obtain your inputs through some other means?

Question 2 would include a review of accounting software or systems such as: Sage Peachtree Accounting, Quickbook or Netsuite Financials (or another you may feel comfortable with). Identify why you chose this system or software for your particular business in order to justify its applicability.

Question 3 would need a similar discussion as you identify your quality assurance/control measures that you intend to use to help minimize defects or errors as you produce a product or provide a service. Your review of quality control measures will include a discussion such as: Will there be a quality control manager named for your business? Why, or why not? Will your business use Six Sigma processes in its operation? Why, or why not? Is there a need to utilize ISO 9000 quality standards? Why, or why not?

Be specific in your essay. It may be helpful to "brainstorm your needs" on a separate sheet of paper and once done, create an outline for this section (numbers 1, 2, and 3), using topical headings. Then, note how you will address each requirement of these sections with specific content.

Please score your paper or have a friend score your paper using the "rubric," or "scoring guide" on the following page. The levels will equate to the following letter grades:

4 = A; 3 = B; 2 = C; 1 = D; and 0 = F

Level	Criterion/Requirement
	Research and Documentation (40%)
4	A minimum of four scholarly/peer-reviewed publications should be used to support your content. References should come from scholarly sources (i.e. textbooks, scholarly articles, etc). Any in-text citations MUST be cited in APA format using the APA Manual 6th edition. You should also include a References page, also in APA format, at the end of your paper to cite any sources used.
3	The paper uses at least three scholarly sources to support your content, but it does not meet the minimum requirement for 4 sources.
2	Three or more popular sources (i.e. newspapers, internet sites, magazines, etc.) make up a majority of the references to support your content. The paper lacks credible, scholarly sources and does not meet the minimum number of sources required.
1	The paper includes one or two sources. The paper lacks the use of credible, scholarly sources and may focus on using popular sources. The number of sources used does not meet the minimum requirement (4 sources) and the resources used may not fully support the content of your paper.
0	The paper fails to cite referenced sources, or does not include any research or sources to support ideas. The paper is based off of non-original content.
	Analysis and Argument (40%)
4	Your paper addresses the three questions in the instructions with the use of supporting evidence and specific details and explanation. You effectively address the following:Identify and assess any specific purchasing procedures you will use in obtaining supplies, or inputs, for your company.Discuss any specific accounting systems you will use for this company to help you analyze and evaluate the financial condition of your company. List specific quality control procedures/processes the company will use to help ensure quality whether you are providing a product or a service.
3	The content addresses only some of the questions presented in the instructions section and reflects minimal original thought and /or critical analysis relative to the business.
2	The content is vague and is weakly supported by researched evidence. The essay lacks critical analysis relative to the business.
1	The content does not address the required elements; ideas presented are not supported by research or critical analysis.
0	There is a lack of critical analysis for the operation management plan, and/or the essay does not address the business content from the Unit 1 Activity.
	Grammar/Style (15%)
4	The content contains a maximum of two grammatical, citation, and punctuation errors. The ideas are concise and presented in a logical manner that is easy for the reader to follow.
3	The content contains three or four grammatical, citation, punctuation, and/or spelling errors. The sentence structure flows in a concise, logical manner.
2	The paper contains more than four grammatical, citation, punctuation and/or spelling errors that distract the reader from the comprehension of ideas being presented.
1	The paper demonstrates poor writing skills, reflected by lack of syntax and proper grammar, which makes ideas difficult to communicate. Ideas are not presented in a logical manner that is easy to follow.
0	The paper contains numerous grammatical, citation, punctuation, and/or spelling errors that detract from the reader's comprehension.

	Format (5%)
4	The paper is properly formatted (paragraph style, margins, etc.), using the APA Manual, 6th edition. The content is typed in MS Word format, labeled with the student's name and the activity title/unit number, and a reference section to cite any outside sources used. The essay meets the page requirement of 2-3 full pages.
3	The paper meets most of the requirements for formatting, using the APA Manual, 6th edition, though may contain some errors. The paper is close to meeting the page requirements of 2-3 full pages.
2	The paper lacks proper formatting, based on the APA Manual, 6th edition, and it may use another style of formatting (i.e. MLA, Chicago, etc.). The paper does not quite meet the page length requirement, and may be less than 2 pages.
1	The paper is typed in a format other than MS Word. A style of formatting other than APA may be used. The page length requirement was not completely met, and the paper may be about a half to 1 full page.
0	The formatting does not comply with the APA Manual, 6th edition and is not created in MS Word. The paper does not meet the 2-3 page length requirement.

UNIT 3: PRODUCT DESIGN AND THE PROCESS SELECTION

Unit 3: Product Design and Process Selection

If you have purchased a mobile phone recently, you have witnessed a product category with perhaps the most diverse range of product designs in the marketplace. The variety can be mind-boggling. Looking back a year or two, you can probably recall a design that looked very promising, but simply faded away from the shelves after a few months. Have you ever wondered what happened to those short-lived products?

Businesses want to design the products that consumers demand. A good marketing department can tell the organization what consumers want, and even convince consumers that they want it. A company with the most wonderful product concept cannot be successful unless it also can devise a process to profitably manufacturer the product. In this unit, we will consider the steps involved in designing a product with the manufacturing process in mind. We will look at several models that businesses can use to select the best design process or analyze an existing process.

Unit 3 Learning Outcomes

Learning Objectives

Upon successful completion of this unit, you will be able to:

- describe the steps in the product/service design process:
  - evaluate opportunities and select best idea,
  - get feedback and refine concept,
  - evaluate product/service performance and appeal to market
  - design with manufacturing/delivery in mind,
  - build and test prototypes/ service,
  - ramp up production or capability and run market tests, and
  - launch the product/service;
- discuss how managers can use the cost-volume-profit model to estimate profit level by volume;
- apply customer needs research methods as a way to improve design;
- and evaluate the appropriateness of applying project, batch, mass, and continuous process types.

3.1: Generating Ideas

NEW PRODUCT DEVELOPMENT

INNOVATION

Innovation is the creation of better, more effective products, processes, services, or technologies.

Learning Objectives

Subdivide the innovation process in to sources, goals, failures, and diffusion

Key Takeaways

Key Points

- Innovation is defined in this context as the development of better products or services.
- In business and economics, innovation is the catalyst to growth. With rapid advancements in transportation and communications over the past few decades, the old-world concepts of factor endowments and comparative advantage, which focused on an area's unique inputs, are outmoded for today's economy.
- In the organizational context, innovation may be linked to positive changes in efficiency, productivity, quality, competitiveness, market share, and others. All organizations can innovate, including hospitals, universities, and local governments.

Key Terms

- **innovation**: The creation of better or more effective products, processes, services, technologies, or ideas that are not readily available but will soon be.

In business and economics, innovation is the catalyst to growth. With rapid advancements in transportation and communications over the past few decades, the old-world concepts of factor endowments and comparative advantage, which focused on an area's unique inputs, are outmoded for today's global economy.

Organizations

In the organizational context, innovation may be linked to positive changes in efficiency, productivity, quality, competitiveness, market share, and others. All organizations can innovate, including hospitals, universities, and local governments.

Sources of Innovation

The famous robotics engineer Joseph F. Engelberger asserts that innovations require only three things: (1) A recognized need; (2) competent people with relevant technology; (3) financial support.

The Kline Chain-linked model of innovation places emphasis on potential market needs as drivers of the innovation process, and describes the complex and often iterative feedback loops between marketing, design, manufacturing, and research and development (R&D). Innovation by businesses is achieved in many ways, with much attention now given to formal research and development for "breakthrough innovations. " R&D helps spur on patents and other scientific innovations that lead to productive growth in such areas as industry, medicine, engineering, and government. Yet, innovations can be developed by less formal on-the-job modifications of practice, through exchange and combination of professional experience and by many other routes. The more radical and revolutionary innovations tend to emerge from R&D, while more incremental innovations may emerge from practice—but there are many exceptions to each of these trends. An important innovation factor includes customers buying products or using services. As a result, firms may incorporate users in focus groups (user-centered approach), work closely with so-called lead users (lead user approach) or users might adapt their products themselves.

Goals and Failures

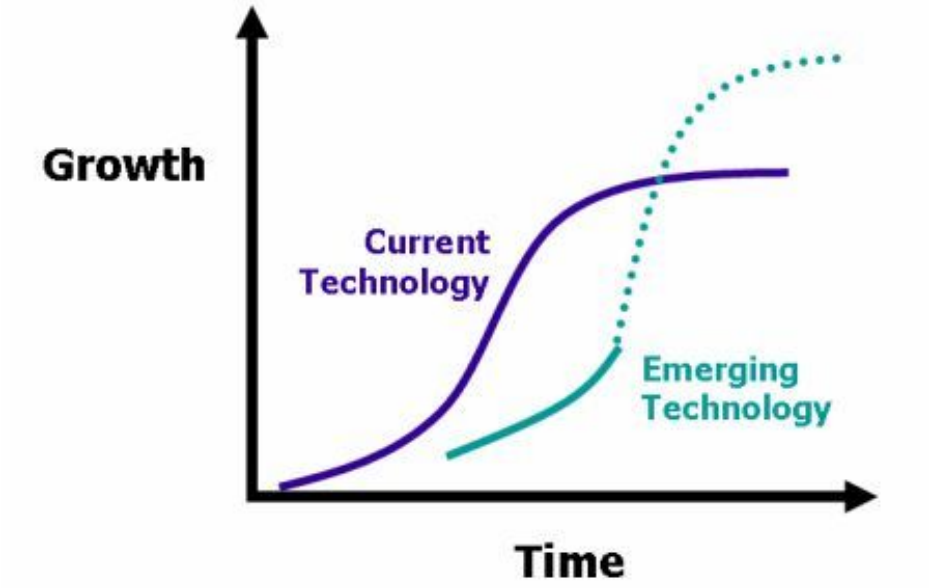
Programs of organizational innovation are typically tightly linked to organizational goals and objectives, to the business plan, and to market competitive positioning. One driver for innovation programs in corporations is to achieve growth objectives. A survey across a large number of manufacturing and services organizations found that systematic programs of organizational innovation are most frequently driven by (ranked in decreasing order of popularity): Improved quality, creation of new markets, extension of the product, range, reduced labor costs, improved production processes, reduced materials, reduced environmental damage, replacement of products/ services, reduced energy consumption, and conformance to regulations. These goals vary between improvements to products, processes and services and dispel a popular myth that innovation deals mainly with new product development. Most of the goals could apply to any organization, be it a manufacturing facility, marketing firm, hospital or local government. Whether innovation goals are successfully achieved depends greatly on the environment prevailing in the firm. Conversely, failure can develop in programs of innovations. The causes of failure have been widely researched and can vary considerably. Some causes will be external to the organization and outside its influence of control while others will be internal and ultimately within the control of the organization. Internal causes of failure can be divided into causes associated with the cultural infrastructure and causes associated with the innovation process itself. Common causes of failure within the innovation process in most organizations can be distilled into five types: (1) Poor goal definition; (2) poor alignment of actions to goals; (3) poor participation in teams; (4) poor monitoring of results; (5) poor communication and access to information.

Diffusion of Innovations

Once innovation occurs, innovations may be spread from the innovator to other individuals and groups. This

process has been proposed that the life cycle of innovations can be described using the "S-curve' or diffusion curve. The S-curve maps growth of revenue or productivity against time. In the early stage of a particular innovation, growth is relatively slow as the new product establishes itself. At some point customers begin to demand and the product growth increases more rapidly. New incremental innovations or changes to the product allow growth to continue. Toward the end of its life cycle growth slows and may even begin to decline. In the later stages, no amount of new investment in that product will yield a normal rate of return.

Innovative companies will typically be working on new innovations that will eventually replace older ones. Successive S-curves will come along to replace older ones and continue to drive growth upwards. The S-curve derives from an assumption that new products are likely to have "product life" (i.e. a start-up phase, a rapid increase in revenue and eventual decline). In fact the great majority of innovations never get off the bottom of the curve, and never produce normal returns.



***Technological Innovation Chart**: In the figure above the first curve shows a current technology. The second shows an emerging technology that currently yields lower growth but will eventually overtake current technology and lead to even greater levels of growth.*

NEW PRODUCT IDEAS

New product ideas can generate from existing frustrations using a certain product, or a desire to do something better or more simply.

Learning Objectives
Explain the front-end process of new product development (NPD) and the characteristics of a SWOT analysis

Key Takeaways
Key Points

- Most new product ideas come from experiences, like frustrations with an existing product.
- There are two parallel paths involved in the NPD process: one involves the idea generation, product design and detail engineering; the other involves market research and marketing analysis.
- Lots of ideas are generated about the new product. Out of these ideas many are implemented. The ideas are generated in many forms. There are many factors responsible for generation of an idea.

Key Terms

- **SWOT Analysis**: a structured planning method used to evaluate the strengths, weaknesses, opportunities, and threats involved in a project or in a business venture
- **life cycle**: The useful life of a product or system; the developmental history of an individual or group in society.
- **product life cycle**: the stages that a good or service goes through from when it is first introduced to when it is taken off the market

In business and engineering, new product development (NPD) is the complete process of bringing a new product to market. A product is a set of benefits offered for exchange. It can be tangible (something physical you can touch) or intangible (like a service, experience, or belief). There are two parallel paths involved in the NPD process: idea generation, including product design and detail engineering; and market research and marketing analysis. Companies typically see new product development as the first stage in generating and commercializing a new product within the overall strategic process of product life cycle management, used to maintain or grow their market share.

Ideas for new products can be obtained from basic research using SWOT analysis: Strengths, Weaknesses, Opportunities & Threats. Many methods may be used to gain insight into new product lines or product features, including:

SWOT Analysis: Here is an example of the SWOT analysis matrix.

- Market and consumer trends
- Research and development
- Competitors
- Focus groups and trade shows
- Employees and corporate spies
- Salespeople
- Ethnographic discovery methods (searching for user patterns and habits)

Five Different Front-End Elements

1. Opportunity identification: Large or incremental business and technological chances are identified in a relatively structured way. Using the guidelines established here, resources are allocated to new projects, leading to a structured New Product & Process Development or NPPD strategy.
2. Opportunity analysis: This element translates identified opportunities into implications for the business and technology specific context of the company. This element focuses on aligning ideas to target customer groups, and can include market studies and/or technical trials and research.
3. Idea genesis: The evolutionary and iterative process of progressing an initial idea from birth to maturation into a tangible idea. This process can occur internally or externally (e.g., a supplier offering a new material or technology, or a customer presenting an unusual request.
4. Idea selection: The decision to pursue an idea is determined by analyzing its potential business value.

5. Concept and technology development: During this part of the front-end, the business case is developed based on estimates of the total available market, customer needs, investment requirements, competition analysis and project uncertainty. Some organizations consider this the first stage of the NPPD process

FOLLOWING A PRODUCT DEVELOPMENT PROCESS

Product development is idea generation, screening, business analysis, technical development, manufacturing, testing, and commercialization.

Learning Objectives

Outline the several stages in new product development

Key Takeaways

Key Points

- Ideas for new products can be obtained from customers (employing user innovation), the company's research and development department, competitors, focus groups, employees, salespeople, and more.
- The object of idea screening is to eliminate unsound concepts prior to devoting resources to them.
- The focus of the business analysis is primarily on profits, but other considerations, such as social responsibilities, may also be involved.
- Manufacturing planning must consider how to secure the availability of required funds, facilities, and personnel at the intended time, as well as the methods of coordinating this effort.
- Test marketing is the final step before commercialization; the objective is to test all the variabilites in the marketing plan including elements of the product.

Key Terms

- **Focus Group**: A group of people, sampled from a larger population, interviewed in open session for market research or political analysis

New Product Development Process

There are several stages in the new product development process–not always followed in order:

Idea Generation

Generating new product ideas is a creative task that requires a specific way of thinking. Ideas for new products can be obtained from customers (employing user innovation), the company's R&D department, competitors, focus groups, employees, sales people, corporate spies, trade shows, or through a policy of Open Innovation. Formal idea generating techniques include attribute listing, forced relationships, brainstorming, morphological analysis, and problem analysis.

Idea Screening

The second step in the product development process is screening. It is a critical part of the development activity. The object is to eliminate unsound concepts prior to devoting resources to them. The screeners must ask at least three questions:

1. Will the customer in the target market benefit from the product?
2. Is it technically feasible to manufacture the product?
3. Will the product be profitable when manufactured and delivered to the customer at the target price ?

Business Analysis

After the various product ideas survive their initial screening, very few viable proposals will remain. Before the development of prototypes can be decided upon, however, a further evaluation will be conducted to gather additional information on these remaining ideas in order to justify the enormous costs required. The focus of the business analysis is primarily on profits, but other considerations, such as social responsibilities, may also be involved. Management must:

- Estimate the likely selling price based upon competition and customer feedback.
- Estimate sales volume based upon size of market.
- Estimate profitability and the break even point.

Technical and Marketing Development

A product that has passed the screening and business analysis stages is ready for technical and marketing development. Technical development involves two steps. The first is the applied laboratory research required to develop exact product specifications.The goal of this research is to construct a prototype model of the product that can be subjected to further study. Once the prototype has been created, manufacturing-methods research can be undertaken to plan the best way of making the product in commercial quantities under normal manufacturing conditions. This is an extremely important step, because there is a significant distinction between what an engineer can assemble in a laboratory and what a factory worker can produce.

Prototypes: One step in the product development process is technical development.

While the laboratory technicians are working on the prototype, the marketing department is responsible for testing the new product with its intended consumers and developing the other elements of the marketing mix. They must ask the following questions:

1. Who is the target market, and who is the decision maker in the purchasing process?
2. What product features must the product incorporate?
3. What benefits will the product provide?
4. How will consumers react to the product?
5. How will the product be produced most cost effectively?
6. What will it cost to produce it?

Marketers must then prove feasibility through a virtual computer-aided rendering and rapid prototyping, and test the concept by asking a sample of prospective customers what they think of the idea.

Manufacturing Planning

Assuming that the product has cleared the technical and marketing development stage, the manufacturing department is asked to prepare plans for producing it. The plan begins with an appraisal of the existing production plant and the necessary tooling required to achieve the most economical production. Compromise between attractiveness and economy is often necessary. Finally, manufacturing planning must consider how to secure the availability of required funds, facilities, and personnel at the intended time, as well as the methods of coordinating this effort.

Marketing Planning

It is at this point that the product planner must prepare a complete marketing plan–one that starts with a statement of objectives and ends with the fusion of product, distribution, promotion, and pricing into an integrated program of marketing action.

Test Marketing

Test marketing is the final step before commercialization; the objective is to test all the variabilites in the marketing plan including elements of the product.

Commercialization (often considered post-NPD)

At last, the product is ready to go. It has survived the development process, and it is now on the way to commercial success. How can it be guided to that marketing success? It is the purpose of the lifecycle marketing plan to answer this question. Such a complete marketing program will, of course, involve additional decisions about distribution, promotion, and pricing.

SCREENING

Idea screening attempts to eliminate unsound product concepts prior to devoting resources to them.

Learning Objectives

Explain how product developers use a simple checklist and assign weights of importance in order to best screen ideas

Key Takeaways

Key Points

- If a poor product idea is allowed to pass the screening state, it wastes effort and money in subsequent stages until it is later abandoned. However, the possibility of screening out a worthwhile idea is even more serious.
- The first technique of screening is a simple checklist. For example, new product ideas can be rated on a scale ranging from very good to poor.
- A second technique goes beyond the first, in which criteria are assigned importance weights, with products rated on a point scale measuring product compatibility.
- New product criteria include value added, sales volume, patent protection and affect on present products.

Key Terms

- **patent**: A declaration issued by a government agency declaring someone the inventor of a new invention and having the privilege of stopping others from making, using or selling the claimed invention; a letter patent.
- **idea screening**: the process of testing concepts and eliminating unsound ones

Idea screening is an early step in the new product development process and is a critical part of the development activity. If a poor product idea is allowed to pass the screening state, it wastes effort and money in subsequent stages until it is later abandoned. However, the possibility of screening out a worthwhile idea is even more serious, There are two common techniques for screening new product ideas. Both involve the comparison of a potential product idea against criteria of acceptable new products.

The first technique is a simple checklist. For example, new product ideas can be rated on a scale ranging from very good to poor by such criteria as value added, sales volume, patent protection and affect on present products. Unfortunately, it is quite difficult for raters to define what is fair or poor. In addition, the rating system does not address the issue of the time and expense associated with each idea, nor does it instruct with regard to scores. A second technique goes beyond the first, in which criteria are assigned importance weights, with products rated on a point scale measuring product compatibility. These scores are then multiplied by their respective weights and added to yield a total score for the new product idea.

SUMMARY

The object is to eliminate unsound concepts prior to devoting resources to them.

The screeners should ask several questions:

1. Will the customer in the target market benefit from the product?
2. What is the size and growth forecast of the market segment / target market?
3. What is the current or expected competitive pressure for the product idea?
4. What are the industry sales and market trends the product idea is based on?
5. Is it technically feasible to manufacture the product?
6. Will the product be profitable when manufactured and delivered to the customer at the target price?

***Product Screening**: Before introducing the iPad to market, Apple had to go through a process of screening in order to conclude the new product would be a worthwhile investment.*

ANALYSIS

The focus of the business analysis is primarily on profits, but other considerations such as social responsibilities may also be involved.

Learning Objectives

Explain the business analysis stage of new product development

Key Takeaways

Key Points

- Before the development of prototypes can be decided upon, a further evaluation will be conducted to gather additional information on these remaining ideas in order to justify the enormous costs.
- The first step in the business analysis is to examine the projected demand. This would include two major sources of revenue: The sales of the product and the sales or license of the technology developed for or generated as a by-product of the given product.
- A complete cost appraisal is also necessary as a part of the business analysis.
- The Fourt-Woodlock equation is a market research tool to describe the total volume of consumer product purchases per year based on households which initially make trial purchases of the product and those households which make a repeat purchase within the first year.

Key Terms

- **learning curve**: An experience or graphic representation of progress in learning measured against the time required to achieve mastery of something.
- **economies of scale**: The characteristics of a production process in which an increase in the scale of the firm causes a decrease in the long-run average cost of each unit.

After the various product ideas survive their initial screen, very few viable proposals will remain. Before the development of prototypes can be decided upon, however, a further evaluation will be conducted to gather additional information on these remaining ideas in order to justify the enormous costs. The focus of the business analysis is primarily on profits, but other considerations such as social responsibilities may also be involved. The first step in the business analysis is to examine the projected demand. This would include two major sources of revenue: The sales of the product and the sales or license of the technology developed for or generated as a by-product of the given product. A complete cost appraisal is also necessary as a part of the business analysis. It is difficult to anticipate all the costs that will be involved in product development, but the following cost items are typical:

- Expected development cost, including both technical and marketing research and development.
- Expected set-up costs. These can include production, manufacturing equipment, distribution, etc.
- Operating costs that account for possible economies of scale and learning curves.

- Marketing costs, especially promotion and distribution.
- Management costs.

Other necessary steps in business analysis include:

- Estimating the likely selling price based upon competition and customer feedback.
- Estimating sales volume based upon the size of the target market and such tools as the Fourt-Woodlock equation.
- Estimating profitability and the break-even point.

The Fourt-Woodlock equation is a market research tool to describe the total volume of consumer product purchases per year based on households which initially make trial purchases of the product and those households which make a repeat purchase within the first year. Since it includes the effects of initial trial and repeat rates, the equation is useful in new product development.

$$V = (HH \cdot TR \cdot TU) + (HH \cdot TR \cdot MR \cdot RR \cdot RU)$$

The Fourt-Woodlock Equation: The left-hand-side of the equation is the volume of purchases per unit time (usually taken to be one year). On the right-hand-side, the first parentheses describes trial volume, and the second describes repeat volume. HH is the total number of households in the geographic area of projection, and TR ("trial rate") is the percentage of those households which will purchase the product for the first time in a given time period. TU ("trial units") is the number of units purchased on this first purchase occasion. MR is "measured repeat," or the percentage of those who tried the product who will purchase it at least one more time within the first year of the product's launch. RR is the repeats per repeater (the number of repeat purchases within that same year). RU is the number of repeat units purchased on each repeat event.

TESTING

The objective of testing is to test all the variabilites in the marketing plan, including elements of the product.

Learning Objectives

Compare and contrast initial product testing and test marketing

Key Takeaways

Key Points

- Product testing is totally initiated by the producer. He or she selects the sample of people, provides the consumer with the test product, and offers the consumer some sort of incentive to participate.
- In test marketing, the consumer must make the decision him- or herself, must pay using his or her money, and the test product must compete with the existing products in the actual marketing environment.
- Because of the special expertise needed to conduct test markets and the associated expenses, most manufacturers employ independent marketing research agencies with highly trained project directors, statisticians, psychologists, and field supervisors.

Key Terms

- **Market Share**: Percentage of some market held by a company.
- **marketing mix**: The marketing mix is a business tool used in marketing products. The marketing mix is often crucial when determining a product or brand's unique selling point and is often synonymous with the four Ps: price, product, promotion, and place.

Testing is the final step before commercialization. The objective is to test all the variabilites in the marketing plan including elements of the product. Test marketing represents an actual launching of the total marketing program, but on a limited basis.

Three general issues are addressed through test marketing. First, the overall workability of the marketing plan is assessed. Second, alternative allocations of the budget are evaluated. Third, whether the new product is inspiring users to switch from other brands is determined. In the end, the test market should include an estimate of sales, market share, and financial performance over the life of the product.

***Product Testing**: This is a photo of a temperature and humidity chamber used to simulate transport, warehouse environments, and shelf life conditions of a packaged product.*

Initial *product testing* and *test marketing* are not the same. Product testing is totally initiated by the producer. He or she selects a sample of people, provides the consumer with the test product, and offers the consumer some sort of incentive to participate. Test marketing, on the other hand, is distinguished by the fact that the test cities should represent the national market. The consumer must make the decision him- or herself, must pay with his or her money, and the test product must compete with the existing products in the actual marketing environment. For these and other reasons, a market test is an accurate simulation of the national market and serves as a method for reducing risk. It should enhance the new product's probability of success and allow for final adjustment in the marketing mix before the product is introduced on a large scale.

However, running a test marketing simulation has inherent risks. First, there are substantial costs in buying the necessary plant and machinery needed to manufacture the product or locating manufacturers willing to make limited runs. There are also promotional costs, particularly advertising and personal selling. Although not always easy to identify, there are indirect costs as well. For example, the money used to test market could be used for other activities; in other words, there is an opportunity cost. There is also a risk of losing consumer goodwill through the testing of an inferior product. Finally, engaging in a test market might allow competitors to become aware of a new product and quickly copy it.

Because of the special expertise needed to conduct test markets and take on associated expenses, most manufacturers employ independent marketing research agencies with highly trained project directors, statisticians, psychologists, and field supervisors. Such firms assist the product manager in making the remaining test market decisions. These include:

1. Duration of testing: the product should be tested long enough to account for market factors to even out,

allow for repeat purchases, and account for deficiencies in any other elements in the new product (three to six months of testing may be sufficient for a frequently purchased and rapidly consumed convenience item).

2. Selection of test market cities: the test market cities should reflect the norms for the new product in such areas as advertising, competition, distribution system, and product usage.
3. Number of test cities: should be based on the number of variations considered (i.e., price, package, or promotion), representativeness, and cost.
4. Sample size determination: the number of stores used should be adequate to represent the total market.

Even after all the test results are in, adjustments in the product are still made. Additional testing may be required, or the product may be discontinued.

COMMERCIALIZATION

Once a product is ready to take to market, commercialization involves key decisions about distribution, promotion, and pricing.

Learning Objectives

Outline the basics of commercialization

Key Takeaways

Key Points

- The actual launch of a new product is the final stage of new product development, and the one where the most money will have to be spent for advertising, sales promotion, and other marketing efforts.
- Commercialization of a product will only take place if the following three questions can be answered: When is the appropriate time to introduce the product? Where is the appropriate market to launch the product? To whom will the product be targeted primarily?
- The company has to decide on an action plan for introducing the product by implementing the above decisions.

Key Terms

- **marketing mix**: The marketing mix is a business tool used in marketing products. The marketing mix is often crucial when determining a product or brand's unique selling point and is often synonymous with the four Ps: price, product, promotion, and place.

Commercialization is the process or cycle of introducing a new product or production method into the market. This actual launch of a new product is the final stage of new product development, and the one where the most money will have to be spent for advertising, sales promotion, and other marketing efforts. Commercialization

is often confused with sales, marketing or business development. The commercialization process has three key aspects:

***Commercialization**: Bringing new products to market will require creative marketing techniques to achieve success like Red Bull did by creating mascot automobiles.*

- It is essential to look at many ideas to get one or two products or businesses that can be sustained long-term. This is often known as the funnel.
- Commercialization is a stage-wise process, and each stage has its own key goals and milestones.
- It is vital to involve key stakeholders early on, including customers.

Commercialization of a product will only take place if the following three questions can be answered:

1. *When is the appropriate time to introduce the product?* When facing the danger of cannibalizing the sales of the company's other products, if the product can be improved further, or if the economy is down, the launch should be delayed.
2. *Where is the appropriate market to launch the product?* It can be in a single location, in several regions, or it might be more appropriate for a national or international market. This decision will be strongly influenced by the company's resources in terms of capital, managerial confidence and operational capacities. Smaller companies usually launch in attractive cities or regions, while larger companies enter a national market all at once. Global roll outs are generally only undertaken by multinational conglomerates, since they have the necessary size and make use of international distribution systems. Other multinationals use the "lead-country" strategy by introducing the new product in one country/region at a time.
3. *To whom will the product be targeted primarily?* These primary consumer groups should consist of innovators, early adopters, heavy users and/or opinion leaders. This will ensure adoption by other buyers in the marketplace during the product growth period.

The company has to decide on an action plan for introducing the product by thinking about the questions above and making informed decisions. It has to develop a viable marketing mix and create a respective marketing budget.

HAZZ DESIGN: "BRAINSTORM TO BOX: GOOD DESIGN"

Watch this video to learn how design is defined and what makes good design. Good design is often difficult. Once you understand user needs, the creation process requires that those needs be met in the most pleasing and useful way possible. Brainstorming is a method used to help facilitate good design process.

One or more interactive elements has been excluded from this version of the text. You can view them online here:
https://pressbooks.nscc.ca/operationsmanagement2/?p=171#oembed-1

TEDXKYOTO: CATHERINE COURAGE'S "IGNITING CREATIVITY TO TRANSFORM CORPORATE CULTURE"

Watch this video on the importance of developing a culture of creativity to drive business success. Culture is the foundation of what and how we do things within an organization. The culture must support a creative approach to solving problems, designing product/services, and testing new ideas. Consider how you would apply this information to the operations landscape.

One or more interactive elements has been excluded from this version of the text. You can view them online here:
https://pressbooks.nscc.ca/operationsmanagement2/?p=171#oembed-2

RIVER VALLEY TV: LISA R. HOROWITZ'S "USER NEEDS RESEARCH: GENERATING IDEAS FOR PRODUCTS AND SERVICES"

Watch this lecture on the importance of discovering the needs of your customers/users. A product or service will only be successful if the customer/user finds utility in what you have created. This requires user needs research to help identify areas where you can focus the development of new products/services. Consider how you would gather information on what customers' want/need for your current organization.

One or more interactive elements has been excluded from this version of the text. You can view them online here:
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PRODUCT CONCEPT GENERATION

By Mical Nobel

ABSTRACT

Concept generation, getting the ideas, is the most critical step in the engineering design process. Starting with a set of customer needs and target specifications, the process concludes with an array of product alternatives from which a final design is selected. There are multiple steps involved in the generic concept generation process, as well as various approaches. This article reviews and critiques these different perspectives within the context of successfully developing an electronic medical product that is innovative in design and customer appeal.

INTRODUCTION

Concept generation, which is when a product development team comes up with the ideas, is the most critical step in the engineering design process – without it, there is no design. A concept can be defined as both an "approximate description of the technology, working principles, and form of the product" as well as a "concise description of how the product will satisfy customer needs" (Ulrich & Eppinger, 2012). Concept generation is a procedure that begins with a set of customer needs and target specifications and results in an array of product concept design alternatives from which a final design will be selected. This step requires a more abstract style of thinking than perhaps most engineers are used to. As Einstein and Infeld (1938) wrote in The Evolution of Physics, the "formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill. To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science." While many have proposed their own specific theories, approaches, and metrics regarding concept development and, in particular, generation, there are a few general guidelines and postulates that are echoed in each specific method. The common theme: patience and open-mindedness are vital to successful concept generation.

The invention of the light bulb highlights the importance of the concept generation process. Famous inventor Thomas Edison once said, "None of my inventions came by accident. I see a worthwhile need to be met and I make trial after trial until it comes. What it boils down to is 1 percent inspiration and 99 percent perspiration" (Newton, 1989). Edison understood that trying a large quantity of ideas was extremely important, because failure is inevitable. Before finding a stable material for the first successful light bulb, his lab tried and failed with thousands of different filaments (Zenios, et al., 2010). Obviously, the concept that was settled on stuck, because well over 100 years later, commercially available light bulbs are omnipresent.

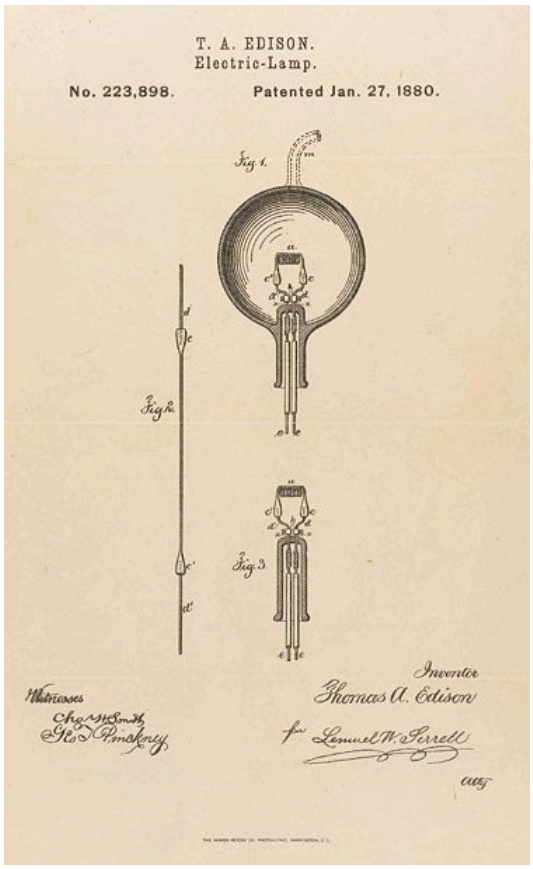

Figure 1 *Thomas Edison's patent drawing and application for an improvement in electric lamps, 1/27/1880; Records of the Patent and Trademark Office; Record Group 241; National Archives [retrieved from the Access to Archival Databases at www.archives.gov, April 24, 2013].*

The Yellow Team, the 2012-2013 Tufts ECE senior design group that served as a case study for this article, faced the added complexities and challenges involved in designing a medical device for their project, which was to digitize an outdated device utilized in assessing glaucoma. Invention is a very intricate process, perhaps more so in the design of medical devices than in most other fields because there are so many factors that must be considered. Some upstream issues include: medical need, gaps in the treatment landscape, stakeholder interests, and market opportunity. Some downstream concerns are: patenting, regulation, reimbursement, and deployment in the healthcare system. Successful concept generation is critical for building a reliable product that will be able to satisfy many multi-faceted requirements.There are two components in the concept generation stage: ideation, and then concept screening. Each component comes with its own set of rules and guidelines. Yet we can combine and break down the whole stage into a generic five step process.

STEP ONE: CLARIFY AND DECONSTRUCT THE PROBLEM

Before coming up with any possible solutions, familiarization with some background information may be necessary. Perhaps the most important in a situation where people are looking to develop a solution to needs, the needs specification and problem deconstruction forms the foundation of this background information. For example, the Yellow Team found it important to have an overview of existing treatment options and a basic

understanding of electronics and sensors in order to facilitate their flow of ideas and discussion. It is also really critical to decompose a complex problem into simpler sub-problems.

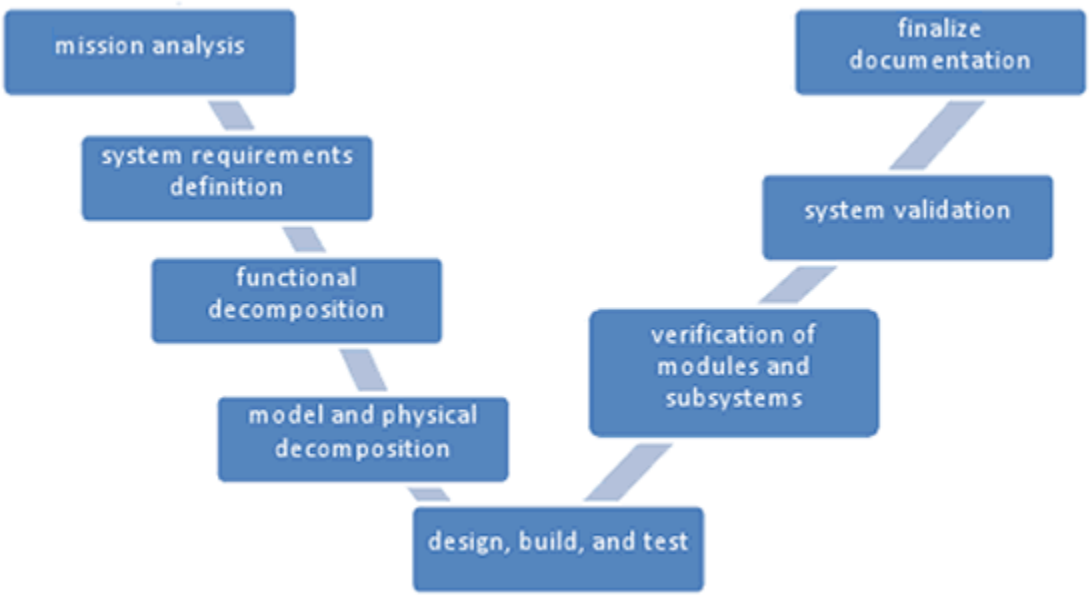

Figure 2 System Engineering Tasks. Source: Lasser (2012).

One can look at a product in development as a system. Many transactions occur relating to this system – what are the inputs being given from the user to the product, and what are the outputs being received? This analysis is important to understand the dependencies and the risks involved with the product, and help determine what needs to happen in between. The "in-between stuff" are the sub-problems. Systems engineering is a means to enable the realization of successful systems. It focuses on defining customer requirements and necessary functionality before proceeding with design synthesis and system validation while considering the complete problem.

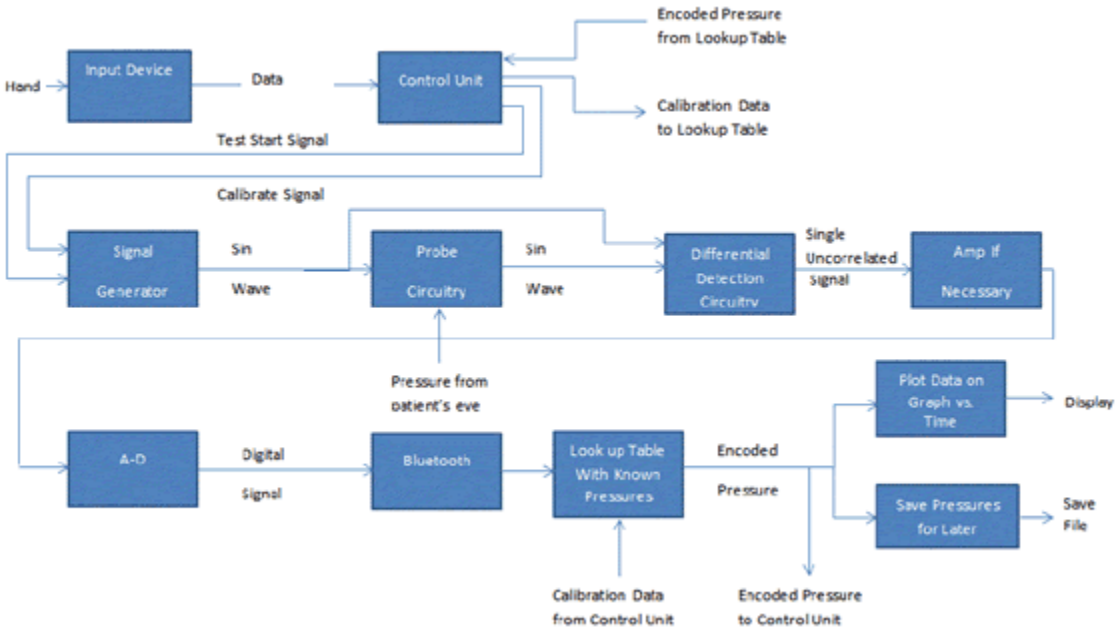

Figure 3 Tufts ECE 2013 Yellow Team's System Engineering Diagram. Source: Ferrentino at al (2013).

A system engineering diagram can help one look at the big picture, identify the modes of failure, and ultimately optimize the performance of the system. A system engineering diagram increases a system's probability of success. It helps clarify, for the designer, what the system specifications are. It also helps clarify for the designer which features, functionality, and requirements are unnecessary and can be eliminated. This, in effect, means reduced total development costs and cycle time, as well as overall functional reliability. The Yellow Team's system engineering diagram (Figure 3) is an example.

Once the problem has been defined and effectively broken down, initial efforts should be focused on critical sub-problems.

STEP TWO: SEARCH FOR SOLUTIONS

SEARCHING FOR SOLUTIONS EXTERNALLY

An external search is an information-gathering process. It should be performed to find existing concepts relating to both the overall problem and to the sub-problems identified during the problem clarification step. Implementing an existing solution can be easier, cheaper, and much faster than developing a new solution. Another option is to optimize a pre-existing solution, or to apply it as-is to one sub-problem and pair it with an original concept for another sub-problem, combined to yield a novel and improved overall design.

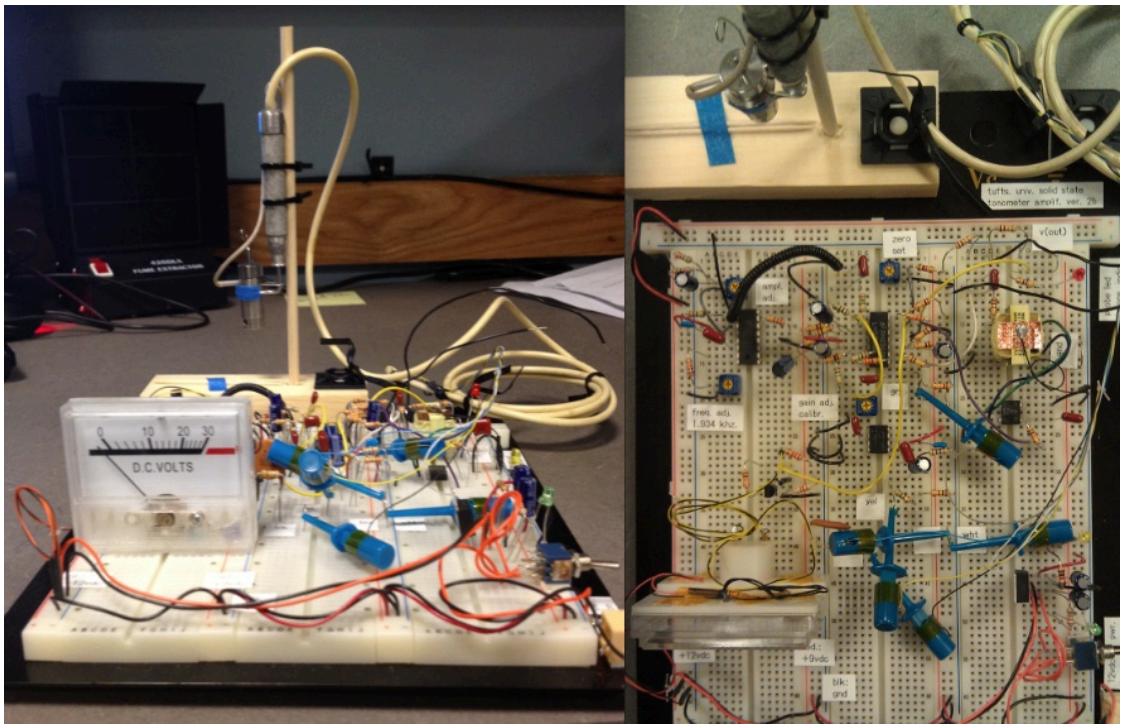

Figure 4 Tufts ECE 2013 Yellow Team's Reconstructed Tonographer Circuit. Source: Ferrentino et al (2013).

As the Yellow Team learned the hard way, it is much more efficient to proceed with this search by first broadly gathering information that might be related to the problem and then focus the scope of the search by exploring more directed details. An imbalanced approach renders an inefficient external search. Some examples of good resources are the following: searching through patents and published literature – the Yellow Team performed this step throughout the first semester of the project, but found it a somewhat vague resource; benchmark related product – with the help of some department faculty advisors, the Yellow Team was able to recreate the circuit (Figure 4) of the device in order to fully understand it; interviews with lead users, and consulting experts – the Yellow Team did this by working with an active ophthalmologist to determine the project requirements and finally narrow the scope.

SEARCHING FOR SOLUTIONS INTERNALLY

Searching internally for solutions, also known as brainstorming, is an enormous part of successful concept generation. One important thing to keep in mind during this step is to be patient. Engineers love jumping to conclusions, but it's important to be open to the unknown. Successful concept generation requires a new mindset that perfectionism "is the enemy". As a result of contemporary education's emphasis on immediate solutions and fact-finding, today's engineers tend to neglect the consideration of different ideas. Zenios et al. (2010) said that "most of us like to solve problems and move on. Idea finding may seem childlike (and it should be) but at its heart is the exploration of possibilities, free from as many constraints as possible". These opinions are not new. Osborn (1953), the alleged founder of brainstorming, claimed the following four tenets of brainstorming:

- *The judgment of ideas is not allowed*
- Outlandish ideas are encouraged
- A large quantity of ideas is preferred
- Members should build on one another's ideas

IDEO, a contemporary global design consultancy, incorporated Osborn's themes into a proposed set of rules to traditional group brainstorming (IDEO, 2011):

- Defer judgment
- Encourage wild ideas
- Build on the ideas of others
- Stay focused on the topic – minimize noise and don't lose track of the focus for that session
- One conversation at a time
- Be visual – use props, have a scribe, and utilize doodles, diagrams, and buzz words in a logical way that illustrates your ideas
- Go for quantity

Brainstorming describes a set of methods for creative problem solving, implemented in group settings as well as by individuals. The term was popularized by Osborn in his 1953 book, *Applied Imagination*, which launched the study of creativity in business development. The principles Osborn proposed over half a century ago hold just as true today: it is critical that participants – in any variation of a brainstorming session – set aside any preconceived notions or preemptively formed solutions and "temporarily suspend their instinct to criticize new ideas". They must "open their minds to a creative flow" of new possibilities as well as look for original, even unusual, connections among the generated ideas. Critical filtering, while necessary and important at many points throughout product development including later in the concept development process, can be counterproductive to a team's results when first considering solutions. It can be quite difficult for people in science fields, who are so accustomed to producing quick, correct solutions, to restrain from making snap judgments on new ideas. This is one of the many reasons why forming a multidisciplinary team and seeking unique, interdisciplinary perspectives for a group brainstorming session is extremely important.

Concept generation is enormously enabled by including a group of participants with diverse backgrounds, expertise, and perspectives. Establishing a multidisciplinary perspective is particularly paramount in developing medical devices, as opportunities for adapting technologies and approaches from one area to another arise so frequently in the medical technology sector: between physicians and engineers, between different medical specialties, and even between medical and non-medical technologies (Zenios et al., 2010).

Group sessions are critical for building team consensus, communicating information, and refining concepts (Ulrich & Eppinger, 2012). Group sessions can also be useful by allowing any participant to build on the ideas of others. One person's idea can stimulate the creativity of other participants to come up with the next level – a solution enhancement, a novel connection, or just some totally random idea that they would not have thought of otherwise (IDEO, 2011).

Figure 5 Tufts ECE 2013 Yellow Team Meeting and Discussing Ideas with Ophthalmologist. Source: Ferrentino at al (2013).

There are some matters to consider when it comes to picking participants for a brainstorming session, especially when dealing with medical devices. For one, the deeply ingrained value of avoiding damage to patients makes physicians and engineers alike particularly conservative when it comes to pre-screening ideas, along with all their other knowledge and experience based biases. A second important action is to consider all of the areas that potentially will come into play in designing and developing a medical device solution. Find people who understand the field of interest and existing technologies, but also have the ability to see past their own knowledge so as not to bias the group toward a particular type of solution. An alternative approach is to turn this "expert problem" – having someone almost *too* knowledgeable come in with all of their biases and preconceived notions – into an advantage by bringing in an expert to lead some sort of working session can uncork the expert's mind and arouse some interesting ideas. For the Yellow Team, this was the ophthalmologist who acted as both their project sponsor and lead user.

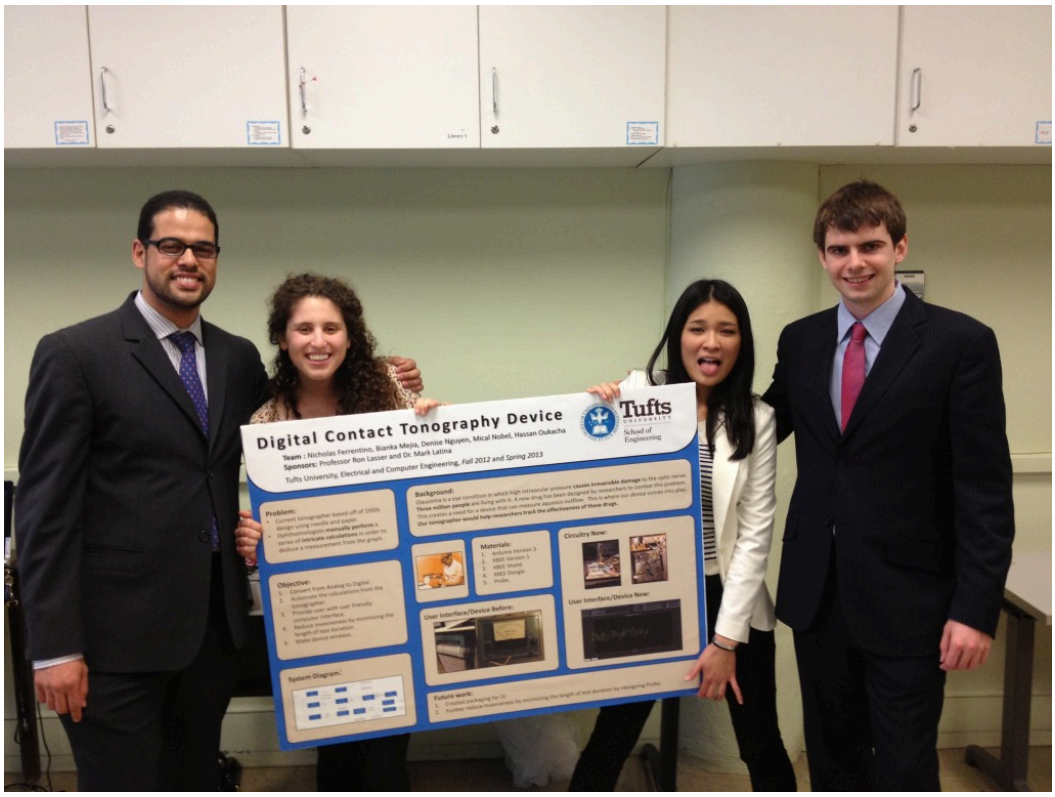

Figure 6 Tufts ECE 2013 Yellow Team's ECE Students at Poster Session. Source: Ferrentino at al (2013).

The Yellow Team and its project exemplify the inevitable interdisciplinary nature of such a product. The project required the efforts of all five team members, from a number of educational backgrounds. The electronics required knowledge of biomedical engineering and electrical, specifically signal processing and processing sensor data. The two electrical engineers and the biomedical engineering double-major on the team were responsible for this section of the project work. Human computer interaction, specifically the user interface is critical to communicating the test results and making the device intuitive for use by trained medical staff. A human factors engineer and a computer engineer worked together to design a graphical user interface that provides functionality for ease of use.

STEP THREE: SYSTEMATICALLY EXPLORE THE SOLUTIONS

Brainstorming may result in tens or hundreds of ideas that need to be screened, sorted, and then evaluated before any single idea can be chosen. Being selective about which concepts to pursue form the pile generated during the ideation phase is of the utmost importance. Concept screening involves organizing and analyzing all of the ideas. It is critical to understand how to cluster and organize the output of a brainstorming session so it can be presented and analyzed in a meaningful way. Grouping ideas can reveal potential gaps or biases in the proposed solutions, as well as opportunities to combine ideas into unique, synergistic ones that ultimately yield more optimal, cohesive, and complete solutions that better address the need than any individual concept. It is also crucial to learn how to objectively compare all of the possibilities against the defined need specification to determine which course to pursue based on how well each option satisfies the need.

Effectively organizing data before beginning concept screening primarily boils down to two activities: clustering and concept mapping. The first step to clustering is to identify the primary organizing principle on which the

clustering pattern is based. This can be quite challenging, as there are always multiple factors that have significance and benefits in different ways.

Table 1

Organizing Principles prior to concept screening. Source: Von Hippel (page 196, 2004).

Organizing principle	Description
Mechanism of action	Group ideas according to how the solutions are intended to work.
Technical feasibility	Group ideas according to the likelihood of coming to fruition. This is based on understanding what is feasible using current engineering and scientific methods.
Funding required	Group ideas around the amount and/or source of funding required to develop them.
Affected stakeholder	Group ideas around the stakeholder most affected, typically the patient or healthcare provider.

Another approach is to create an organize hierarchy, dividing big clusters into subgroups of smaller clusters based onto additional organizing principles, and so on, incorporating into deeper and deeper levels. After one or more organizing principles have been applied to clusters, the clusters can be documented in a concept map, also known as a mind map. A concept map illustrates how ideas relate to one another and to the main problem or need. These maps help the innovator recognize patterns and build connections. When developing a concept map, the need is placed at the center, with the clusters of ideas spanning in different directions. To be effective, an innovator must strive to ensure that all of the clusters have an obvious relationship to the need.

Screening is intended to filter the vast universe of ideas to the ones that best address the need. This requires rigorous comparison and analysis to the original need statement and the explicitly defined need criteria laid out in the customer specifications to see which concepts satisfy the requirements and which do not. It is essential to not lose focus of these original specifications. Any modification or compromising of the specifications may undermine the integrity of the screening process and lead to poor choices. Concept maps will lead to a greater understanding of the different parameters along which each solution is aligned. While not completely fail-safe, this method is a good attempt at objectively assessing the current state of the concepts. Remember that some solutions may meet the need criteria but still need to be eliminated from consideration because they are too impractical or infeasible given the circumstances, such as technology constraints, potential customer or user concerns, etc. Although relatively rare, if screening yields too many solid potential concepts rather than approaches that meet the need criteria, then the need criteria may be too broad, requiring the innovator to revisit the need specification to generate more specific criteria. Some additional tools that can be used are the concept classification tree, used to reorganize lists or mind maps by function, and the concept combination table, which provides a method for combining solution fragments systematically – each column in the table represents a sub-problem and each row a conceptual solution.

STEP FOUR: REFLECT AND REFINE THE SOLUTION

It is important to realize that the ideation and brainstorming steps of the process are not over once they are completed the first time – the concept generation process is cyclical. As new information and new circumstances continue to crop up at all stages of the process, the team may be required to go back into brainstorming mode, for example when refining the direction or approach on an already accepted solution. This process is a feedback loop. Good prototypes tend to provide powerful stimuli for new ideas. The relationship between prototyping and brainstorming is an iterative one.

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3.2: Product & Service Screening

NADIA BHUIYAN'S "A FRAMEWORK FOR SUCCESSFUL NEW PRODUCT DEVELOPMENT"

Read this article to explore the challenges associated with choosing a successful product design. A new product strategy is important to successful screening. This provides you with another way that screening a new product can be approached. As you can see there variety in the types of approaches available.

1 INTRODUCTION

The new product development (NPD) literature emphasizes the importance of introducing new products on the market for continuing business success. Its contribution to the growth of the companies, its influence on profit performance, and its role as a key factor in business planning have been well documented (Booz, Allen & Hamilton, 1982; Crawford, 1987; Urban & Hauser, 1993; Cooper, 2001; Ulrich & Eppinger, 2011). New products are responsible for employment, economic growth, technological progress, and high standards of living. Therefore, the study of NPD and the processes through which they emerge is important.

In the last few decades, the number of new product introductions increased dramatically as the industry became more aware of the importance of new products to business. Correspondingly, managing the NPD process has become a challenge for firms as it requires extensive financial and human resources and is time sensitive. The harsh realities are that the majority of new products never make it to market and those that do face a failure rate somewhere in order of 25 to 45 percent (Crawford, 1987; Cooper, 2001). For every seven new product ideas, about four enter development, one and a half are launched, and only one succeeds (Booz, Allen & Hamilton, 1982). Despite the extensive research on how to achieve success in NPD, firms continue to deliver products that fail and therefore NPD ranks among the riskiest and most confusing tasks for most companies. As the number of dollars invested in NPD goes up, the pressure to maximize the return on those investments also goes up. It becomes worse as an estimated 46 percent of resources allocated to NPD are spent on products that are canceled or fail to yield an adequate financial return.

In this paper, we propose a framework that identifies the critical success factors (CSF) for each phase in the NPD process, metrics to measure them, and the tools and techniques that can be used to evaluate each metric. Our study is based on an extensive review of the NPD literature. The paper is presented as follows. In the next section, we discuss the NPD process, followed by a discussion of critical success factors and metrics. Our framework is then described in detail, and we conclude with a discussion of our work.

2 NEW PRODUCT DEVELOPMENT

The NPD process consists of the activities carried out by firms when developing and launching new products. A new product that is introduced on the market evolves over a sequence of stages, beginning with an initial product concept or idea that is evaluated, developed, tested and launched on the market (Booz, Allen & Hamilton, 1982).

This sequence of activities can also be viewed as a series of information gathering and evaluation stages. In effect, as the new product evolves, management becomes increasingly more knowledgeable (or less uncertain) about the product and can assess and reassess its initial decision to undertake development or launch. Following this process of information gathering and evaluation can lead to improved new product decisions on the part of firms by limiting the level of risk and minimizing the resources committed to products that eventually fail. The NPD process differs from industry to industry and from firm to firm. Indeed it should be adapted to each firm in order to meet specific company resources and needs (Booz, Allen & Hamilton, 1982).

Many researchers have tried to develop a model that captures the relevant stages of the NPD process (Ulrich & Eppinger, 2011; Wind, 2001; Cooper, 2001; Crawford, 1987; Scheuing, 1974). A number of detailed NPD models have been developed over the years, the best known of which is the Booz, Allen and Hamilton (1982) model, shown if Figure 1, also known as the BAH model, which underlies most other NPD systems that have been put forward. This widely recognized model appears to encompass all of the basic stages of models found in the literature. It is based on extensive surveys, in depth interviews, and case studies and, as such, appears to be a fairly good representation of prevailing practices in industry.

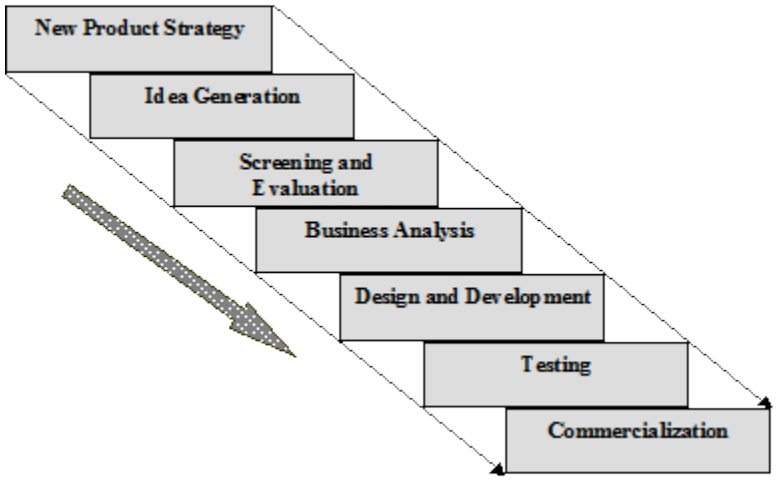


Figure 1. Stages of New Product Development (NPD) (Booz, Allen & Hamilton, 1982)

The stages of the model are as follows:

- *New Product Strategy*: Links the NPD process to company objectives and provides focus for idea/concept generation and guidelines for establishing screening criteria.
- *Idea generation*: Searches for product ideas that meet company objectives.
- *Screening*: Comprises of an initial analysis to determine which ideas are pertinent and merit more detailed study.
- *Business Analysis:* Further evaluates the ideas on the basis of quantitative factors, such as profits, Return-on-investment (ROI), and sales volume.
- *Development*: Turns an idea on paper into a product that is demonstrable and producible.
- *Testing*: Conducts commercial experiments necessary to verify earlier business judgments.
- *Commercialization*: Launches products.

Booz, Allen and Hamilton (1982) found that companies that have successfully launched new products are more

likely to have some kind of formal NPD process and that they generally pass through all of the above stages. Our framework is based on the BAH model, however, we exclude the commercialization stage; while this stage represents an important area of concern, our study deals with the pre-commercialization stages of the NPD process.

2.1 CRITICAL SUCCESS FACTORS

Over the last two decades, several studies have examined the determinants of NPD success and identified many factors that distinguish successful products from unsuccessful ones. Factors that are necessary and guarantee commercial success are termed as critical success factors (CSF): it is imperative to reflect on how one can benefit from each and how one can translate each into an operational aspect of the NPD process. Daniel (1961) and Rockart (1979) proposed that organizations need to identify factors that are critical to the success of that organization, and they suggested that the failure to achieve goals associated with those factors would result in organizational failure. In fact, it is even suggested that NPD itself is a CSF for many organizations. Given that this is now a well-known fact, the idea is to determine what factors in NPD are essential for success, and how to measure the extent of this success. The challenge is to design a process for successful product innovation – a process whereby new product projects can move quickly and effectively from the idea stage to a successful launch and beyond.

2.2 METRICS

A metric tracks performance and allows a firm to measure the impact of process improvement over time. Metrics can play an important role in helping companies to enhance their NPD efforts and are important for at least three reasons. First, metrics document the value of NPD and are used to justify investments in this fundamental, long term, and risky venture. Second, good metrics enable Chief Executive Officers and Chief Technical Officers to evaluate people, objectives, programs, and projects in order to allocate resources effectively. Third, metrics affect behavior. When scientists, engineers, managers, and other NPD employees are evaluated on specific metrics, they often make decisions, take actions, and otherwise alter their behavior in order to improve the metrics. The right metrics align employees' goals with those of the corporation; wrong metrics are counterproductive and lead to narrow, short-term, risk-avoiding decisions and actions.

Any metric that might be applied to NPD will often focus on one function or another or on the entire NPD process. But no one function is the sole contributor to the process that produces new products. A metric for the productivity of the R&D organization, for example, may show constant improvement. In spite of this improvement, however, there may be no improvement in the rate at which new products reach the market (Beliveau et al., 2002). What is important to measure is the effectiveness of the stages of NPD process in an interdependent fashion. A lack of useful metrics is undoubtedly one reason that the success rate of NPD has not improved appreciably over the past 40 years Crawford (1979, 1992). If companies had reliable metrics to gauge their performance, then specific problem areas could be addressed and managers might see the same improvement in their NPD efforts that they come to expect from their quantifiable total quality management programs (Lynn & Reilly, 2000).

3 CRITICAL SUCCESS FACTORS AND METRICS FOR STAGES OF THE NPD PROCESS

In what follows, each stage of the NPD process and its respective CSFs, metrics, and tools and techniques for measuring progress are explained in detail.

3.1 NEW PRODUCT STRATEGY

Prior to commencing an NPD project, companies must set objectives and devise a clear new product strategy (NPS) to meet them (Wind, 1982). The purpose of this stage is to provide guidance for the new product effort. It identifies the strategic business requirements that the new product should comply with, and these are derived from the corporate objectives and strategy of the firm as a whole. These business requirements assign roles to be played by the new products, which in turn are influenced by the needs of the industry (Booz, Allen & Hamilton, 1982).

CSFs for NPS

A firms' strategy should provide a clear understanding of the goals or objectives for the company's new product program, and should indicate the return-on-investment (ROI) expected such that the contribution of new products to corporate goals is well-understood. Furthermore, clearly defined arenas, i.e., specified areas of strategic focus, such as products, markets, or technologies, are needed to give direction to the firm's total new product program.

The problem at this stage is not only one of developing a clear strategy but also its implementation, i.e., translating the strategy into terms that everyone understands to bring focus to day-to-day actions, and communicating the strategy with other members in the organization. Prior research suggests that companies that recognize the importance of interventional coordination and effectively sharing an NPS across departments will have more successful new products (Cooper, 1999). The role of new products in achieving company goals was clearly communicated to all in such firms. Thus, once a clear NPS is defined, the related confounding problem is communicating clearly the needs, requirements, resources, and plans for a new product effort – in essence, internalizing the strategy. This communication must take place in multiple forms; however, a well-documented plan and specification must serve as the foundation. In summary, the establishment and communication of a clear plan and a strategy for an NPD project is a key requisite for success. Businesses that have a well-articulated NPS fare much better than those lacking in this aspect and they have 32 percent higher NPD success rates, meet sales objectives 42 percent more often, and meet profits objectives 39 percent better (Cooper & Kleinschmidt, 1995).

Metrics for NPS

The return-on-investment (ROI) compares the company's yearly income with the investment in the asset. While the ROI is not too challenging, management should understand how the ROI benchmarks have been calculate so that relevant comparisons can be made for the project under evaluation. A company's ROI proves to be useful in setting the new product goals. This metric will help to determine if the cost to develop a new product exceeds the resulting benefit, or if the payback affects the corporate bottom line. The aim here is to compare the return expected to be received from the project with some pre-established requirement. This long-term metric set by the corporate objectives should be linked with the NPS.

Tools and techniques for NPS

The Balanced Scorecard (BSC) provides the instrument the firm needs to navigate to future competitive success (Kaplan & Norton, 1996). BSC translates an organization's strategy into a comprehensive set of performance measures that provides the framework for a strategic measurement and management system. The scorecard measures organizational performance drivers across four perspectives which provide its framework: financial, customers, internal business processes, and learning and growth. The objectives and the measures of the BSC are the collection of financial and non-financial performance measures; they are derived from a top-down process driven by the strategy of the business unit. The measures are balanced between the outcome measures – the

results from past efforts – and the measures that drive future performance. The scorecard is balanced between objectives, easily quantified outcome measures and subjective performance drivers of the outcome measures. Organizations should use the scorecard as a strategic management system, to manage their strategy over the long run and use it for the measurement focus of the scorecard to accomplish critical management processes, including communicating and linking strategic objectives and measures.

The BSC strategic objectives and measures are communicated throughout an organization via company newsletters, bulletin boards, videos, and even electronically through groupware and networked personal computers. The communication serves to signal to all employees of the critical objectives that must be accomplished if an organization's strategy is to succeed. Once all employees understand high-level objectives and measures, they can establish local objectives that support the business unit's global strategy.

The organizational communication and education program should not only be comprehensive but also periodic. Multiple communication tools can be used to launch the BSC program: executive announcement, videos, meetings, brochures and newsletters. This initial announcement should then be followed continually, by reporting scorecard and outcomes on bulletin boards, newsletters, groupware, and electronic networks. The design of such a program should begin by answering fundamental questions:

- What are the objectives of the communication strategy?
- Who are the target audiences?
- What is the key message for each audience?
- What are the appropriate media for each audience?
- What is the time frame for each stage of the communication strategy?
- How will top management know that the communication has been received?

The BSC links financial objectives to corporate strategy. The financial objectives serve as the focus for the objectives and measures in all the other scorecard perspectives. Every measure should culminate in improving financial performance. The scorecard starts with long-run financial objectives, and then links them to the sequence of actions that must be taken with financial processes, customers, internal processes, and finally employees and systems to deliver the desired long run economic performance. Many corporations, however, use identical financial objectives for all of their divisions and business units. This uniform approach is certainly feasible, consistent, and fair since all business unit managers will be evaluated by the same metric, but different business units may follow quite different strategies.

3.2 IDEA GENERATION

After setting a well-defined NPS for NPD, the idea generation stage begins, where the search for product ideas is made to meet company objectives. The idea generation concerns the birth, development, and maturation of a concrete idea. After defining the markets and segments based on the NPS it wishes to target, the firm must advance and nurture ideas wherever they occur to take advantage of the identified opportunities. As per the study done by Booz, Allen and Hamilton (1982), a firm has to generate at least seven ideas to generate one successful. Griffin (1997) says that an average of 100 ideas must be generated in order to yield 15.2 successes.

The main purpose of this stage is to create a number of different ideas from which the firm can select the most feasible and promising one(s). A greater likelihood of achieving success depends in part on the number of ideas generated. Firms that are effective at idea generation are those that do not focus solely on the first source to generate ideas, i.e. ideas that are originated from inside the firm, but that concentrate on all potential idea sources (Crawford, 1997). There is a multitude of sources as well as many different methods to generate ideas. The firm can derive new ideas from internal sources (i.e., employees, managers), external sources (i.e.,

customers, competitors, distributors, and suppliers), and from implementing formal research and development. Brainstorming, morphological, analysis and gap analysis are most commonly employed methods for generating ideas (Crawford, 1997). Customers can be an especially good place to start searching for new product ideas. The relatively high rate of success for product ideas originated from marketing personnel and customers (Souder, 1987).

CSF for Idea Generation

Customer focused idea generation is a CSF for this stage as per studies done by many researchers that show that a thorough understanding of customer's needs and wants is vital for new product success (Cooper, 1993; Crawford, 1987). Successful businesses and teams that drive winning new products have a dedication towards the voice of the customer. A strong customer involvement is necessary right from the idea generation stage. According to Souder's (1987) review of causes of NPD success and failure, he concluded that internally generated ideas had lower success rates then externally generated ideas. A relatively high rate of success is achieved for project ideas that originated from marketing and customers as compared to ideas originating from R&D, suppliers, and management.

Metrics for Idea Generation

Metrics to track idea generation and enrichment include: number of ideas generated from the customer, number of ideas retrieved and enhanced from an idea portfolio, number of ideas generated over a period of time, and the value of ideas in idea bank. Among all of these metrics, the number of ideas generated from the customer is the most associated with the CSF of the idea generation stage. Firms must devote more resources to customer based idea generation activities, such as focus groups with customers; detailed, one-on-one interviews with customers; customer site visits, especially by technical people; the active solicitation of ideas from customers by the sales force; and the development of a relationship with lead users (Cooper, 1999).

Tools and techniques for Idea Generation

Understanding customer and market needs is a consistent theme for successful product development in studies by Song and Parry (1996) and Cooper (1999). There are many creativity and brainstorming techniques for enriching the idea stream. Effective methods for enriching the customer based idea stream utilize lead user methodology and ethnographic approaches.

The lead user methodology takes a different approach as compared to traditional approaches in which ideas are generated based on customer input and usually collect information on new product needs from a random or typical set of customers. The lead user process collects information about both needs and solutions from the leading edges of the target market and from markets facing similar problems in a more extreme form. The rich body of knowledge collected during this process continues to be useful during the remaining steps of product development and marketing (Lilien et al., 2002).

An ethnographic approach is a descriptive, qualitative market research methodology for studying the customer in relation to his or her environment (Cooper & Edgett, 2008). Researchers spend time in the field observing customers and their environment to acquire a deep understanding of customer's lifestyles or cultures as a basis for better understanding their needs and problems. In this approach, observation, interviews and the documentation are done for traces that people leave as they go about their everyday lives. Since it allows the use of multiple converging perspectives – what people say, do, and use – it will always reveal more and provide greater insight. This deeper level of understanding is derived from customer to generate customer-based ideas.

3.3 SCREENING AND BUSINESS ANALYSIS

While the screening and business analysis are proposed as two different stages in the BAH model, we consider the two stages as one for simplicity of the proposed framework. In the screening stage, initial analysis is done based on the NPS, resources and competition, while in the business analysis stage, ideas are evaluated using quantitative performance criteria. After gathering enough new product ideas through various sources from the idea generation stage, which ideas to pursue will be selected based on the business value they bring. Making a good selection is critical to the future health and success of the business. The point is that product development costs rise substantially with each successive stage in the NPD process (Booz, Allen & Hamilton 1982). The ideas that have been classified as "Go" ideas must be screened further using criteria set up by top management (Cooper & de Brentani, 1984; de Brentani, 1986). These ideas must be described on a standard form that can be accessed by a new product committee. The committee then assesses each idea against a set of criteria, which verify the attractiveness and visibility of the idea as well as its fit with the company's strategy, objectives and resources. The ultimate result from screening and evaluation is a ranking of NPD proposals, such that the resources can be allocated to the projects that seem most promising (Crawford, 1997; Wind, 1982).

After screening, the business analysis is the detailed investigation stage that clearly defines the product and verifies the attractiveness of the project prior to heavy spending. According to Cooper's NewProd studies of new product, it was shown that weakness in the upfront activities seriously compromises the project performance. Inadequate market analysis and a lack of market research, moving directly from an idea into a full-fledged development effort, and failure to spend time and money on the up-front steps, are familiar themes in product failures. The quality of execution of the predevelopment steps is closely tied to the product's financial performance (Cooper, 1980).

In every successive stage of the NPD process, as estimates become more refined and accurate, companies should continue conducting financial evaluation throughout the NPD process, but at this stage it is critical. A review of a costs, potential sales and profit projections of the new product are undertaken in order to determine whether these factors satisfy the company's objectives or not. If a result from this stage shows that the product meets the objectives, then the new product concept can move to the development stage. According to Griffin (1997) among the firms taking part in study, 75.6% developed formal financial objectives against which performance was measured. The final component of the business analysis stage is the action plan. A detailed plan of action is created for the next stage and tentative plans are developed for all subsequent stages. This critical stage opens the door to a significant commitment of resources and to a full-fledged development program based on financial analysis which forms the base for the CSF and its metrics proposed for this stage.

CSF for Screening and Business Analysis

Up-front homework is a CSF for the screening and business analysis stage as too many new product projects move from the idea stage right into development with little or no early preparation (Rosenau et al., 1996). The results of this approach are usually disastrous. Up-front homework includes activities such as financial analysis, undertaking thorough market and competitive analyses, research on the customer needs and wants, concept testing, and technical and operations feasibility assessments. Solid pre-development work drives up new product success rates significantly and is strongly correlated to financial performance. All of these activities lead to solid business analysis prior to beginning serious development work. Firms devote on average only seven percent of a project's funding and 16 percent of the person-days to these critical up-front homework activities, which is not enough to make a successful product according to the NewProd (1999) study. The conclusion is that more time and resources must be devoted to the activities that precede the design and development of the product.

As per a study done by Cooper et al. (2000), the most dominant method used by 40.4% of businesses for performance results is a financial approach, followed by strategic approaches and scoring models. Using financial

methods, profitability, return, payback or economic value of the project are determined and projects are judged and rank-ordered on these criterion.

Metrics for Screening and Business Analysis

Financial or economic models treat project evaluation much like a conventional investment decision. The expected commercial value (ECV), net present value (NPV), internal rate of return (IRR), and the profitability index (PI), are metrics that are proposed as being most useful for measuring the success of the screening and business analysis stage. These metrics should be used to rate, rank order, and ultimately select projects. All metrics have their own advantages and disadvantages. For example, the NPV method ignores probabilities and risk; it assumes that financial projections are accurate and financial goals are important. The ECV depends on extensive financial and other quantitative data. These metrics together give clearer details about the project's financial performance to help select the best project from the group.

Tools and techniques for Screening and Business Analysis

The financial methods of evaluation for the proposed metrics and how they measure the financial performance of each project are explained below.

The Expected Commercial Value (ECV) method seeks to maximize the value or commercial worth of the project, subject to certain budget constraints, and introduces the notion of risks and probabilities. The ECV method determines the value or commercial worth of each project to the corporation. The calculation of the ECV is based on a decision tree analysis and considers the future stream of earnings from the project, the probabilities of both commercial success and technical success, and both commercialization costs and development costs. Therefore, the ECV measures the value of the project in terms of its expected financial returns from the perspective of the company's overall commercial strategic objectives. In order to arrive at a prioritized list of projects, the ECV of each project is determined projects are rank ordered accordingly.

The net present value (NPV) criterion for evaluating proposed capital investments involves summing the present values of cash outflows required to support an investment with the present value of the cash inflows resulting from operations of the project. The inflows and outflows are discounted to present value using the firm's required rate of return for the project. If the NPV is positive, it means the project is expected to yield a return in excess of the required rate; if the NPV is zero, the yield is expected to exactly equal the required rate; if the NPV is negative, the yield is expected to be less than the required rate. Hence, only those projects that have a positive or zero NPV meet the criterion for acceptance.

The internal rate of return (IRR) is that rate which exactly equates the present value of the expected after-tax cash inflows with the present value of the after-tax cash outflows. Once the IRR of a project has been determined, it is a simple matter to compare it with the required rate of return to decide whether or not the project is acceptable. If the IRR equals or exceeds the required rate, the project is acceptable. Ranking the projects is also a simple matter. Projects are ranked according to the IRRs: the project with the highest IRR is ranked first and so on.

The profitability index (PI) is the ratio of the present value of the after-tax cash inflows to the outflows. A ratio of one or greater indicates that the project in question has an expected yield equal to or greater than the discount rate. The profitability index is a measure of a project's profitability per dollar of investment. As a result, it is used to rank projects of varying costs and expected economic lives in order of their profitability. Projects are rank-ordered according to this productivity index in order to arrive at the preferred portfolio, with projects at the bottom of the list placed on hold. In order to ensure that project ideas are carefully screened, and that the business analysis is carefully carried out, these metrics are certain to help select projects so as to maximize the sum of the values of all active projects in the firm's pipeline in terms of business objectives.

3.4 DEVELOPMENT

Once the results of the business case of the new product conform to company objectives, the new product team can move on to the development stage, which is made up of activities that range from prototype development to volume ramp up and test marketing. The interaction between the program and project manager is no longer one of selling or buying the concept, but rather one of bringing the product to market on time, within budget, and to the required specifications.

On average, one third of total NPD expenditures are committed during this stage with 40 percent of total NPD time (Cooper, 1999). In the development stage, business case plans are translated into concrete deliverables. What is critical for success at this stage to move through development to launch as quickly as possible and to ensure that the product prototype or final design does indeed meet customer requirements, which requires seeking customer input and feedback throughout the entire development stage. It is important to gain competitive advantage and to enjoy the product's revenues as soon as possible and it also minimizes the impact of a changing environment. Thus, as the product proceeds from one step of the development stage to the next, the new product team should reassess the market, position, product, and technology in order to increase chances of delivering a successful product (Cooper, 1993; Urban & Hauser, 1993). Marketing and R&D functions in particular should collaborate because, while marketing can express the needs of customers, R&D has the capacity of turning a product concept into an actual physical entity. Therefore they should work together to ensure the product meets customer requirements. Cross-functional teams are widely used in companies to help in identifying and solving problems efficiently by coordination of resources and ideas. Customer input and feedback is a critical activity throughout development, both to ensure that the product is right and also to speed development toward a correctly defined target.

CSFs for Development

Development of new products often takes years, and much that is unexpected can occur during this time frame. The market may change partway through development, making the original estimates of market size and product acceptance invalid. Customer requirements may shift, rendering the original set of product specifications obsolete. Competitors may introduce similar products in the meantime, creating a less receptive market environment. These and other external changes mean the original product definition and justification are no longer valid.

Reducing development time is a vital competitive weapon and yields competitive advantage; it means that there is less likelihood that the market or competitive situation has changed by time the product reaches the market and it means a quicker realization of profits Cooper (1993, 1999, 2001). Companies that develop products quickly gain many advantages over their competitors: premium prices, valuable market information, leadership reputation with consumers, lower development costs, and accelerated learning (Cooper, 2001). Therefore, the goal of reducing the development time is critical. Most importantly, fast development minimizes the impact of a changing environment. If the development time can be reduced from eighteen months to nine, the odds of things changing are similarly greatly reduced that makes the need to reduce the time during the development stage. Most firms have reduced product development times over the past five years with the average reduction being about the one-third. In short, the challenge here is to shorten development time so as to minimize the chances that the development target has changed.

Seeking customer feedback is a vital activity throughout development stage, both to ensure that the product design is right and also to speed development toward a correctly defined target. The original voice-of-customer research that was done prior to development may not be enough to resolve all the design problems during development (Cooper, 1999). Customer feedback is perhaps the most certain way of seeking continual and honest

customer input during the development phase. Seeking customer input should become an integral part of the design team to speed up and make development stage successful.

Metrics for Development

Development time is defined as the duration from the start to completion of the development stage, i.e., the length of time to develop a new product after passing business case stage to initial market sales. Precise definitions of the start and end point vary from one company to another, and may also vary from one project to another within the company. How quickly the team moves through this stage is critical for the reasons stated earlier, and as such, it is imperative that the team measures their progress according to time.

A cross-functional team is defined as a team consisting of representatives from the various functions involved in product development, usually including members from marketing, R&D, and operations (and perhaps others, such as purchasing, as needed). The most effective development teams also involve suppliers in the early stages of development, and frequently rely on suppliers for a large portion of the subsystem design (Clark & Fujimoto, 1988). Cross-functional teams have replaced a more functional approach in which each team relinquishes project responsibility to a down-stream function (e.g. the engineering team hands-off to the manufacturing team). This paradigm requires frequent communication between functions represented on the team and co-location greatly facilitates this process. Cross-functional teams are essential for timely development, improving design quality, and lowering development costs. Cross-functional integration that really matters occurs when individual design engineers work together with individual marketers or process engineers to solve joint problems in development. True cross-functional integration occurs at the working level. It rests on the foundation of tight linkages in time and in communication between individuals and groups working closely related problems. How these groups work together determines the extent and effectiveness of integration in the design and development of the product (Wheelwright & Clark, 1992).

Related to the above is the degree to which team members are committed, or dedicated, to the project. Since project team members' time commitments are typically spread across a number of projects at any one time because departmental managers are vying for team members' time, team members are often on and off development projects. This creates a discontinuity and increases development time. It is in this stage that it is crucial to have a team with dedicated team members. A dedicated, accountable team leader- that is, not doing too many other projects or other assignments at the same time, and held accountable for the result.

Parallel processing involves activities that are undertaken concurrently (rather than sequentially), thus more activities are undertaken in an elapsed period of time. The purpose is to achieve product designs that reflect customer wants as well as manufacturing capabilities and to do so in the shortest possible time. However, due to the need for prerequisite information, not all activities or phases in the NPD process can be overlapped with minimal risk. Therefore, the degree of parallelism must be measured to ensure minimal downstream risk.

The degree of design effort on real customer needs is a qualitative in-process metric which ensures as much as possible that the final design meets customer requirements. This requires seeking customer input and feedback throughout the entire development stage and thus the customer becomes an integral part of the design team to overcome technical problems that arise and that necessitate product design changes during the development stage. Customer needs and wants assessment must be a vital and ongoing activity throughout development, both to ensure that the product is designed right and also to speed development toward a correctly defined target.

Tools and techniques for Development

The literature review has shown that there exist a number of tools and techniques to reduce development times that are consistent with sound management practice.

Dynamic time to market is a tool which can be useful in predicting the end date of the said project as well as in

tracking the progress of a project. It works in the following way: when a schedule prediction is made, the prediction date is plotted against the date the prediction was made. By assessing dynamic time to market, the team members will get an early warning of potential late delivery and appropriate action can usually be taken by the team to maintain schedule integrity. Thus projects are kept on schedule to achieve timely product development.

The degree of team cohesiveness gauges the growth of the team as a working group and it is a function of length of time that a team has worked together in a past or present project (Balakrishnan, 1998). It is the extent to which team members are attracted to the team and motivated to remain in it.

Overlapping means doing various activities in parallel rather than doing them sequentially. By overlapping activities, the cycle time, i.e. the total time taken to complete the product development from concept until the product reaches market, can be greatly reduced. Overlapping activities saves time due to 1) parallel processing of activities, 2) better and more timely identification of design problems, and 3) improved communication earlier and throughout the team. This metric serves as an indicator of the degree of concurrency in the process. In general, the higher the number of overlapped activities, the higher the degree of concurrency and the shorter is the development time. A lower number of overlapped activities indicates a lower degree of concurrency in the process and may also indicate opportunities for improving the process to achieve objectives.

3.5 TESTING

The purpose of this stage is to provide final and total validation of the entire project: the commercial viability of the product, its production, and its marketing (Cooper & Kleinshmidt, 1987). Design and testing go hand in hand, with testing being conducted throughout the development stage. Information obtained during testing is used in developing the product. This phase is extremely important in that it may dramatically decrease the chances of failure in launch, since it has the capacity of revealing flaws that could cause market failure (Urban & Hauser, 1993). Studies by Cooper (1998, 1999) show that a test phase that is customer oriented is the critical factor – whether it is done and how well it is executed – is significantly correlated with the new product success. Different types of testing, i.e. concept testing, prototype/development testing, and test marketing, should be conducted in this stage Cooper (1993, 1998, 2001). It should be noted, however, that testing should not be solely restricted to this stage; it must be conducted throughout the NPD process (Ulrich & Eppinger, 2011).

CSF for Testing

Product functionality is critical for the testing stage as the aim here is to see whether a product with the attributes called for has been produced. It must be proven that claimed attributes exist and the causes for missing attributes must be found.

Customer acceptance is critical for this stage to gauge whether the product is acceptable to the customer, to measure the customer's level of interest, liking, preferences, and intent to purchase, and to determine those benefits, attributes, and features of the product to which the customer responds. Not only must the product work right in the lab or development department, but, more importantly, it must also work right when the customer uses it. The product must excite and, indeed, delight the customer; who must find it not only acceptable but actually like it better than what he or she is currently buying. In short, the customer reaction must be sufficiently positive so as to establish purchase intent.

Metrics for Testing

The performance of a product is how well the product achieves the functionality desired. Product performance is usually measured in such ways as testing physical features, perceptual features, functional modes, and perceived

benefits. Feature is those aspects of an offering that create the benefits; they are typically a focal point of NPD. Perceived benefits are the best point in the needs continuum on which to focus conversations with customers because they represent customer-oriented perceptions but are still close enough to supplier-oriented features to permit that linkage to be made by the product developer. Validation and user testing techniques are used to gather data on product performance. These primary research techniques generate quantitative results. At this stage in the NPD process, these are the types of research results necessary to make final critical decisions and reduce the risk of possible failed launches.

Customer-perceived value is measured to determine whether the customer is willing to purchase the tested product or not and to gauge whether the product is acceptable to the customer. Important metrics for this stage are: perceived relative performance, customer satisfaction (Like/Dislike), and the preference score to determine the nature of the competitive situation. These are qualitative metrics, but are very important nonetheless to record the basic likes/dislikes of the customer early before the product gets launched into the market. Based on the qualitative data, managers can take action to make changes in the product.

Tools and techniques for Testing

Validation testing is of a product model that closely resembles the final product that will be manufactured and sold, and is often called system testing and usually takes place in-house. The purpose of the testing process is to ensure that all product performance requirements and design specifications have been met. The validation test is normally conducted late in the development process to ensure that all of the product design goals have been met. This includes usability, performance, and robustness. Validation tests normally aim to evaluate actual functionality and performance, as is expected in the production version and so activities should be performed in full. It is probable that the validation test is the first opportunity to evaluate all of the component elements of the product together, although elements may have been tested individually already. Thus, the product should be as near to representing the final item as possible, including packaging, documentation and production processes. Also included within validation tests will be any formal evaluation required for certification, safety or legislative purposes.

Data from a validation test is likely to be quantitative, based on measurement of performance. Normally, this is carried out against some benchmark of expected performance or criteria set before. Usability issues may be scored in terms of speed, accuracy or rate of use, but should always be quantified. Issues such as desirability may be measured in terms of preference or user ranking. Data should also be formally recorded, with any failures to comply with expected performance logged and appropriate corrective action determined.

User and field testing is performed by real users or customers, and in some cases, this testing must precede product shipment. This is not to be confused with marketing customer testing, where certain strategies regarding sale and marketing of the product are explored. The purpose of testing is to understand how the product performs in the end-user environment. Customer based testing is indeed complex, and there is no way it can be simulated in laboratories, where use is isolated from users' mistakes, competitive trashing of the concept, and objections by those in the user firm or family whose work or life is disrupted by the change. Products that are entirely new to the market should receive beta testing because there is no base of data on which to judge customer acceptance.

Test protocols are produced by the company and can range from rigorous to nonexistent. In the first case, the developer closely monitors and follows up the beta test with in-house staff or contracted staff from a specialty testing company. In the second case the developer may simply contact the customer by phone or has an group or individual contact to ask for opinions on the product. The test results attempt to confirm that the user feels the same toward the prototype as toward the verbal concept discussed earlier in the NPD stage. The results of the testing either confirm that the product meets its requirement or show the areas where the product is deficient, and is therefore a critical stage to be considered in the development process.

3.6 FRAMEWORK OF CSFS, METRICS AND TOOLS AND TECHNIQUES FOR NPD

The CSFs, metrics, tools and techniques proposed for successful NPD discussed in the previous sections are all summarized in the framework proposed in Table 1.

Stage	Critical Success Factor	Metrics	Tools and Technique
New Product Strategy	Clear Strategy	Return on Investment	Financial Analysis
	Well Communicated Strategy	Degree of Communication	Balanced-scorecard as a Communication Tool
Idea Generation	Customer Focused Idea Generation	Number of Customer Focused Ideas Generated	Lead User Methodology
			Ethnographic Approach
Screening and Business Case	Up-Front Homework	Expected Commercial Value (ECV)	Financial Method of evaluation
		Net Present Value (NPV)	
		Internal Rate of Return (IRR)	
		Productivity Index (PI)	
Development	Speed	Development time	Team Cohesiveness
	Customer feedback	Degree of functional integration	Dynamic Time to Market
		Degree of team commitment	Degree of Parallelism
		Concurrency of activities	
		Degree of design effort on real customer priorities	
Testing	Product Functionality	Product Performance	Validation Testing
	Customer Acceptance	Customer-Perceived Value	User and Field Testing

Table 1. Critical Success Factors and Metrics for Stages of NPD Process

For each stage of the NPD process, the factors that are essential for success for each stage, metrics which can be used to measure the performance of those factors, and tools and techniques to implement the metrics are all detailed in the framework. As a preliminary proposed framework, we believe that any complex NPD project that follows this framework will have an increased chance at success.

4 DISCUSSION AND CONCLUSIONS

New product success still remains the critical challenge for companies. Many companies are aware of the major role new products must play in their future and quest for prosperity: companies are constantly searching for ways to revitalize, restructure and redesign their NPD practices and processes for better results.

This framework proposes that to achieve success, NPD firms should have a clear and well communicated new product strategy. These firms should have well defined new product arenas along with long term trust, with clear goals. Successful businesses and teams of NPD have a dedication towards the voice of the customer. It is critical that firm should gather as many ideas as possible and a large number of these should come from customers so that the firm can be in a position to design and develop winning new products. Up-front homework prior to the initiation of product design and development is found to be a key factor in a firm's success. The quality of execution of the predevelopment steps – initial screening, preliminary market and technical studies and business analysis – is closely tied to the products financial performance. Firms should try to shorten the development time so as to minimize the chances that the development and customer needs have changed when the product comes

into the market. It is important to verify and validate product performance requirements and design specifications along with customer's acceptance before launching the product into the market via validation and user field testing.

This paper explored and analyzed the NPD process and attempted to identify ways in which firms can improve their performance when developing new products, mainly through the study of factors that are critical to success. These factors were identified through an extensive study of the practices and performance of successful firms presented in the NPD literature. The CSFs which have been described in the literature are generally defined for the overall development process, rather than specifically addressing each stage. To overcome this problem, this paper sought out CSFs for each stage of the process. Presumably, no other study to date has developed such a framework, which can be crucial for NPD success.

Several different research directions could provide additional useful information both to firms finding CSF and measuring product development success as well as to academics performing research in this area. The first research opportunity exists in implementing or testing the proposed framework. This would be useful to do over the longer term both among the community of NPD companies and through academic research to determine the impact of this research on both practice and research.

FOLLOWING A PRODUCT DEVELOPMENT PROCESS

Product development is idea generation, screening, business analysis, technical development, manufacturing, testing, and commercialization.

LEARNING OBJECTIVE

- Outline the several stages in new product development

KEY POINTS

- Ideas for new products can be obtained from customers (employing user innovation), the company's research and development department, competitors, focus groups, employees, salespeople, and more.
- The object of idea screening is to eliminate unsound concepts prior to devoting resources to them.
- The focus of the business analysis is primarily on profits, but other considerations, such as social responsibilities, may also be involved.
- Manufacturing planning must consider how to secure the availability of required funds, facilities, and personnel at the intended time, as well as the methods of coordinating this effort.
- Test marketing is the final step before commercialization; the objective is to test all the variabilites in the marketing plan including elements of the product.

TERM

- Focus GroupA group of people, sampled from a larger population, interviewed in open session for market research or political analysis

NEW PRODUCT DEVELOPMENT PROCESS

There are several stages in the new product development process–not always followed in order:

Idea Generation

Generating new product ideas is a creative task that requires a specific way of thinking. Ideas for new products can be obtained from customers (employing user innovation), the company's R&D department, competitors, focus groups, employees, sales people,corporate spies, trade shows, or through a policy of Open Innovation. Formal idea generating techniques include attribute listing, forced relationships, brainstorming, morphological analysis, and problem analysis.

Idea Screening

The second step in the product development process is screening. It is a critical part of the development activity. The object is to eliminate unsound concepts prior to devoting resources to them. The screeners must ask at least three questions:

1. Will the customer in the target market benefit from the product?
2. Is it technically feasible to manufacture the product?
3. Will the product be profitable when manufactured and delivered to the customer at the target price?

Business Analysis

After the various product ideas survive their initial screening, very few viable proposals will remain. Before the development of prototypes can be decided upon, however, a further evaluation will be conducted to gather additional information on these remaining ideas in order to justify the enormous costs required. The focus of the business analysis is primarily on profits, but other considerations, such as social responsibilities, may also be involved. Management must:

- Estimate the likely selling price based upon competition and customer feedback.
- Estimate sales volume based upon size of market.
- Estimate profitability and the break even point.

Technical and Marketing Development

A product that has passed the screening and business analysis stages is ready for technical and marketing development. Technical development involves two steps. The first is the applied laboratory research required to develop exact product specifications.The goal of this research is to construct a prototype model of the product that can be subjected to further study. Once the prototype has been created, manufacturing-methods research can be undertaken to plan the best way of making the product in commercial quantities under normal manufacturing conditions. This is an extremely important step, because there is a significant distinction between what an engineer can assemble in a laboratory and what a factory worker can produce.

While the laboratory technicians are working on the prototype, the marketing department is responsible for testing the new product with its intended consumers and developing the other elements of the marketing mix. They must ask the following questions:

1. Who is the target market, and who is the decision maker in the purchasing process?
2. What product features must the product incorporate?
3. What benefits will the product provide?
4. How will consumers react to the product?
5. How will the product be produced most cost effectively?
6. What will it cost to produce it?

Marketers must then prove feasibility through a virtual computer-aided rendering and rapid prototyping, and test the concept by asking a sample of prospective customers what they think of the idea.

Manufacturing Planning

Assuming that the product has cleared the technical and marketing development stage, the manufacturing department is asked to prepare plans for producing it. The plan begins with an appraisal of the existing production plant and the necessary tooling required to achieve the most economical production. Compromise between attractiveness and economy is often necessary. Finally, manufacturing planning must consider how to secure the availability of required funds, facilities, and personnel at the intended time, as well as the methods of coordinating this effort.

Marketing Planning

It is at this point that the product planner must prepare a complete marketing plan–one that starts with a statement of objectives and ends with the fusion of product,distribution, promotion, and pricing into an integrated program of marketing action.

Test Marketing

Test marketing is the final step before commercialization; the objective is to test all the variabilites in the marketing plan including elements of the product.

Commercialization (often considered post-NPD)

At last, the product is ready to go. It has survived the development process, and it is now on the way to commercial success. How can it be guided to that marketing success? It is the purpose of the life cycle marketing plan to answer this question. Such a complete marketing program will, of course, involve additional decisions about distribution, promotion, and pricing.

UNIT 3 DISCUSSION, PART 1

1. Considering the importance of product selection, review each development and selection tools provided in this unit. Do a web search to identify at least one additional method for development or screening. How might you use these tools together to make a selection choice between three good ideas? Does one method appear more useful than the others? Why?

3.3: Preliminary and Final Design

TEDX CONSTITUTION DRIVE

Martin Steinert's *Engineering Design: Creativity and Analysis.*
Watch *Engineering Design: Creativity and Analysis* to see the movement of a preliminary idea to a final design that is ready for a market. This is important because not every idea should or can move forward to a final design phase. There are many different considerations when looking at preliminary designs. This is not only a creative process but also an analytical evaluation.

One or more interactive elements has been excluded from this version of the text. You can view them online here:
https://pressbooks.nscc.ca/operationsmanagement2/?p=175#oembed-1

CHAPTER 7 CONCEPTUALIZING PRODUCTS/SERVICES USING FAD

The previous chapters have focused on learning the basic concepts related to product differentiation in the context of monopolistic competition. The focus of this chapter is learning-by-doing. We will use techniques to help transform a nagging idea about a new product to be more explicit and real. The tool for completing this task is called the FAD (features, attributes, and design) template. The FAD template is used to identify the features and attributes that can be used for product and service differentiation. The first part of the chapter will introduce the key concepts necessary to understand and motivate the use of the FAD template. The FAD template will then be introduced and used to demonstrate and structure the development of important attributes and features of a new product or service.

7.1 FEATURES, ATTRIBUTES, FORM, DESIGN, FUNCTION, AND MEANING ARE INTERRELATED CONCEPTS

Here are some definitions and concepts that can be used to understand how products and services can be differentiated:

- An attribute is used to describe the characteristics or properties of something.
- A feature is often described as a prominent attribute.

- A function is what something does.
- Form is the external experience or shape.
- Design involves all the above.
- Meaning involves all the above plus the relationship of the product or service to emotional and psychosocial needs.

A very simple way to view all the above is that features, function, form, design, and meaning are all attributes, with different levels of information about a product. Consider the SuperDuper smartphone. The SuperDuper phone has a keypad (attribute, feature, function, and form), with lighted square keys (attribute, feature, and form), and a high color indestructible screen (attribute, feature, and form) with a black onyx color and coarse texture (attributes, features, and form), which can be used for calling and texting (attributes, features and functions), listening to stereo music (attribute, feature, and function), and locating friends within 1 mile (attribute, feature and function). This smart and futuristic SuperDuper phone (attribute and overall design) creates feelings of connectedness, comfort, and security (attributes and meanings).

Figure 7.1 SuperDuper Smartphone

7.2 MEANING AND PRODUCT DESIGN

There are three fundamental approaches to design (Figure 7.2 "Fundamental Design Approaches"). The user-driven design (UDD) school is focused on researching consumer wants and needs. The technology-driven design (TDD) school is not a school per se, but rather an approach that is focused on applying new and emerging technologies to develop products and services. The meaning-driven design (MDD) school focuses on the emotional and psychological relationships that people have with things, objects, and products and attempts to design products that satisfy these meanings. Most products can be designed using all three approaches, for example, software, custom houses, furnishings, electronics, clothes, personal care, appliances, and transportation. Some products such as CPUs' semiconductors and nanotechnology and health equipment are primarily technology driven.

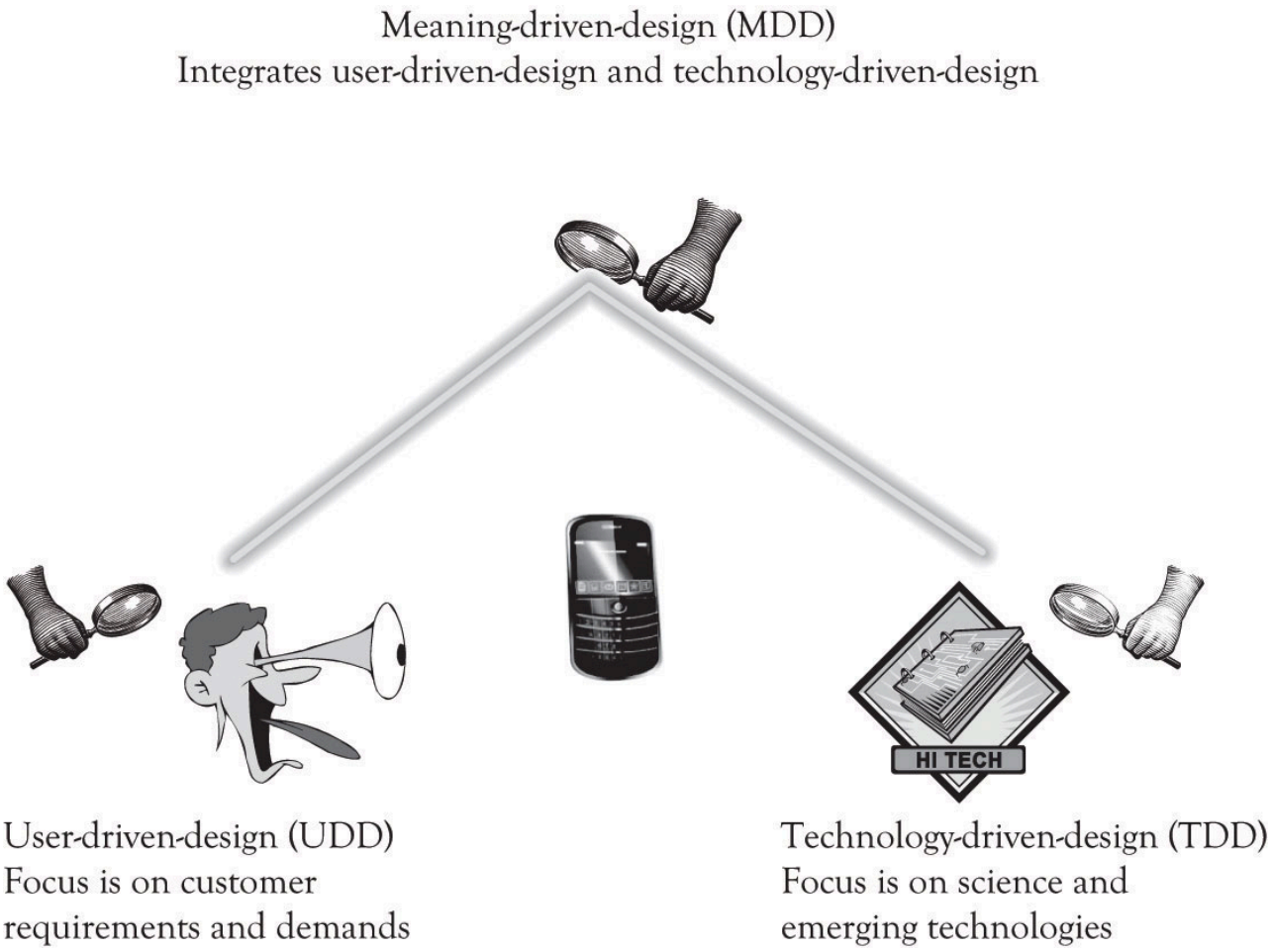


Figure 7.2 Fundamental Design Approaches

MDD also involves UDD, but it is not the motivation behind the entire process. In MDD, the company executives and research and development (R&D) personnel design the next-generation product and then present it to consumers. They still obtain a reaction from potential consumers, but it is not the sole driving force behind the process. The MDD approach also incorporates technology-push innovation, where innovative emerging technologies are pushed to the market. In essence, MDD uses elements of both UDD and TDD to deliver innovative products. The unique part of MDD is the search for meaning. There is a search for meaning in the way that people relate to objects. This is often accomplished by collaborating with other organizations and with experts in the product domain on how the product should be designed. The design of the product is not solely derived from customer pull as is the case of UDD, but is also driven by the innovator and new and emerging technologies. In MDD, the innovator synthesizes information from a variety of sources and then uses this knowledge to design innovative products.[1]

The idea behind the MDD School of innovation is to look for meaning in everyday products and to try to determine how they can be changed in a radical way to support the emotional and psychological needs of consumers. The MDD approach to developing a Blue Ocean market involves understanding how customers

1. Software developers often use a technique referred to as user-centered design or participative design that has elements of UDD and MDD. In user-centered design, there is an iterative process of building the application and having the user continuously validate software solution.

relate to products and then developing new products that get at the core of what meaning customers attach to products.[2]

Many individuals in the MDD school believe that the user-centered design is a hindrance to developing radical innovations.[3] The focus of the MDDapproach is to find the meaning in the way people relate to objects in their everyday life. The MDD school of innovation not only contemplates beauty and form, but also examines the emotional and psychological relationships that people have with things, objects, and products. Proponents of MDD believe that developing innovative ideas that transcend existing product concepts requires more than just attending to product differentiation. Since the MDD school of innovation uses a push strategy. Product ideas are conceived as a vision and offered to consumers as a proposal. As noted by Verganti: "These proposals are not dreams without a foundation. These proposals eventually emerge as the products users were actually looking for. They end-up being what people were waiting for—and thus are great marketing successes" (p. 116).

We alluded to the fundamental meaning of product in the earlier discussion of the basic functions of products. There are many different types of meanings that can be attached to products, some of them are tangible and some of them are complex and elusive. Key areas of meaning include the following: provide physical and emotional sustenance; facilitate control over the environment; provide entertainment; provide feelings of status, superiority, and elitism; provide a sense of stewardship; provide a sense of altruism; provide feelings of adventure; provide security and comfort; facilitate the completion of some work or home task; provide familial support; support learning and adaptation; help us to change location; provide opportunity for communication and networking; provide for respect and recognition; and, of course, be a source of satisfaction and happiness.

Traditional user-centered design approaches are not focused on understanding the meaning of the relationship that people have with objects. The Wii is not a game machine, it is the campfire surrounded by family and friends. Embedding diamonds in wireless phones contributes little to the calling function. But in some people's minds, diamonds are a symbol of affluence and sophistication and are used to convey that image. The iPhone is not just a phone and the iTouch is not just an MP3 player, they are status symbols that also provide comfort and social networking. A Cirque du Soleil performance is not just a circus or just entertainment, it is a risky adventure in an ethereal world never seen before. The iPad is not a replacement for a netbook or a laptop, it is the adventurer's guide to the galaxy of knowledge and entertainment. It is the present day *Hitch Hikers Guide to the Galaxy*.

Attaching meaning to objects is of course somewhat subjective and strongly influenced by the researcher's background and by social mores. There are numerous types of meaning that can be examined and they are often interdependent.

Designing products that draw on meaning requires creativity and hard work. Creativity can be cultivated and is within the grasp of most people. The hard work is the never-ending process of determining the proper ingredients that go into the secret sauce to keep people from becoming bored or even worse, ignoring your product.

A key part of the MDD process involves partnering with interpreters. This partnering involves both learning-about and learning-by-doing. The interpreters are the organizations and individuals who are working on products that are similar to the products that you are examining. They can be suppliers and component manufactures, consultants, consumers, competitors, universities, research firms and think tanks, trade association and publications, research conferences, and of course one of the most important interpreters, the search engine.

There are other approaches to design that focus on marketing, project management, product management, portfolio management, product engineering, creativity, and controlling the process. Later chapters will discuss the role of project management, new product development and portfolio management in providing structure to the innovation process.

Many companies use hybrid approaches that draw on UDD, TDD, and MDD. Our focus in this chapter is primarily on MDD. But we also rely on user-centered design for refining products and making them usable. Even Apple,

2. As noted in an earlier chapter. A Blue Ocean market is a market that is not in existence. A Blue Ocean product is a new product that is radically differentiated from existing products that are being offered.
3. Cf. Verganti (2009).

who we believe is the wunderkind of MDD in the USA, listens to their customers. For example, they redesigned Apple TV to become an inexpensive video-streaming device and put buttons on the smallest shuffle because consumers did not like having all the music control buttons on the ear bud cord.[4] UDD is also very important for software development, whether it be in the context of game development, applications development, or social networking applications. A customer-centric agile development process is essential for delivering products that will be used. Ergonomics, ergonomics laboratories, and usability research are the foundation for delivering high-quality software products to the consumers.

There is one more design strategy that can be linked to many product failures. It is a purely functional design strategy that does not incorporate user needs or meaning at all. There is little if any UDD or MDD. This situation occurs where someone thinks that there is a need or demand for a product or service, but the end-users were not listened to or were ignored completely. This often occurs when there is no need or demand for a product or service, but someone thought that it would be a good idea to develop it anyway. I was involved with such a product when I worked as a programmer. Here is the story.

7.3 FUNCTIONAL DESIGN AND USER IGNORED

Barlow was the head of our IT group and he was also the head scorekeeper for the plant's golf league. Every Monday morning Barlow would take the golf scores from the past week of play and compute the league standings as well as calculate the handicaps. Barlow had been doing this for years. Someone in human resources thought that he was spending too much time on the league and they also thought it was a burden to Barlow. So HR commissioned a golf handicapping and league scoring system. A complete cost–benefit analysis was actually implemented and the payback was deemed acceptable, so the green light was given to the project. A team of analysts and programmers were assigned to gather requirements and implement the system. Tens of thousands of dollars were spent developing and programming the system. The system was used just a couple of times. It was a pain to use, the results were incorrect, and most importantly, Barlow could finish his calculations faster than it would take to key-in the data and generate the reports. Barlow actually liked his manual system and took pride in his ability to produce weekly updates in a few hours. He said as such, in quiet tones, but he was not listened to.

In the current market context, functionally designed products and services are sometimes at risk, unless the meaning of the design is to convey simplicity and functionality. There are numerous examples of successful products and services that simply do what they are supposed to do, because they are functional. Functionally designed products can be even more successful when they are accompanied by user-centered design and meaning-centered design.

7.4 IDENTIFYING KEY MEANINGS, ATTRIBUTES, AND FEATURES

One thing is for sure. There are literally thousands of attributes, features, designs, and meanings that can be used to define products and services. This section details the major attributes that should be considered during product and service development.

- *Functions of the product or service and target customers*. What does the product do? What important subfunctions does it perform? What type of customers or customer segment are you trying to attract?
- *Quality*. How well does the product or service conform to specifications? Does the product or service do what it says it is supposed to do in the user manual? Is it effective in performing its function?
- *Reliability*. Does the product or service perform as it is supposed to over the expected life of the product or service. Is it prone to failure? Is it easily maintained? Can parts be obtained at a reasonable cost and

4. Lyons (2010b, September 1).

are they easy to change? Does the product perform satisfactorily in a variety of environmental conditions?

- *Ease-of-use*. Is the product or service easy to use and can consumers learn how to use it without much trouble? Is the product convenient to use? A convenient product or service is readily available, performs the task for which it was designed, and reduces the time it takes to complete a task.
- *Performance*. Is the product smaller than the competition? Is it more powerful? Does the product or service complete a task faster? Is the product adaptable to many situations?
- *Design*. Is the external form attractive? Is the product packaged properly? Does the product suggest a certain meaning? Do the materials used in developing a product also contribute to the overall look and feel? Thus, the meaning of a product is derived from the type and color of the material used to construct a product, the texture and feel of the product, the size, the product name, and from the overall form or style of the product or service.[5] Examples of abstract design meanings might include: futuristic, scary, hallow, delicate, intellectual, feminine, masculine, macho, healthy, psychedelic, smart, fashionable, earthy, retro, metal, avant-garde, youthful, personal, worldly, mature, luxurious, elite, western, oriental, simple, sassy, cool, organic, green, and even abstract.

Design attractiveness and innovation also applies to services. Packaging for a service includes the overall look and feel of the service. It is the gestalt or form and configuration of the service as perceived by the consumer. The key success indicator for a service is the customer's perception of the overall experience with the service process.[6]

- *Technology*. Is there an emerging technology or a process that can improve the quality, reliability ease-of-use, performance, value, design, and meaning of the product?
- *Value creation*. Is there any intrinsic value in the product that significantly distinguishes it from other products or services offered by your company or the competition? Does the product or service solve a problem that consumers want to solve and will the solution attract them to the product or service?
- *Meaning*. The meaning of a product or service can be thought of as super-attribute or super-feature that nurtures the inner needs of the individual. Meaning can include the following: provides physical, health, religious, or emotional sustenance; provides feelings of being needed or being listened to; supports artistic and creative needs; facilitates control over the environment; supports feelings of closeness to the earth and being organic; provides entertainment; supports feelings of status, superiority, and elitism; provides a sense of stewardship or a sense of altruism; supports feelings of adventure; supports gender needs; supports feelings of security and comfort; facilitates and assists in the completion of some work or home task; provides feelings of familial support; helps an individual or a community to learn and adapt; helps us to change location; provides an opportunity for communication and networking; has above-average intrinsic value to some or many people; provide for respect and recognition; and finally, provides a source of satisfaction, happiness, or hope. The meaning of a product or service is very much tied-in to what the product does. For example, communicating is one of the most important and ongoing functions in our lives and we attach significant meaning to products and services that support communication.

Overlap in Meanings, Attributes, and Features

After reading through the list, you can probably notice that there is a significant amount of overlap among the

5. Verganti (2009).
6. [7]
7. Bitner, Ostrom, and Morgan (2008).

different attribute categories. This is in part related to the imprecision of words in all languages and to the proliferation of synonyms. A Venn diagram illustrating the relationships among words and their meanings would visually depict significant degrees of overlap. This ties in very well with the concept of a brand and MDD. Recall that a brand is simply something that lives in the head of consumers.[89] A brand is simply a composite of the mental associations that are generated when you see or think about a certain product. Another way to think about branding is as a gestalt view of the product. It is more than the sum of its parts (the attributes, features, functions, form, design, and meaning). It is the meaning we attach to the product and all the neural associations that are invoked when the product or service is recalled.

7.5 DESIGN PRODUCTS AND SERVICES THAT FACILITATE CONTROL

A fundamental force of adaptation in human beings is our attempt to control the environment.[1112] Infants try to get control of their environment by crying. Cuteness is a built-in genetic adaptation that augments crying and also facilitates environmental control. As we age, this strategy does not work very well and people control the environment by fitting-in, which is another type of control. Security, freedom, independence, and emancipation are the rewards of obtaining control. Getting wheels and driving, acquiring a secure and comfortable home, obtaining a job, and achieving financial security are milestones in achieving control. One person's gain in control can sometimes lead to a loss of control by another. This is the collateral damage that can occur when someone gains too much control over others. For example, colleagues, family, and friends can facilitate (or hinder) the drive for environmental control. However, that same individual can in turn use the control to dominate those who helped him or her to achieve environmental control. Many individual and group conflicts can be traced to someone seeking excessive control or to someone else seeking emancipation from the excessive control.

The two fundamental strategies used to control the environment are primary control and secondary control. Primary control occurs when an individual tries to directly engage with and change the external environment to fit his or her needs and wishes[1415] Secondary control is a type of control that is directed at changing the self in order to cope with the environment. Secondary control is a goal-directed coping strategy for minimizing losses in primary control and also a mechanism for maintaining and increasing primary control. Individuals that do not engage in primary or secondary control have relinquished control and this is manifested by passivity and helplessness. Individuals engaging in primary control try to fix the environment, and those engaged in secondary control try to adapt to the environment. Both strategies assist in coping with the stress and complexity that are part of the everyday activities in the external environment.

We have found that primary and secondary controls also influence feelings of psychological ownership an individual has towards his or her avatar in an online game.[1718] Psychological ownership occurs when people have feelings of ownership towards material things or tangible objects and even immaterial or intangible objects.[20] It occurs when an individual views the object as *mine.* We have found that the key to obtaining lock-in in online

8.
9. [10]
10. Adamson (2006).
11.
12. [13]
13. Cf. Jo, Moon, Garrity, and Sanders (2007).
14. .[16]
15. .
16. Heckhausen and Schulz (1995); Skinner (1996)
17.
18. [19]
19. Jo et al. (2011).
20. [21]
21. Pierce, Kostovab, and Dirks (2003).

gaming environments is to get game players to embrace the system as though they own it. This ownership is the direct result of being able to exercise both primary and secondary controls over their online character by way of the user interface and by successfully interacting with members of the online guilds.

Facebook is a very interesting case of using systems to gain environmental control. It is very difficult for people to actually brag about their day-to-day accomplishments and activities in the *real world* or nononline world. It is much easier, and is indeed acceptable, in Facebook interactions to talk about oneself. There are several mechanisms built into Facebook that encourage bragging. For example, if a picture is added to the photo library or is used to display the image on the Facebook profile, then it is acceptable to brag or tout one's stuff on the accomplishment or the activity. Facebook permits people to control what is known and what is not known about them. It also opens up new lines of communication and it can sometimes alleviate loneliness and even increase recognition and status. LinkedIn is the social networking tool of choice for bragging about professional accomplishments and looking for a job, while Twitter is the outlet of choice for serial braggers and businesses that want to obtain exposure.

The bottom line is that if people can control a product or service or if a product or service helps to actually control the world, people will feel that they own the artifact and thus become locked-in to using that product or service out of loyalty.

There are of course issues of having too much control and having too many options. There is some evidence that having too many choices leads to decision paralysis and some people believe that having too many choices contributes to depression.[22] Novice users of any product or service need directed guidance. A wireless phone or a DVR needs to be easy to use for the first-time user, but also readily customizable as experience grows and new features are sought.

7.6 CATEGORIZING THE IMPORTANCE OF PRODUCT ATTRIBUTES

Some attributes of products were important 5 years ago, but they are not today. Some product features were not even available last year, but they are mandatory today. Similarly, product designs and their accompanying meanings are constantly in flux. The importance of product attributes changes. The following classification scheme can be used to ascertain whether attributes and features are increasing or declining in importance. The classification scheme was derived from a variety of sources.[23]

Points of Parity and Must-Haves (POPS)

These are attributes that most of the products in a category usually have. They are the basic features found in a product or service. They help to define the prototypical product. A product, something that is tangible, does something, and has a function. is something that is tangible and it does something and has a function.[2526] For example, it provides sustenance; it provides security and comfort; it helps us to complete some task; it helps us to learn and adapt; and it helps us to change location, communicate, and network. The product should do what it is meant to do, with certain features that are compelling and functional. These features with their accompanying functionality are "must-haves" for a product or service to be minimally acceptable, and preferably strongly desired. If a product does not possess these essential features and functionality, it might be eliminated from consideration. For example, an auto global positioning system (GPS) should have the ability to enter an address and display how

22. Schwartz (2003).
23. [24]
24. Iyer and Muncy (2005); Keller, Sternthal, and Tybout (2002); Keller and Tybout (2002); Kim and Mauborgne (2005); McGrath and MacMillan (2000); Tybout and Sternthal (2005).
25.
26. [27]
27. Adamson (2006).

long it will take to get to a location; a word processor should have spell-checking capabilities; and a movie theater should sell treats.The attributes that most products in a category usually have.

Points of Difference and Differentiators (PODs)

These are the attributes of a product or service that assist in distinguishing products from the competition and from similar models in a product line. Product and service features that are differentiators are usually derived from Midas products and are high-end products. They are for nonprice-sensitive consumers. You can think of the demand curve as a steep incline where product features roll down from Midas products to Atlas products. When costs are further driven down, the features become the standard of Hermes products. Hermes products are for price-sensitive consumers. Important differentiators for auto GPSs include Bluetooth capability, voice recognition, and topography maps. A movie theater could have very comfortable seats. A word processor could have voice control. As noted earlier, the features tend to roll down the demand curve and the differentiators become must-haves over time.Attributes of a product or service that assist in distinguishing products from the competition and from similar models in a product line.

Blue Ocean Features and Exciters (BOFs)

These features are typically in the very early stages of R&D and part of a secret plan to develop a new market. BOFs have the potential to deliver a knockout punch by developing a Blue Ocean market, a brand new uncontested marketplace. In general, BOF features are in their infancy—beginning to unfold and emerge. Examples for auto GPS might include location of friends and family in close proximity.Features typically in the very early stages of R&D and part of a secret plan to develop a new market.

Another way to identify exciters or BOFs is to think about ways you could go about putting your company out of business or for that matter any company out of business. These are nightmare features and technologies. Many of the ideas that have contributed to putting companies, industries, and even countries out of business were derived from radical technological innovation. Examples include the printing press; armaments and tactical innovations; and networking, computing, and communications innovations. These so-called disruptive technologies are product or process innovations that eventually eclipse or overturn the existing dominant technology. Disruptive technologies can lead to sunrise features and to sunrise products. Sunrise features and products are the dawn of new technological and conceptual capabilities.

Extinct and vestigial features (EXTs)

These are attributes that are no longer necessary or on the verge of becoming extinct. They are sunset features. They are features that are on the verge of becoming obsolete and fading into darkness and oblivion. Sometimes EXTs cannot be removed because there may be a small subset of people that demand the feature. In this case, a decision has to be made to abandon the features or keep the feature. Sometimes the decision to abandon is the best way to go because of cost issues and because the company is going down a new technology path. This was the case with recent versions of Microsoft's operating systems that abandoned some of the legacy DOS code. Apple made a similar decision in regards to abandoning DVD drives in the MacBook Air product and the decision not to include a camera in the iTouch. All of Apple's decisions are influenced by product positioning, product costs, and the emergence and decline of technologies.Attributes that are no longer necessary or on the verge of becoming extinct.

The next category is actually a subcategory of extinct features. When products or services lead to actual dislike of a product or service, then they should be retired or at a minimum require major redesign.

Dissatifiers (DISs)

There are instances when products and features in existing products can discourage consumers from using your product or your competitor's products. Sometimes features can actually cause consumers to actually avoid using a product. The feature may be a negative attribute of the product. This can occur because the product or service has not been designed correctly and is basically unusable. Numerous products and services have failed because consumers have been dissatified with the design. Consumers can also be dissatified with a product because the consumer does not want the feature in the product or service. DISs are often sunset features. For example, many people did not attend circuses because they were opposed to the use of wild animals in the shows or because they thought that the animals were not interesting. That is one of many reasons why Cirque du Soleil became popular with a larger adult market. Cirque du Soleil simply abandoned the use of animals in their programs.Instances when products and features in existing products can discourage consumers from using a product or competitor's products.

7.7 THE FAD TEMPLATE

The purpose of the FAD template is to try to facilitate and provide a degree of structure for conceptualizing new products and services . The first step in using the FAD template is to provide a description of the product or service that is being considered. The second step in using the FAD template involves describing the meaning of the product. Several product meanings have been listed to provide a starting point. The next step in using the FAD template involves identifying potential attributes. The attributes can be features, performance characteristics, form, design, and even additional meanings. We have included a few attributes that are often considered, but you are encouraged to seek the attributes that are important in the development of your product or service. One goal of using the FAD template is to facilitate product differentiation. Focusing on attributes that are exciters and Blue Ocean features will assist in the differentiation process. It is sometimes helpful to focus on features that are on the verge of extinction or features that consumers are not satisfied with or wish they were not there. Considering exciters and disastisfiers helps to expand the way designers view the meaning behind a product or service, and it allows the designer to gain deeper insight into how to improve the current performance of the product.

Prototyping and the FAD Template

The final stage of using the FAD template is to provide a way to visualize the product by: a drawing, a schematic of the product or service, or a physical model. Learning-by-doing means that you make and build things. You try experiments and you construct prototypes. Prototypes need to be constructed for tangible products, for services, and also for systems applications. If the product is a tangible product, then a generic mock-up of the product needs to be constructed as early as possible. The idea is to develop a very rough prototype of the product or service. There are many different ways to do this. It could be a report developed in a word-processing program, an interface developed in a presentation program, a sketch using a vector or raster-based drawing program or even drawn using a pencil on the back of a napkin, a three-dimensional (3D) model developed in Google's free SketchUp program, or a flow diagram illustrating a process. If the product is a computer application, then a prototype can be constructed using a rapid prototyping language or demonstrated via a presentation package such as PowerPoint. There are also many excellent applications available for tablet computers that are very effective for developing mock-ups of applications and for drawing or sketching preliminary product ideas.

Services should also be prototyped. A uniquely designed service can be used as a way to differentiate a firm from the competition. Service design should always focus on the customer and how the customer interacts with the business in receiving the service. These interactions between the customer and the business are referred to as the touch points or connections. There are many components that go into the design of a service. They

include the people, the verbal and nonverbal interactions, the processes, the scripts, the tools, the materials, the infrastructure, and the technologies. Execution of the service is a function of how all the service components work together.

One popular tool for designing services is service blueprinting. It is a visual and descriptive tool for modeling visible customer interactions with employees and processes that also illustrates how the hidden processes support the customer interactions.[2829]There are a number of tools that can be used to conceptualize, design, and test the design of the service including drawings, sketches, scenario analysis and task structuring, mock-ups, storyboarding, systems, Lego mock-ups, and many more. Because services often involve queues or lines, simulations can be used to understand how fast or how slow a service will be performed in a particular situation.

The goal of the first-cut prototype is to learn-by-doing, to get other people to understand what you are thinking about, and to help you understand what you are trying to do. Developing a prototype in some form or another is an important part of the learning-about and the learning-by-doing process that *will* facilitate creative insight.[31]

Many prototypes start out with paper and pencil and then become increasingly more sophisticated as they mature. The basic sequence of iterative design with stepwise refinement includes the following:

1. Initial Prototype: In the early stages, develop a pencil and paper picture of the product, the application, or the process. The key is to focus on the key or essential functions of the product or service.
2. Review: Let business stakeholders, family, friends, and eventually potential customers provide feedback on the product or service.
3. Revise and redesign prototype: Use the feedback to refine and improve the design of the product or service. Use more advanced tools as the prototype becomes more refined and detailed. This usually leads to the use of graphics, drawing, and mock-up software. Towards the later stages of development, the prototype might be a functioning product or service or an actual application with some level of functionality.
4. Go back to step 2 after revising and redesigning the prototype.

There are some very exciting prototyping tools for manufactured products. Although currently in their infancy, they have the potential to completely change the way that products are prototyped and eventually how everything will be manufactured.[32] These new tools are part of a new approach for manufacturing called additive manufacturing or desktop manufacturing. Rapid prototyping is becoming a reality because additive manufacturing assists in producing prototypes very quickly. One of the most promising technologies for implementing additive manufacturing is the 3D printer. Very detailed and complex plastic working models of products can be generated using 3D printers.[33] The parts or products are made by using 3D digital descriptions to print successive thin layers of plastic on top of plastic until a 3D solid emerges. Some of these plastic products and parts can be used as final products and not just as prototypes. There are versions of the 3D printers that use titanium powder to construct very complex objects such as jewelry and avionics components. Several aviation companies are investigating the use of very large 3D printers to create entire aircraft wings.

28.
29. [30]
30. Bitner et al. (2008).
31. This notion is discussed in the chapter on innovation and is also the result of several research projects I have been involved with. See in particular Cerveny, Garrity, and Sanders (1986).
32. The Printed World (2011).
33. In 2011, the 3D printers start at around $10,000 (just search for “3D printers” to see what is currently available.). There are hobbyists versions of 3D printers in the $1,000 range.

Example of the FAD Template in Wine Aging Cooler

Aged wine has always been attractive to wine enthusiasts and wine connoisseurs, but aged wine is expensive because of the time involved. A merlot can take up to 15 years to age and Shiraz-based wines may require 20 years of aging. Several products have been introduced and patents have been secured and applied for that are purported to speed up the aging process.[34] Suppose an inventor found that it was possible to dramatically speed up the wine aging process by exposing a wine to an electromagnetic field with a very specific magnetic field strength. Suppose that the same inventor found that the taste of all wines could be improved using the special aging process. The net effect is that the technology could reduce the time to produce fine aged wine and also increase the quality of low-priced wines as well as increase the status of the owner of the wine aging product.

Use the FAD Template to Develop the Blue Ocean Strategy Canvas

Chan Kim and Renée Mauborgne developed a technique they call the Strategy Canvas to assist in identifying a Blue Ocean market.[35] A Blue Ocean market is essentially an uncontested new market with high profit and significant growth potential. They use the Strategy Canvas as a tool to assist in identifying Blue Ocean markets. One purpose of the Strategy Canvas is to understand where the competition is playing and investing their time and resources. Another purpose of the Strategy Canvas is to try to identify new customer segments in uncontested market spaces. The idea is simply to create new markets and attract customers.

One area where the Strategy Canvas is deficient is in the identification of attributes and features for competition and differentiation. The FAD template is ideally situated for assisting in that process. The FAD template can be used as an input device for constructing the Strategy Canvas by facilitating the identification of important attributes and features on which to compete.

The following approach can be used to develop a strategic canvas:

- Use the FAD template to identify the key competitive factors in terms of product and process features including price, meaning, technology, performance, design, availability, customer support, technology, size, weight, speed, ease of use, and other product features. These key competitive factors are then placed on the *X*-axis of the canvas (either at the top or the bottom).
- Then, each competitor and your company are plotted on the *Y*-axis. If a competitor has a high level of a particular factor, then it is plotted above the middle of the *Y*-axis. Similarly, competitors with low levels of a factor are plotted below the middle of the *Y*-axis.

A generic Strategy Canvas with the FAD categories is illustrated in Figure 7.3 “Preliminary Strategy Canvas with FAD Categories”. It incorporates the essential concepts from the FAD template into the development of a Strategy Canvas. Figure 7.4 “Potential Strategy Canvas for Nintendo Wii” illustrates how the Strategy Canvas could be used to position the Nintendo Wii. We identified what we believed is the key meaning of the Wii along with several important attributes and key design issues for the Wii. The feature categories that apply to the attributes are highlighted in bold. For example, the *Appeal to the entire Family* attribute is considered a point of differentiation and a Blue Ocean Feature. The attributes and their values are, of course, contingent on who actually constructs the Strategy Canvas and they will change very quickly according to the whims of the market. Figure 7.5 “Nintendo Wii Strategy Canvas” illustrates a more attractive graphic that was created using the Strategy Canvas data.

34. Search for “wine aging” at the U.S. patent office and with any search engine.
35. Kim and Mauborgne (2005).

		Meaning of product or service↓	BOF POD POP EXTDIS	BOF POD POP EXTDIS	BOF POD POP EXTDIS	BOF POD POP EXTDIS	BOF POD POP EXTDIS	BOF POD POP EXTDIS
Attribute name	Price		Quality					
Very High								
High								
Average								
Low								
Very Low								
Not Applicable								

Figure 7.3 Preliminary Strategy Canvas with FAD Categories

		Meaning of product or service↓	BOF POD POP EXT DIS	BOF POD POP EXT DIS	BOF POD POP EXT DIS	BOF POD POP EXT DIS
Attribute Name	Price	Family campfire	Ease of use	Appeal to entire family	Resolution	Disk space
Very High		Wii		Wii		
High	PS3 Xbox		Wii		PS3 Xbox	PS3
Average		PS3	PS3	PS3		Xbox
Low	Wii	Xbox	Xbox	Xbox		
Very Low					Wii	
Not Applicable						Wii

Figure 7.4 Potential Strategy Canvas for Nintendo Wii

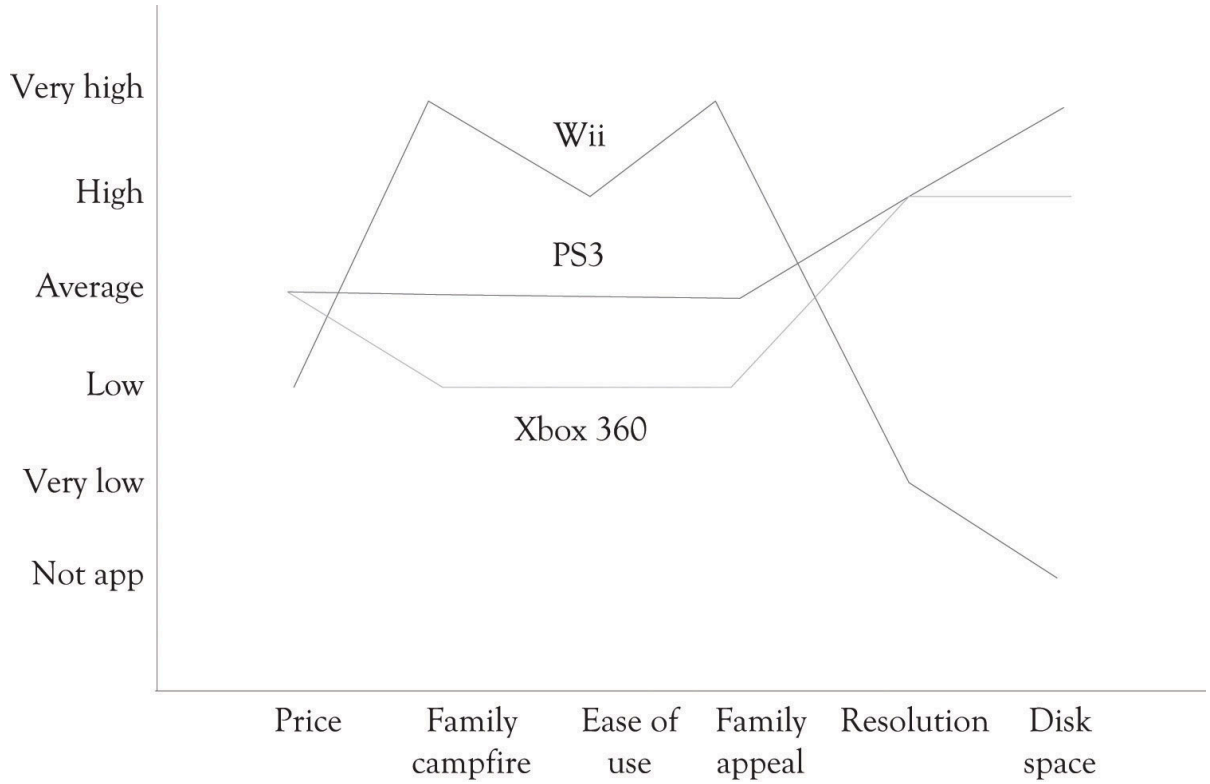


Figure 7.5 Nintendo Wii Strategy Canvas

Benefits of the FAD Strategy Canvas

The FAD strategic canvas can be used to determine where a company wants to differentiate themselves from the competition. The objective is to determine where you would add, delete, or change the level of a factor in order to identify a Blue Ocean. It can also be used to identify attributes or factors that could be eliminated because the product features are considered low-value, extinct, or dissatisfiers. It could of course be used to assist in identifying unique features that could be added. You can also use the ideas discussed earlier such as combining products, borrowing ideas from other industries and products, and flipping ideas.

It should also be noted that the approach can be used in conjunction with a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis diagram to identify the major strengths and weaknesses in the design of existing and new products.

Lateral Marketing, FAD, and the Strategy Canvas

Lateral Marketing, a related concept found in the marketing literature, can also be used to assist in identifying Blue Ocean markets. The goal of lateral marketing[36] is to help create new markets by:

- trying to reach a new set of customers by radically changing the product features either by adding or subtracting features;
- trying to identify substitute products or services that can compete with an existing product or service;
- trying to identify complementary products and services for existing lines;

36. Kotler and de Bes (2003).

- trying to reposition a product by having it satisfy different needs for different market segments.

The lateral marketing approach along with the other ideas presented in this chapter complements the Blue Ocean approach as a mechanism for identifying how product features can be added, subtracted, and adapted to create innovative products and services. Not all products and services introduced will be Blue Oceans; nevertheless, the approach using the FAD template and the Strategy Canvas will certainly provide a useful tool for understanding the positioning of your products and your competitors.

Marketing research is a complementary and systematic avenue for identifying key attributes and marketing opportunities for products and services. The literature describes a number of approaches for identifying what features are relevant to consumers:

- Brainstorm to identify a superset of existing and future product and service features
- Use auctions to identify what products and features are relevant to consumers
- Develop consumer surveys and sampling approaches
- Ask consumers what features they think are important
- Ask consumers to evaluate, compare, and rank the features they deem important in a product and service
- Use statistical analysis to disentangle and understand the relationships between customer wants and product features
- Look at consumer and editorial reviews and try to understand what features of a product or service appear to be attracting people.

For additional and more detailed insight into the concepts and approaches for conducting market research, you are encouraged to read Naresh K. Malhotra and David F. Birk's very thorough book on the topic[37] and the Cavusgil, Knight, Riesenberger, and Yaprak[38] book on conducting international marketing research.

7.8 DEVELOPING BLUE OCEAN MARKETS FROM COMPLEMENTARY PRODUCTS AND SERVICES

Many innovative products and services are actually complements of the original products. The innovation can be an add-on feature, an after-market service, or a different product or service. Transportation devices have spurred the development of substitute energy sources such as steam, electric, fuel cells, and solar energy. The automobile was the driving force behind the development of better roads, fueling stations, diners, and truck stops. The development of better sailing ships led to the need for complementary devices for navigation tools such as maps, star maps, compasses, sextants, and GPSs. The FAD template and the Strategy Canvas can also be used to identify competitive complementary products and services.

7.9 AVOID THE SWISS ARMY KNIFE APPROACH TO PRODUCT DIFFERENTIATION

One model of the Wenger Swiss Army knife, called the *Giant*, has 87 tools, performs 141 functions, and costs $1,400[39] If you were sent to a deserted island and were limited to what you could bring, that knife would certainly be on a short list of must-have items. The Giant was probably introduced because Wenger could introduce it and also because it creates a great image in the mind of consumers. Wenger has excellent engineering skills. In

37. Malhotra and Birks (2009).
38. Cavusgil, Knight, Riesenberger, and Yaprak (2009).
39. .[40]
40. http://www.wengerna.com/giant-knife-16999

general, however, specialized tools perform better than the all-in-one tool. There is a trade-off between having everything in one place that is readily accessible and having superb capabilities and functionality. The cork-screw, the scissors, the magnifier, the golf club cleaner, and the wire cutter in a Swiss Army knife are OK, but they are not the best tools for doing the respective jobs.

Wireless phones have become the Swiss Army knife for communication, networking, and entertainment. Not all the implements (camera, music playing, video, net interface, retail showroom and purchasing, gaming, GPS, social networking, and communications) are stellar; they are, however, always available to the user. Apple has been very successful at integrating features on the iPhone, the iPad, and their other products that are attractive to their customers, but they are very cautious in adding features for feature sake.[4142] Some of the hubris exhibited by Apple is attributable to the cache of the superb Apple brand. But there is a secret sauce for Apple's success. There are strong design principles at work at Apple, involving minimalism, attention to quality, and focusing on the design of a high-quality user interface. Apple is also very big on attaching meaning to their entire product portfolio. Their commercials exude the development of meaning. The Flip Mino video camera was once very successful because it was simple and very easy to use. The very young and the old are always looking for easy-to-use products and services.

Feature creep occurs when a new feature is added and many of the old features are retained. Sometimes features are beneficial. Sometimes they become vestigial and forever encoded in the DNA of the product or service. They are like vestigial physical characteristics in human beings that are no longer needed. For example, humans have tailbones or coccyx, but they do not have tails. Once a feature is in place, it is difficult to remove it because some company will use the features to illustrate how they have more features than their competition. Automobile GPSs illustrate how feature creep occurs over time. Feature creep has been the boom and the boon of companies that produce automobile GPS applications. Figure 7.6 "Features Used to Differentiate GPS Offerings" illustrates the numerous product features that can be found in automobile GPS products. It is unlikely that many people are using the MP3 and photo players on their auto GPSs to play music or view photos, but these features have crept into many of the units sold by GPS manufacturers. The point is that there are instances where it might make sense to scale back on features because the features are either truly vestigial or overkill. This would also reduce the cognitive burden facing consumers because of the numerous choice points. Sometimes the vestigial features hinder design changes and can adversely affect the ability to add new features that are truly valuable to the consumer. One of the greatest impediments facing hardware and software developers in redesigning systems is in maintaining backward compatibility.

41.
42. [43]
43. Manjoo (2010).

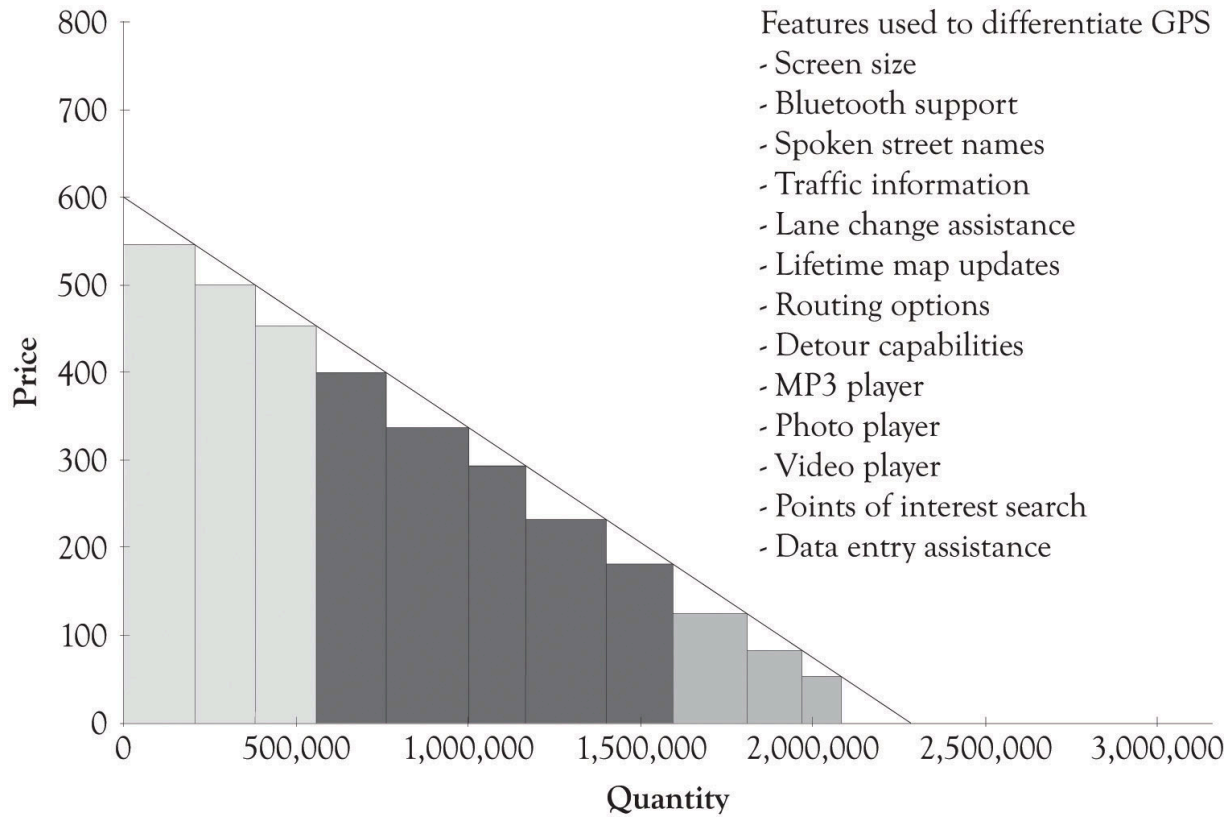


Figure 7.6 Features Used to Differentiate GPS Offerings

7.10 CONCLUSION

Successful product development should involve both UDD that is focused on consumer wants and needs and MDD that is predicated on understanding the emotional and psychological relationships that people have on products as well as incorporating the importance of new technological developments (TDD). We have also introduced the FAD template. The FAD template is based on the various design approaches and also draws on a classification scheme that can be used to ascertain whether attributes and features are increasing or declining in importance. The FAD template in conjunction with the Strategy Canvas can be used to assist in taking an abstract product concept and preparing a first-cut prototype of the product. The key points are the following:

- The focus of MDD allows the innovators to develop ideas that transcend existing product concepts, conceiving product ideas as a vision rather than only on product differentiation.
- Concentrating on function and ignoring user input is a recipe for failure.
- Identifying key meanings, attributes, and features is an essential step in MDD, including the customer relationship to the product, quality, reliability, ease-of-use, performance, design, technology, and most importantly, value creation and meaning.
- The meaning of a product or service is very much tied into what the product does.
- Attributes of a product to help users control either their internal or external environments have the power to make a significant impact.
- Psychological ownership of a product promotes user attachment and use, keeping users locked into the product out of loyalty.

- Attending to POPS as well as PODS is necessary to keep your product competitive. POPS ensure that your product meets the minimal essential features. PODS are necessary for distinguishing a product from the competition.
- Disruptive technologies and sunrise features are the dawn of new technological and conceptual capabilities.
- Use the FAD template to facilitate and provide structure when conceptualizing new products and services.
- Create a FAD Strategy Canvas to understand the attributes of your product in the context of your current and potential competitors.
- Seriously consider your feature list in terms of must-haves, points of differentiation, and vestigial features. Try to avoid feature creep, which involves adding features just for the sake of adding new features.

7.11 EXHIBIT 1: FAD TEMPLATE

1. **Product or service description (what will it do or what is its function?). What type of customer or customer segment(s) are you targeting?**

   _____

2. **What is the meaning(s) behind the product or service?**

   _____

   Potential meanings: The product or service provides physical, health, religious, and emotional sustenance; provides feelings of being needed or being listened to; supports artistic and creative needs; facilitates control over the environment; provides entertainment; supports feelings of status, superiority, and elitism; provides a sense of stewardship; supports feelings of closeness to the earth and being organic; provides a sense of altruism; supports feelings of adventure; supports gender needs; supports feelings of security and comfort; facilitates and assists in the completion of some work or home task; provides feelings of familial support; helps an individual or a community to learn and adapt; helps us to change location; provides an opportunity for communication and networking; has above-average intrinsic value to some or many people; provides for respect and recognition; and finally, the product or service is a source of satisfaction, happiness, and hope.

3. **Identify potential product and service attributes, features, and functions. Here are some ideas for the attributes, features, and functions:**

   Price: How much does it cost?

   _____

   Quality: How well does the product or service conform to the product specifications? Does the product do what it says it is supposed to do in the user manual? Is it effective in performing its function?

   _____

   Reliability: Does the product or service perform as it is supposed to over its expected life? Is it prone to failure? Is it easily maintained?

   _____

   Ease-of-use: Is the product or service easy to use and can consumers learn to use it without much trouble?

   _____

   Performance: Is the product or service faster, smaller, more convenient, greater capacity, better

resolution, compatible, and adaptable? Which features, functions, and processes are unique or distinguishing?

_____

Design: Is the external form attractive? Is it visually, tactically, audibly, and olfactorily attractive? Is the product packaged properly? Is the service experience attractive and positive from the consumer's perspective? Does the product or service suggest a certain meaning?

_____

Technology: Is there an emerging technology or a process that can improve quality, reliability, ease-of-use, performance, value, design, and meaning?

_____

Value creation: Is there any intrinsic value in the product that distinguishes it from other products or services? Does it solve a problem that consumers want to solve and will attract them to the product or service?

_____

4. **List the key attributes, features, and functions that will be focused on and, in particular, those that reinforce or detract from the meaning. Attribute can be in more than one category. Attributes can refer to the product you are planning to introduce and to existing products,**

   Points of parity and must-haves (POPS): List the attributes, features, and functions that most of the products or services in a category usually have.

   - _____
   - _____
   - _____

   Points of difference and differentiators (PODs): List the attributes, features, and functions of a product that distinguish it from the competition. This typically refers to a product or service that you are developing.

   - _____
   - _____
   - _____

   Blue Ocean features and exciters (BOFs): List the sunrise attributes, features, and functions that could be used to develop a new Blue Ocean market.

   - _____
   - _____
   - _____

   Extinct and vestigial features (EXTs): List the sunset attributes, features, and functions that are no longer necessary or on the verge of becoming extinct for the product or service. This typically refers to products and services that are already being sold.

   - _____
   - _____
   - _____

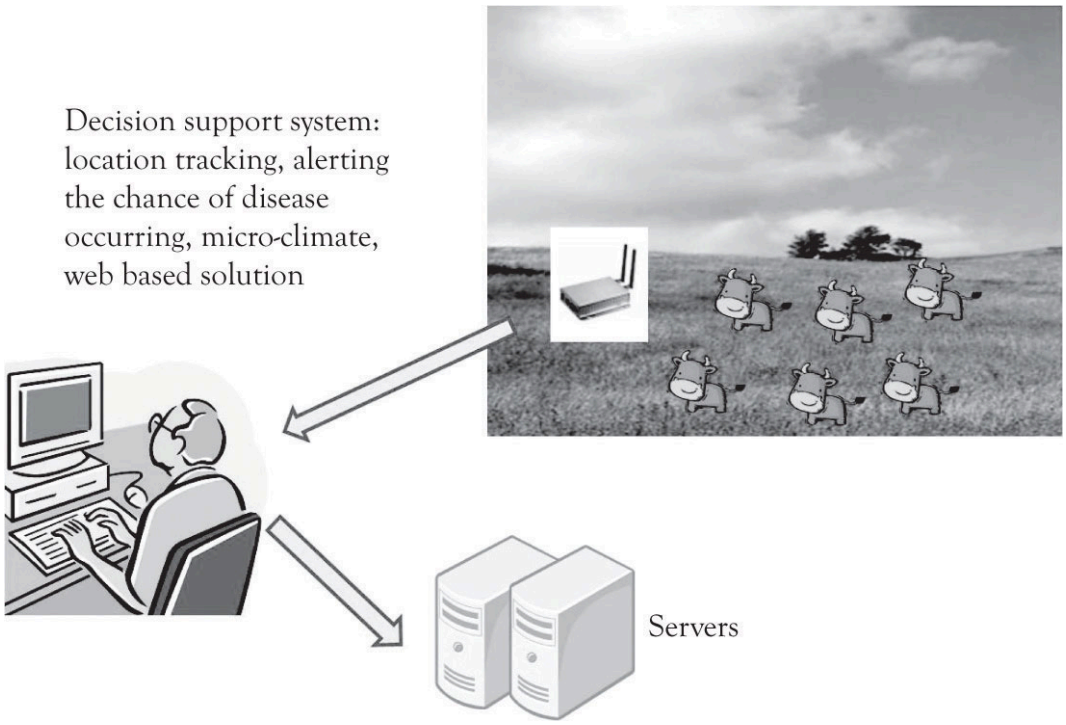
Dissatisfiers (DISs): List the attributes, features, and functions that can cause some consumers to avoid using your product or your competitor's product. This typically refers to products and services that are already being sold.

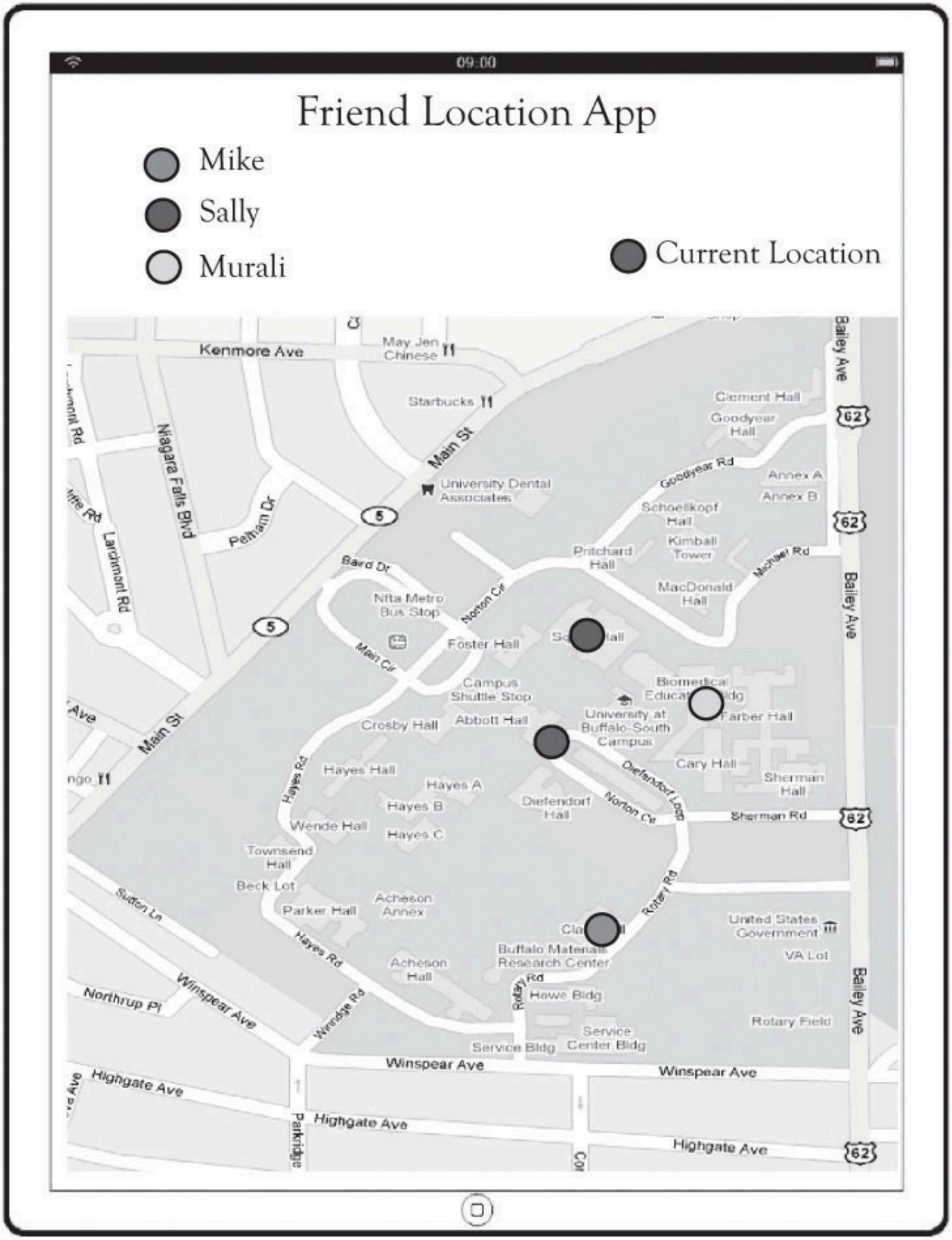
- _____
- _____
- _____

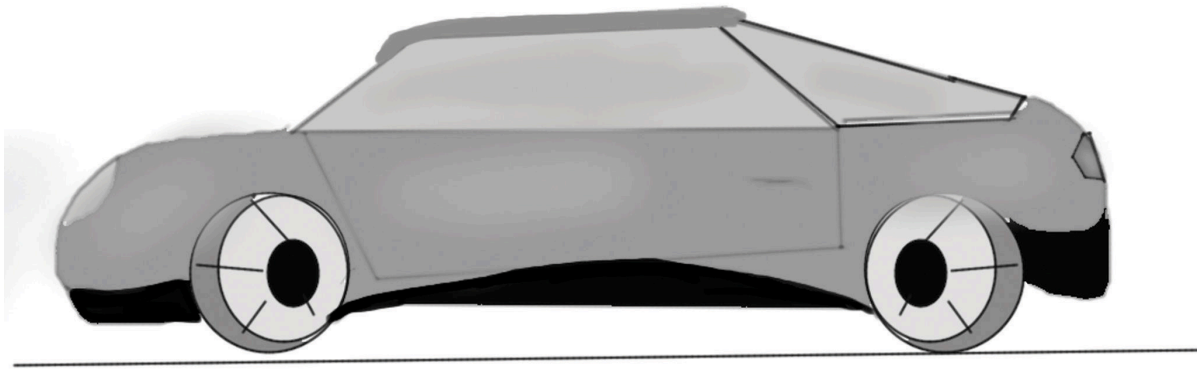
7.12 DESIGN AND PROTOTYPE PRODUCT OR SERVICE

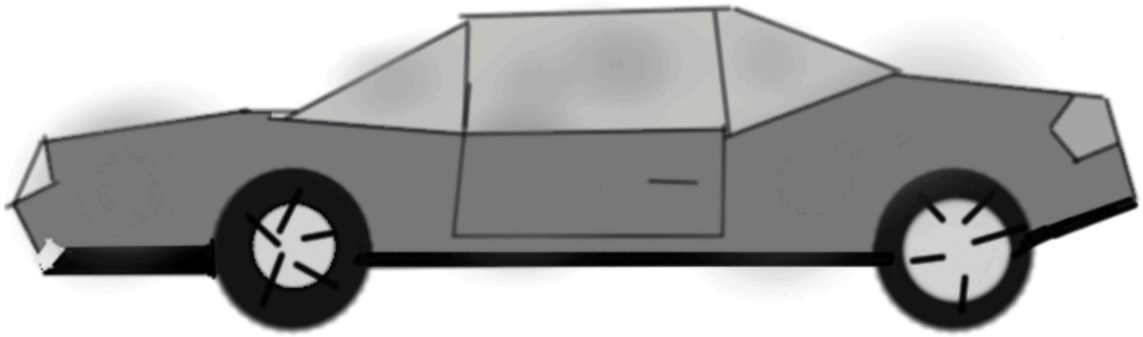
Put a mock-up picture of the product or service here (use sketching, drawing software, mock-up software, photo software, or presentation software). If the product is a software, put an example of a critical report or input screen here (use a word processor or presentation software). If the idea behind the product or service involves a complex process or business process, then draw a flow diagram or a business process diagram (use presentation software or specialized flowchart and business process diagramming software).

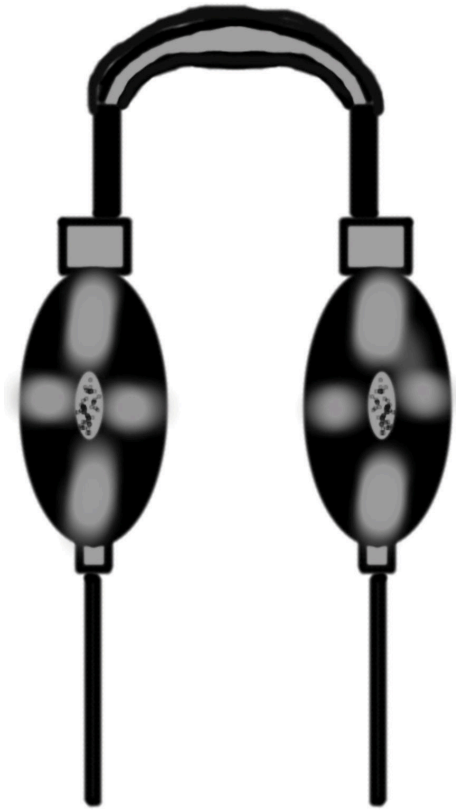
7.13 APPENDIX 1: EXAMPLES OF PROTOTYPES




09:00
Friend Location App
Mike
Sally
Murali
Current Location
Kenmore Ave
May Jen Chinese
Starbucks
Niagara Falls Blvd
Main St
Pelham Dr
Larchmont Rd
Baird Dr
Nfta Metro Bus Stop
Norton Cir
Main Cir
Foster Hall
Campus Shuttle Stop
Crosby Hall
Abbott Hall
Hayes Rd
Hayes Hall
Hayes A
Hayes B
Hayes C
Wende Hall
Townsend Hall
Beck Lot
Parker Hall
Acheson Annex
Acheson Hall
Sutton Ln
Northrup Pl
Winspear Ave
Winridge Rd
Highgate Ave
Parkridge
Clement Hall
Goodyear Hall
Goodyear Rd
University Dental Associates
Annex A
Annex B
Schoellkopf Hall
Kimball Tower
Pritchard Hall
Michael Rd
MacDonald Hall
Bailey Ave
62
5
University at Buffalo-South Campus
Biomedical Education Bldg
Farber Hall
Cary Hall
Sherman Hall
Sherman Rd
Diefendorf Hall
Diefendorf Loop
Norton Cir
Rotary Rd
Buffalo Materials Research Center
Howe Bldg
Service Bldg
Service Center Bldg
United States Government
VA Lot
Rotary Field







7.14 APPENDIX 2: FAD TEMPLATE FOR WINE AGING PRODUCT

1. **Product or service description (what will it do or what is its function?) What type of customer or customer segment(s) are you targeting?**

Uses some type of technology to age inexpensive wines and make them more pleasant. Considering using an electromagnet with a specific magnetic field strength. The potential target customers are wine connoisseurs and individuals interested in fine wine.

2. **What is the meaning(s) behind the product or service?**

   Appeals to status.

   Potential Meanings: The product or service provides physical, health, religious, and emotional sustenance; provides feelings of being needed or being listened to; supports artistic and creative needs; facilitates control over the environment; provides entertainment; supports feelings of status, superiority, and elitism; provides a sense of stewardship; supports feelings of closeness to the earth and being organic; provides a sense of altruism; supports feelings of adventure; supports gender needs; supports feelings of security and comfort; facilitates and assists in the completion of some work or home task; provides feelings of familial support; helps an individual or a community to learn and adapt; helps us to change location; provides an opportunity for communication and networking; has above-average intrinsic value to some or many people; provides for respect and recognition; and finally, the product or service is a source of satisfaction, happiness and hope.

3. **Identify potential product and service attributes, features, and functions. Here are some ideas for the attributes, features, and functions:**

   Price: How much does it cost?

   Unsure but will have two versions priced at $300 and $1,000 price level.

   Quality: How well does the product or service conform to the product specifications? Does the product do what it says it is supposed to do in the user manual? Is it effective in performing its function?

   Need to test the effectiveness of the technology in a research setting.

   Reliability: Does the product or service perform as it is supposed to over its expected life? Is it prone to failure? Is it easily maintained?

   Unsure. Plan on having a refrigerator function in the high-end version.

   Ease-of-use: Is the product or service easy to use and can consumers learn to use it without much trouble?

   Will have either knobs or a digital key pad to program the aging time.

   Performance: Is the product or service faster, smaller, more convenient, greater capacity, better resolution, compatible, and adaptable? Which features, functions, and processes are unique or distinguishing?

   We are optimistic that it will be faster than existing wine aging products. Will also have greater capacity than existing products.

   Design: Is the external form attractive? Is it visually, tactically, audibly, and olfactorily attractive? Is the product packaged properly? Is the service experience attractive and positive from the consumer's perspective? Does the product or service suggest a certain meaning?

   The high-end model will look like a high-end, high-tech refrigerator.

   Technology: Is there an emerging technology or a process that can improve quality, reliability, ease-of-use, performance, value, design, and meaning?

   Unsure. However, our approach could be ineffective.

   Value Creation: Is there some intrinsic value in the product that distinguishes it from other products or services? Does the product or service solve a problem that consumers want to solve and will the solution attract them to the product or service?

   It may attract wine enthusiasts because it has the potential to improve the taste of all wines. We also think that it will also appeal to buyers of wine storage devices including refrigerators and coolers.

4. **List the key attributes, features, and functions that will be focused on and, in particular, those**

that reinforce or detract from the meaning. Attribute can be in more than one category. Attributes can refer to the product you are planning to introduce and to existing products,

Points of parity and must-haves (POPS): List the attributes, features, and functions that most of the products or services in a category usually have.

- Capable of aging

Points of difference and differentiators (PODs): List the attributes, features, and functions of a product that distinguish it from the competition. This typically refers to a product or service that you are developing.

- Sophistication aging technology. Aging refrigerator available.
- High-tech design

Blue Ocean features and exciters (BOFs): List the sunrise attributes, features, and functions that could be used to develop a new Blue Ocean market.

- Sophistication aging technology
- High-tech design

Extinct and vestigial features (EXTs): List the sunset attributes, features, and functions that are no longer necessary or on the verge of becoming extinct for the product or service. This typically refers to products and services that are already being sold.

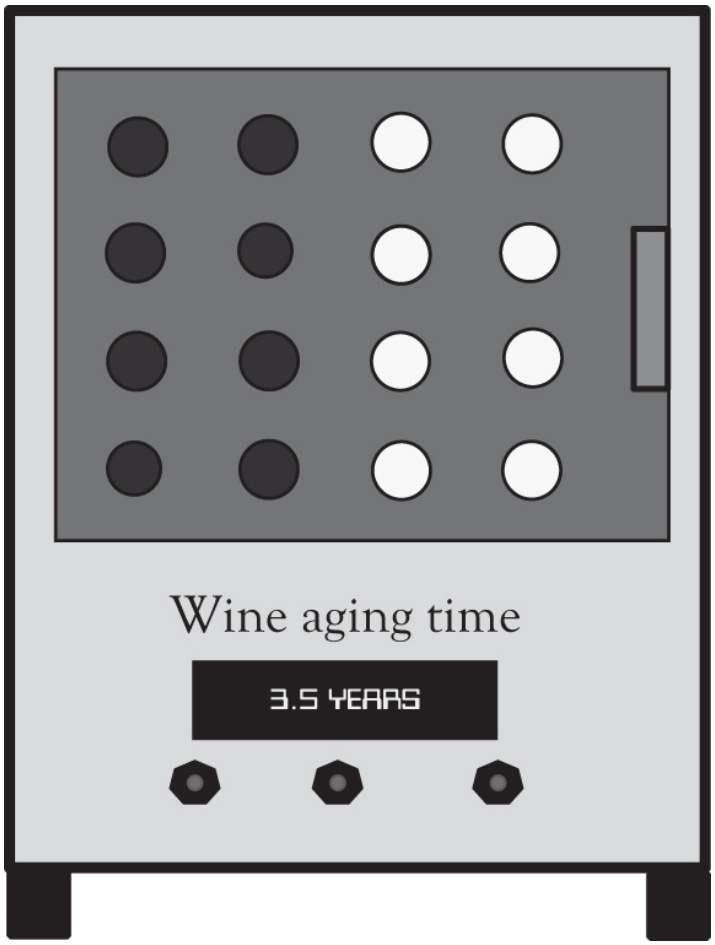
- Traditional wine aging process

Dissatisfiers (DISs): List the attributes, features, and functions that can cause some consumers to avoid using your product or your competitor's product. This typically refers to products and services that are already being sold.

- Does not age wine

7.15 DESIGN AND PROTOTYPE PRODUCT OR SERVICE

Put a mock-up picture of the product or service here (use sketching, drawing software, mock-up software, photo software, or presentation software). If the product is a software, put an example of a critical report or input screen here (use a word processor or presentation software). If the idea behind the product or service involves a complex process or business process, then draw a flow diagram or a business process diagram (use presentation software or specialized flowchart and business process diagramming software).


Wine aging time
3.5 YEARS

CHAPTER 6 HOW IS COST-VOLUME-PROFIT ANALYSIS USED FOR DECISION MAKING?

Recilia Vera is vice president of sales at Snowboard Company, a manufacturer of one model of snowboard. Lisa Donley is the company accountant. Recilia and Lisa are in their weekly meeting.

Recilia:	*Lisa, I'm in the process of setting up an incentive system for my sales staff, and I'd like to get a better handle on our financial information.*
Lisa:	*No problem. How can I help?*
Recilia:	*I've reviewed our financial results for the past 12 months. It looks like we made a profit in some months, and had losses in other months. From what I can tell, we sell each snowboard for $250, our variable cost is $150 per unit, and our fixed cost is $75 per unit. It seems to me that if we sell just one snowboard each month, we should still show a profit of $25, and any additional units sold should increase total profit.*
Lisa:	*Your unit sales price of $250 and unit variable cost of $150 look accurate to me, but I'm not sure about your unit fixed cost of $75. Fixed costs total $50,000 a month regardless of the number of units we produce. Trying to express fixed costs on a per unit basis can be misleading because it depends on the number of units being produced and sold, which changes each month. I can tell you that each snowboard produced and sold provides $100 toward covering fixed costs—that is, $250, the sales price of one snowboard, minus $150 in variable cost.*
Recilia:	*The $75 per unit for fixed costs was my estimate based on last year's sales, but I get your point. As you know, I'd like to avoid having losses. Is it possible to determine how many units we have to sell each month to at least cover our expenses? I'd also like to discuss what it will take to make a decent profit.*
Lisa:	*We can certainly calculate how many units have to be sold to cover expenses, and I'd be glad to discuss how many units must be sold to make a decent profit.*
Recilia:	*Excellent! Let's meet again next week to go through this in detail.*

Answering questions regarding break-even and target profit points requires an understanding of the relationship among costs, volume, and profit (often called *CVP*). This chapter discusses cost-volume-profit analysis, which identifies how changes in key assumptions (for example, assumptions related to cost, volume, or profit) may impact financial projections. We address Recilia's questions in the next section.

6.1 COST-VOLUME-PROFIT ANALYSIS FOR SINGLE-PRODUCT COMPANIES

Learning Objective

1. Perform cost-volume-profit analysis for single-product companies.

Question: The profit equation shows that profit equals total revenues minus total variable costs and total fixed costs. This profit equation is used extensively in cost-volume-profit (CVP) analysis, and the information in the profit equation

is typically presented in the form of a contribution margin income statement (first introduced in Chapter 5 "How Do Organizations Identify Cost Behavior Patterns?"). What is the relationship between the profit equation and the contribution margin income statement?

Answer: Recall that the contribution margin income statement starts with sales, deducts variable costs to determine the contribution margin, and deducts fixed costs to arrive at profit. We use the term "variable cost" because it describes a cost that *varies in total* with changes in volume of activity. We use the term "fixed cost" because it describes a cost that is *fixed (does not change) in total* with changes in volume of activity.

To allow for a mathematical approach to performing CVP analysis, the contribution margin income statement is converted to an equation using the following variables:

Key Equation

S = Selling price *per unit*
V = Variable cost *per unit*
F = *Total* fixed costs
Q = Quantity of units produced and sold
Thus
Profit=Total sales−Total variable costs−Total fixed costsProfit=(S×Q)−(V×Q)−F

Figure 6.1 "Comparison of Contribution Margin Income Statement with Profit Equation" clarifies the link between the contribution margin income statement presented in Chapter 5 "How Do Organizations Identify Cost Behavior Patterns?" and the profit equation stated previously. Study this figure carefully because you will encounter these concepts throughout the chapter.

Figure 6.1 Comparison of Contribution Margin Income Statement with Profit Equation

Recall that when identifying cost behavior patterns, we assume that management is using the cost information to make short-term decisions. Variable and fixed cost concepts are useful for short-term decision making. The

short-term period varies, depending on a company's current production capacity and the time required to change capacity. In the long term, all cost behavior patterns are likely to change.

Break-Even and Target Profit

Question: Companies such as Snowboard Company often want to know the sales required to break even, which is called the break-even point. What is meant by the term break-even point?

Answer: The *break-even point* can be described either in units or in sales dollars. The break-even point in units is the number of units that must be sold to achieve zero profit. The break-even point in sales dollars is the total sales measured in dollars required to achieve zero profit. If a company sells products or services easily measured in units (e.g., cars, computers, or mountain bikes), then the formula for break-even point in *units* is used. If a company sells products or services not easily measured in units (e.g., restaurants, law firms, or electricians), then the formula for break-even point in *sales dollars* is used.

Break-Even Point in Units

Question: How is the break-even point in units calculated, and what is the break-even point for Snowboard Company?

Answer: The break-even point in units is found by setting profit to zero using the profit equation. Once profit is set to zero, fill in the appropriate information for selling price per unit (S), variable cost per unit (V), and total fixed costs (F), and solve for the quantity of units produced and sold (Q).

Let's calculate the break-even point in units for Snowboard Company. Recall that each snowboard sells for $250. Unit variable costs total $150, and total monthly fixed costs are $50,000. To find the break-even point in units for Snowboard Company, set the profit to zero, insert the unit sales price (S), insert the unit variable cost (V), insert the total fixed costs (F), and solve for the quantity of units produced and sold (Q):

Profit=(S×Q)−(V×Q)−F$0=$250Q−$150Q−$50,000$0=$100Q−$50,000$50,000=$100QQ=500 units

Thus Snowboard Company must produce and sell 500 snowboards to break even. This answer is confirmed in the following contribution margin income statement.

	Amount	Calculation
Sales	$125,000	(500 units × $250)
Variable costs	75,000	(500 units × $150)
Contribution margin	$ 50,000	(500 units × $100)
Fixed costs	50,000	(given)
Operating profit	$ 0	

Target Profit in Units

Question: Although it is helpful for companies to know the break-even point, most organizations are more interested in determining the sales required to make a targeted amount of profit. How does finding the target profit in units help companies like Snowboard Company?

Answer: Finding a target profit in unitsThe number of units that must be sold to achieve a certain profit. simply means that a company would like to know how many units of product must be sold to achieve a certain profit.

At Snowboard Company, Recilia (the vice president of sales) and Lisa (the accountant) are in their next weekly meeting.

Lisa:	*Recilia, last week you asked how many units we have to sell to cover our expenses. This is called the break-even point. If each unit produced and sold provides $100 toward covering fixed costs, and if total monthly fixed costs are $50,000, we would have to sell 500 units to break even—that is, $50,000 divided by $100.*
Recilia:	*What happens once we sell enough units to cover all of our fixed costs for the month?*
Lisa:	*Good question! Once all fixed costs are covered for the month, each unit sold contributes $100 toward profit.*
Recilia:	*I think I'm getting the hang of this. It will take 500 units in sales to break even, and each unit sold above 500 results in a $100 increase in profit. So if we sell 503 units for a month, profit will total $300?*
Lisa:	*You've got it!*
Recilia:	*So if our goal is to make a profit of $30,000 per month (target profit), how many units must be sold?*
Lisa:	*It takes 500 units to break even. We also know each unit sold above and beyond 500 units contributes $100 toward profit. Thus we would have to sell an additional 300 units above the break-even point to earn a profit of $30,000. This means we would have to sell 800 units in total to make $30,000 in profit.*
Recilia:	*Wow, I'm not sure selling 800 units is realistic, but at least we have a better sense of what needs to be done to make a decent profit. Thanks for your help!*

Profit Equation

Question: Let's formalize this discussion by using the profit equation. How is the profit equation used to find a target profit amount in units?

Answer: Finding the target profit in units is similar to finding the break-even point in units except that profit is no longer set to zero. Instead, set the profit to the target profit the company would like to achieve. Then fill in the information for selling price per unit (S), variable cost per unit (V), and total fixed costs (F), and solve for the quantity of units produced and sold (Q):

Profit=(S×Q)−(V×Q)−F$30,000=$250Q−$150Q−$50,000$30,000=$100Q−$50,000$80,000=$100QQ=800 units

Thus Snowboard Company must produce and sell 800 snowboards to achieve $30,000 in profit. This answer is confirmed in the following contribution margin income statement:

	Amount	Calculation
Sales	$200,000	(800 units × $250)
Variable costs	120,000	(800 units x $150)
Contribution margin	$ 80,000	(800 units x $100)
Fixed costs	50,000	(given)
Operating profit	$ 30,000	

Shortcut Formula

Question: Although using the profit equation to solve for the break-even point or target profit in units tends to be the easiest approach, we can also use a shortcut formula derived from this equation. What is the shortcut formula, and how is it used to find the target profit in units for Snowboard Company?

Answer: The shortcut formula is as follows:

Key Equation

Q = (F + Target Profit) ÷ (S − V)

If you want to find the *break-even point in units*, set "Target Profit" in the equation to zero. If you want to find a *target profit in units*, set "Target Profit" in the equation to the appropriate amount. To confirm that this works, use the formula for Snowboard Company by finding the number of units produced and sold to achieve a target profit of $30,000:

Q=(F+Target Profit)÷(S−V)Q=($50,000+$30,000)÷($250−$150)Q=$80,000÷$100Q=800 units

The result is the same as when we used the profit equation.

Break-Even Point in Sales Dollars

Question: Finding the break-even point in units works well for companies that have products easily measured in units, such as snowboard or bike manufacturers, but not so well for companies that have a variety of products not easily measured in units, such as law firms and restaurants. How do companies find the break-even point if they cannot easily measure sales in units?

Answer: For these types of companies, the break-even point is measured in sales dollars. That is, we determine the total revenue (total sales dollars) required to achieve zero profit for companies that cannot easily measure sales in units.

Finding the break-even point in sales dollars requires the introduction of two new terms: *contribution margin per unit* and *contribution margin ratio*.

Contribution Margin per Unit

The contribution margin per unit is the amount *each unit sold* contributes to (1) covering fixed costs and (2) increasing profit. We calculate it by subtracting variable costs per unit (V) from the selling price per unit (S).

Key Equation

Contribution margin per unit = S − V

For Snowboard Company the contribution margin is $100:

Contribution margin per unit=S−V$100=$250−$150

Thus *each unit sold* contributes $100 to covering fixed costs and increasing profit.

Contribution Margin Ratio

The contribution margin ratio (often called *contribution margin percent*) is the contribution margin as a percentage of sales. It measures the amount *each sales dollar* contributes to (1) covering fixed costs and (2) increasing profit. The contribution margin ratio is the contribution margin per unit divided by the selling price per unit. (Note that the contribution margin ratio can also be calculated using the *total* contribution margin and *total* sales; the result is the same.)

Key Equation

Contribution margin ratio = (S − V) ÷ S

For Snowboard Company the contribution margin ratio is 40 percent:
Contribution margin ratio=(S − V)÷S40%=($250 − $150)÷$250

Thus *each dollar in sales* contributes 40 cents ($0.40) to covering fixed costs and increasing profit.

Question: With an understanding of the contribution margin and contribution margin ratio, we can now calculate the break-even point in sales dollars. How do we calculate the break-even point in sales dollars for Snowboard Company?

Answer: The formula to find the break-even point in sales dollars is as follows.

Key Equation

Break-even point in sales dollars=Total fixed costs + Target profitContribution margin ratio

For Snowboard Company the break-even point in sales dollars is $125,000 per month:
Break-even point in sales dollars=$50,000+$00.40$125,000 in sales=$50,000+$00.40

Thus Snowboard Company must achieve $125,000 in total sales to break even. The following contribution margin income statement confirms this answer:

	Amount	Calculation
Sales	*$125,000*	(500 units x $250)
Variable costs	75,000	(500 units x $150)
Contribution margin	$ 50,000	(500 units x $100)
Fixed costs	50,000	(given)
Operating profit	$ 0	

Target Profit in Sales Dollars

Key Equation

Target profit in sales dollars = Total fixed costs + Target profitContribution margin ratio

Question: Finding a target profit in sales dollarsThe total sales measured in dollars required to achieve a certain profit. *simply means that a company would like to know total sales measured in dollars required to achieve a certain profit. Finding the target profit in sales dollars is similar to finding the break-even point in sales dollars except that "target profit" is no longer set to zero. Instead, target profit is set to the profit the company would like to achieve. Recall that management of Snowboard Company asked the following question: What is the amount of total sales dollars required to earn a target profit of $30,000?*

Answer: Use the break-even formula described in the previous section. Instead of setting the target profit to $0, set it to $30,000. This results in an answer of $200,000 in monthly sales:

Target profit in sales dollars=Total fixed costs + Target profitContribution margin ratio$200,000 in sales=$50,000+$30,0000.40

Thus Snowboard Company must achieve $200,000 in sales to make $30,000 in monthly profit. The following contribution margin income statement confirms this answer:

	Amount	Calculation
Sales	*$200,000*	(800 units x $250)
Variable costs	120,000	(800 units x $150)
Contribution margin	$ 80,000	(800 units x $100)
Fixed costs	50,000	(given)
Operating profit	$ 30,000	

Business in Action 6.1

Measuring the Break-Even Point for Airlines

During the month of September 2001, **United Airlines** was losing $15 million per day. With $2.7 billion in cash, **United** had six months to return to profitability before facing a significant cash shortage. Many analysts believed **United's** troubles resulted in part from a relatively high break-even point.

Airlines measure break-even points, also called *load factors*, in terms of the percentage of seats filled. At the end of 2001, one firm estimated that **United** had to fill 96 percent of its seats just to break even. This is well above the figure for other major airlines, as you can see in the list that follows:

- **American Airlines:** 85 percent
- **Delta Airlines:** 85 percent
- **Southwest Airlines:** 65 percent
- **Alaska Airlines:**75 percent

United Airlines filed for bankruptcy at the end of 2002 and emerged from bankruptcy in 2006 after reducing costs by $7 billion a year. Other airlines continue to work on reducing their break-even points and maximizing the percentage of seats filled.

Source: Lisa DiCarlo, "Can This Airline Be Saved?" *Forbes* magazine's Web site (http://www.forbes.com), November 2001; "United Airlines Emerges from Bankruptcy," Reuters (http://www.foxnews.com), February 1, 2005.

CVP Graph

Question: The relationship of costs, volume, and profit can be displayed in the form of a graph. What does this graph look like for Snowboard Company, and how does it help management evaluate financial information related to the production of snowboards?

Answer: Figure 6.2 "CVP Graph for Snowboard Company" shows in graph form the relationship between cost, volume, and profit for Snowboard Company. The vertical axis represents dollar amounts for revenues, costs, and profits. The horizontal axis represents the volume of activity for a period, measured as units produced and sold for Snowboard.

There are three lines in the graph:

- Total revenue
- Total cost
- Profit

The total revenue line shows total revenue based on the number of units produced and sold. For example, if Snowboard produces and sells one unit, total revenue is $250 (= 1 × $250). If it produces and sells 2,000 units, total revenue is $500,000 (= 2,000 × $250).

The total cost line shows total cost based on the number of units produced and sold. For example, if Snowboard produces and sells one unit, total cost is $50,150 [= $50,000 + (1 × $150)]. If it produces and sells 2,000 units, total cost is $350,000 [= $50,000 + (2,000 × $150)].

The profit line shows profit or loss based on the number of units produced and sold. It is simply the difference between the total revenue and total cost lines. For example, if Snowboard produces and sells 2,000 units, the profit is $150,000 (= $500,000 − $350,000). If no units are sold, a loss is incurred equal to total fixed costs of $50,000.

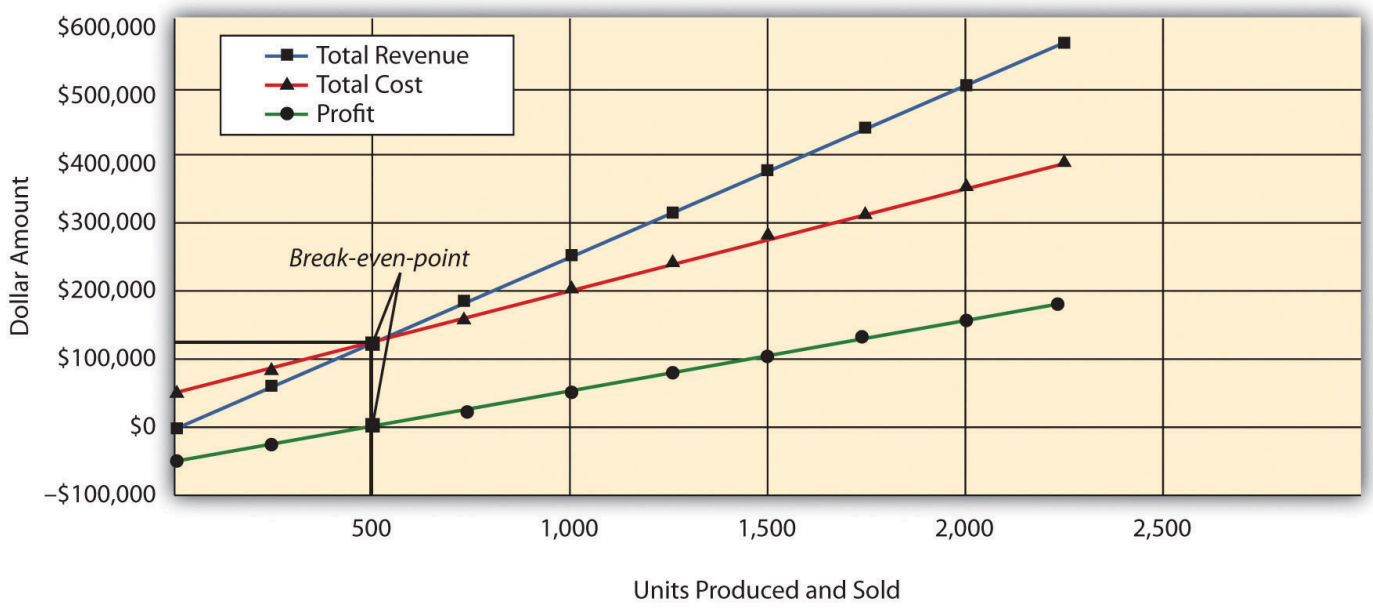


Figure 6.2 CVP Graph for Snowboard Company

Margin of Safety

Question: Managers often like to know how close projected sales are to the break-even point. How is this information calculated and used by management?

Answer: The excess of projected sales over the break-even point is called the margin of safety. The margin of safety represents the amount by which sales can fall before the company incurs a loss.

Key Equation

Margin of safety (in units) = Projected sales (in units) − Break-even sales (in units)

Assume Snowboard Company expects to sell 700 snowboards and that its break-even point is 500 units; the margin of safety is 200 units. The calculation is

Margin of safety (in units)=Projected sales (in units)−Break-even sales (in units)200=700−500

Thus sales can drop by 200 units per month before the company begins to incur a loss.
The margin of safety can also be stated in sales dollars.

Key Equation

Margin of safety (in sales $) = Projected sales (in sales $) − Break-even sales (in sales $)

For Snowboard the margin of safety in sales dollars is $50,000:
Margin of safety (in sales $)=Projected sales (in sales $)−Break-even sales (in sales $)$50,000=(700 units×$250)−(500 units×$250)
Thus sales revenue can drop by $50,000 per month before the company begins to incur a loss.

Key Takeaway

- Cost-volume-profit analysis involves finding the break-even and target profit point in units and in sales dollars. The key formulas for an organization with a single product are summarized in the following list. Set the target profit to $0 for break-even calculations, or to the appropriate profit dollar amount for target profit calculations. The margin of safety formula is also shown:
  - Break-even or target profit point measured in *units*:
    Total fixed costs + Target profitSelling price per unit − Variable cost per unit
    (The denominator is also called "contribution margin per unit.")
  - Break-even or target profit point measured in *sales dollars*:
    Total fixed costs + Target profitContribution margin ratio
  - Margin of safety in units or sales dollars:
    Projected sales − Break-even sales

Review Problem 6.1

Star Symphony would like to perform for a neighboring city. Fixed costs for the performance total $5,000. Tickets will sell for $15 per person, and an outside organization responsible for processing ticket orders charges the symphony a fee of $2 per ticket. Star Symphony expects to sell 500 tickets.

1. How many tickets must Star Symphony sell to break even?
2. How many tickets must the symphony sell to earn a profit of $7,000?
3. How much must Star Symphony have in sales dollars to break even?
4. How much must Star Symphony have in sales dollars to earn a profit of $7,000?
5. What is the symphony's margin of safety in units and in sales dollars?

Solution to Review Problem 6.1

Note: All solutions are rounded.

1. The symphony must sell 385 tickets to break even:
   Total fixed costs + Target profitSelling price per unit − Variable cost per unit=$5,000+$0$15−$2=385 tickets (rounded)
2. The symphony must sell 923 tickets to make a profit of $7,000:
   Total fixed costs + Target profitSelling price per unit − Variable cost per unit=$5,000+$7,000$15−$2=923 tickets (rounded)
3. The symphony must make $5,769 in sales to break even:
   Total fixed costs + Target profitContribution margin ratio=$5,000+$0$(15−$2) ÷$15=$5,769 (rounded)
4. The symphony must make $13,846 in sales to earn a profit of $7,000:
   Total fixed costs + Target profitContribution margin ratio=$5,000+$7,000$(15−$2) ÷$15=$13,846 (rounded)
5. The symphony's margin of safety is 115 units or $1,725 in sales:
   Margin of safety=Projected sales − Break-even sales115 tickets=500 tickets−385 tickets$1,725 in sales=(500×$15)−(385×$15)

6.2 COST-VOLUME-PROFIT ANALYSIS FOR MULTIPLE-PRODUCT AND SERVICE COMPANIES

Learning Objective

1. Perform cost-volume-profit analysis for multiple-product and service companies.

Question: Although the previous section illustrated cost-volume-profit (CVP) analysis for companies with a single product easily measured in units, most companies have more than one product or perhaps offer services not easily measured in units. Suppose you are the manager of a company called Kayaks-For-Fun that produces two kayak models, River and Sea. What information is needed to calculate the break-even point for this company?

Answer: The following information is required to find the break-even point:

- Monthly fixed costs total $24,000.
- The River model represents 60 percent of total sales volume and the Sea model accounts for 40 percent of total sales volume.
- The unit selling price and variable cost information for the two products follow:

	River	Sea
Selling price	$500	$600
Variable cost	100	450
Contribution margin	$400	$150

Finding the Break-Even Point and Target Profit in Units for Multiple-Product Companies

Question: Given the information provided for Kayaks-For-Fun, how will the company calculate the break-even point?

Answer: First, we must expand the profit equation presented earlier to include multiple products. The following terms are used once again. However, subscript *r* identifies the River model, and subscript *s* identifies the Sea model (e.g., S_r stands for the River model's selling price per unit). CM is new to this section and represents the contribution margin.

Key Equation

S = Selling price *per unit*
V = Variable cost *per unit*
F = *Total* fixed costs
Q = Quantity of units produced and sold
CM = Contribution margin

Thus

Profit=Total sales−Total variable costs−Total fixed costsProfit=[(Sr ×Qr)+(Ss ×Qs)]−[(Vr ×Qr)+(Vs ×Qs)]−F

Without going through a detailed derivation, this equation can be restated in a simplified manner for Kayaks-For-Fun, as follows:

Profit=(Unit CM for River×Quantity of River)+(Unit CM for Sea×Quantity of Sea)−FProfit=$400Qr+$150Qs−$24,000

One manager at Kayaks-For-Fun believes the break-even point should be 60 units in total, and another manager believes the break-even point should be 160 units in total. Which manager is correct? The answer is both might be correct. If only the River kayak is produced and sold, 60 units is the break-even point. If only the Sea kayak is produced and sold, 160 units is the break-even point. There actually are many different break-even points, because the profit equation has two unknown variables, Q_r and Q_s.

Further evidence of multiple break-even points is provided as follows (allow for rounding to the nearest unit), and shown graphically in Figure 6.3 "Multiple Break-Even Points for Kayaks-For-Fun":

Profit ($0) = ($400 × **30** units of River) + ($150 × **80** units of Sea) − $24,000
Profit ($0) = ($400 × **35** units of River) + ($150 × **67** units of Sea) − $24,000
Profit ($0) = ($400 × **40** units of River) + ($150 × **53** units of Sea) − $24,000

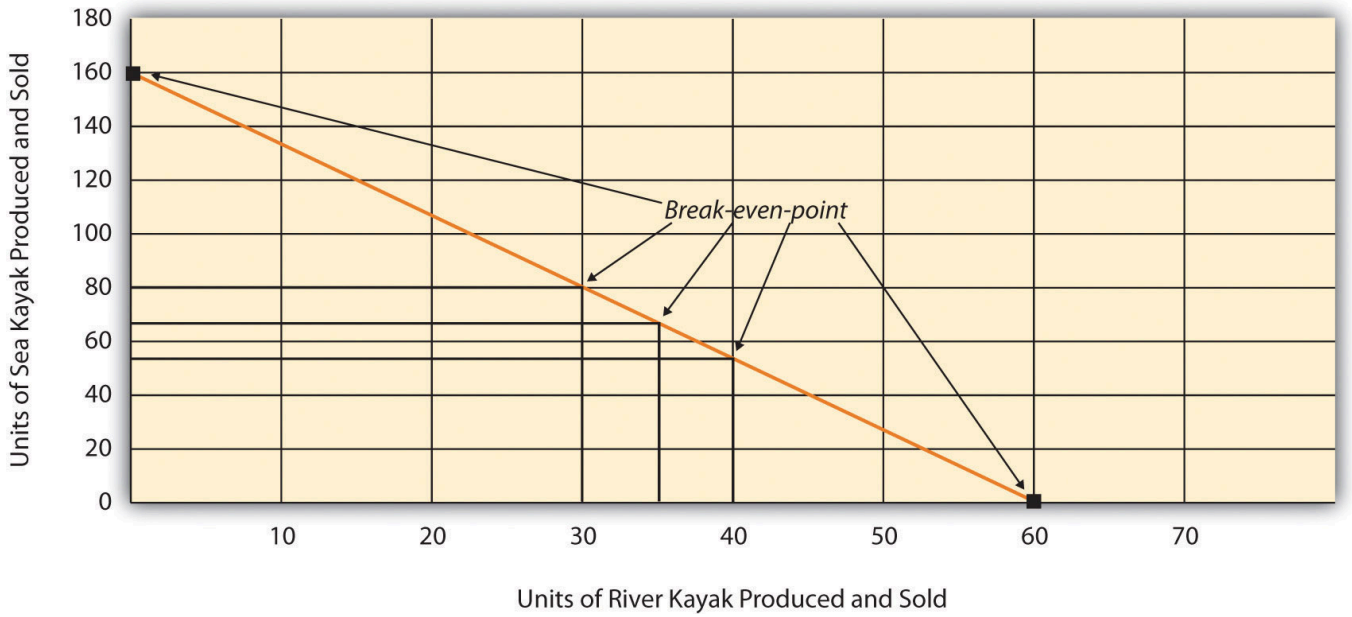


Figure 6.3 Multiple Break-Even Points for Kayaks-For-Fun

Break-Even Point in Units and the Weighted Average Contribution Margin per Unit

Question: Because most companies sell multiple products that have different selling prices and different variable costs, the break-even or target profit point depends on the sales mix. What is the sales mix, and how is it used to calculate the break-even point?

Answer: The sales mix is the proportion of one product's sales to total sales. In the case of Kayaks-For-Fun, the River model accounts for 60 percent of total unit sales and the Sea model accounts for 40 percent of total unit sales.

In calculating the break-even point for Kayaks-For-Fun, we must assume the sales mix for the River and Sea models will remain at 60 percent and 40 percent, respectively, at all different sales levels. The formula used to solve for the break-even point in units for multiple-product companies is similar to the one used for a single-product company, with one change. Instead of using the contribution margin per unit in the denominator, multiple-product companies use a *weighted average contribution margin per unit*. The formula to find the break-even point in units is as follows.

Key Equation

Total fixed costs + Target profitWeighted average contribution margin per unit

When a company assumes a constant sales mix, a weighted average contribution margin per unit can be

calculated by multiplying each product's unit contribution margin by its proportion of total sales. The resulting weighted unit contribution margins for all products are then added together.

At Kayaks-For-Fun, the weighted average contribution margin per unit of $300 is

$300 = ($400 × 60 percent) + ($150 × 40 percent)

We can now determine the break-even point in units by using the following formula:

Break-even point in units=Total fixed costs + Target profitWeighted average contribution margin per unitBreak-even point in units=$24,000+$0$300=80 total kayaks

Kayaks-For-Fun must sell 48 River models (= 60 percent × 80 units) and 32 Sea models (= 40 percent × 80 units) to break even. Again, this assumes the sales mix remains the same at different levels of sales volume.

Target Profit in Units

Question: We now know how to calculate the break-even point in units for a company with multiple products. How do we extend this process to find the target profit in units for a company with multiple products?

Answer: Finding the target profit in units for a company with multiple products is similar to finding the break-even point in units except that profit is no longer set to zero. Instead, profit is set to the target profit the company would like to achieve.

Key Equation

Target profit in units=Total fixed costs + Target profitWeighted average contribution margin per unit

For example, assume Kayaks-For-Fun would like to know how many units it must sell to make a monthly profit of $96,000. Simply set the target profit to $96,000 and run the calculation:

Target profit in units=Total fixed costs + Target profitWeighted average contribution margin per unitTarget profit in units=$24,000+$96,000$300=400 total kayaks

Kayaks-For-Fun must sell 240 River models (= 60 percent × 400) and 160 Sea models (= 40 percent × 400) to make a profit of $96,000.

Review Problem 6.2

International Printer Machines (IPM) builds three computer printer models: Inkjet, Laser, and Color Laser. Information for these three products is as follows:

	Inkjet	Laser	Color Laser	Total
Selling price per unit	$250	$400	$1,600	
Variable cost per unit	$100	$150	$ 800	
Expected unit sales (annual)	12,000	6,000	2,000	20,000
Sales mix	60 percent	30 percent	10 percent	100 percent

Total annual fixed costs are $5,000,000. Assume the sales mix remains the same at all levels of sales.

1. How many printers in total must be sold to break even?
2. How many units of each printer must be sold to break even?
1. How many printers in total must be sold to earn an annual profit of $1,000,000?
2. How many units of each printer must be sold to earn an annual profit of $1,000,000?

Solution to Review Problem 6.2

Note: All solutions are rounded.

1. IPM must sell 20,408 printers to break even:
   Total fixed costs + Target profitWeighted average contribution margin per unit
   $5,000,000+$0($150×0.60)+($250×0.30)+($800×0.10)=$5,000,000$245=20,408 total units
2. As calculated previously, 20,408 printers must be sold to break even. Using the sales mix provided, the following number of units of each printer must be sold to break even:
   - Inkjet: 12,245 units=20,408 × 0.60
   - Laser: 6,122 units=20,408 × 0.30
   - Color laser: 2,041 units=20,408 × 0.10

1. IPM must sell 24,490 printers to earn $1,000,000 in profit:
   Total fixed costs + Target profitWeighted average contribution margin per unit
   $5,000,000+$1,000,000($150×0.60)+($250×0.30)+($800×0.10)=$6,000,000$245=24,490 total units
2. As calculated previously, 24,490 printers must be sold to earn $1,000,000 in profit. Using the sales mix provided, the following number of units for each printer must be sold to earn $1,000,000 in profit:
   - Inkjet:14,694 units=24,490 × 0.60
   - Laser:7,347 units=24,490 × 0.30
   - Color laser:2,449 units=24,490 × 0.10

Finding the Break-Even Point and Target Profit in Sales Dollars for Multiple-Product and Service Companies

A restaurant like **Applebee's**, which serves chicken, steak, seafood, appetizers, and beverages, would find it difficult to measure a "unit" of product. Such companies need a different approach to finding the break-even point. Figure 6.4 "Type of Good or Service Determines Whether to Calculate Break-Even Point and Target Profit Points in Units or Sales Dollars" illustrates this point by contrasting a company that has similar products easily measured in units (kayaks) with a company that has unique products (meals at a restaurant) not easily measured in units.

Break-Even Point in Sales Dollars and the Weighted Average Contribution Margin Ratio

Question: For companies that have unique products not easily measured in units, how do we find the break-even point?

Answer: Rather than measuring the break-even point in units, a more practical approach for these types of

companies is to find the break-even point in sales dollars. We can use the formula that follows to find the break-even point in sales dollars for organizations with multiple products or services. Note that this formula is similar to the one used to find the break-even point in sales dollars for an organization with one product, except that the contribution margin ratio now becomes the *weighted average* contribution margin ratio.

Key Equation

$$\text{Break-even point in sales dollars} = \frac{\text{Total fixed costs + Target profit}}{\text{Weighted average contribution margin ratio}}$$

For example, suppose Amy's Accounting Service has three departments—tax, audit, and consulting—that provide services to the company's clients. Figure 6.5 "Income Statement for Amy's Accounting Service" shows the company's income statement for the year. Amy, the owner, would like to know what sales are required to break even. Note that fixed costs are known in total, but Amy does not allocate fixed costs to each department.

	Tax	Audit	Consulting	Total
Sales	$100,000	$150,000	$250,000	$500,000
Variable costs	30,000	120,000	125,000	275,000
Contribution margin	$ 70,000	$ 30,000	$125,000	$225,000
Fixed costs				120,000
Operating profit				$105,000

Figure 6.5 Income Statement for Amy's Accounting Service

The *contribution margin ratio* differs for each department:

Tax	70 percent (= $70,000 ÷ $100,000)
Audit	20 percent (= $30,000 ÷ $150,000)
Consulting	50 percent (= $125,000 ÷ $250,000)

Question: We have the contribution margin ratio for each department, but we need it for the company as a whole. How do we find the contribution margin ratio for all of the departments in the company combined?

Answer: The contribution margin ratio for the company as a whole is the weighted average contribution margin ratio. We calculate it by dividing the *total* contribution margin by *total* sales. For Amy's Accounting Service, the weighted average contribution margin ratio is 45 percent (= $225,000 ÷ $500,000). For every dollar increase in sales, the company will generate an additional 45 cents ($0.45) in profit. This assumes that the sales mix remains the same at all levels of sales. (The sales mix here is measured in sales dollars for each department as a proportion of total sales dollars.)

Now that you know the weighted average contribution margin ratio for Amy's Accounting Service, it is possible to calculate the break-even point in sales dollars:

Break-even point in sales dollars=Total fixed costs + Target profitWeighted average contribution margin ratioBreak-even point in sales dollars=$120,000+$00.45=$266,667 (rounded)

Amy's Accounting Service must achieve $266,667 in sales to break even.[1]

Target Profit in Sales Dollars

Question: How do we find the target profit in sales dollars for companies with products not easily measured in units?

Answer: Finding the target profit in sales dollars for a company with multiple products or services is similar to finding the break-even point in sales dollars except that profit is no longer set to zero. Instead, profit is set to the target profit the company would like to achieve.

Key Equation

Target profit in sales dollars=Total fixed costs + Target profitWeighted average contribution margin ratio

For example, assume Amy's Accounting Service would like to know sales dollars required to make $250,000 in annual profit. Simply set the target profit to $250,000 and run the calculation:

Target profit in sales dollars=Total fixed costs + Target profitWeighted average contribution margin ratioTarget profit in sales dollars=$120,000+$250,0000.45=$822,222 (rounded)

Amy's Accounting Service must achieve $822,222 in sales to earn $250,000 in profit.

Important Assumptions

Question: Several assumptions are required to perform break-even and target profit calculations for companies with multiple products or services. What are these important assumptions?

Answer: These assumptions are as follows:

- Costs can be separated into fixed and variable components.
- Contribution margin ratio remains constant for each product, segment, or department.
- Sales mix remains constant with changes in total sales.

These assumptions simplify the CVP model and enable accountants to perform CVP analysis quickly and easily.

1. The weighted average contribution margin ratio can also be found by multiplying each department's contribution margin ratio by its proportion of total sales. The resulting weighted average contribution margin ratios for all departments are then added. The calculation for Amy's Accounting Service is as follows:45 percent weighted average contribution margin ratio = (tax has 20 percent of total sales × 70 percent contribution margin ratio) + (audit has 30 percent of total sales × 20 percent contribution margin ratio) + (consulting has 50 percent of total sales × 50 percent contribution margin ratio)Thus 45 percent = 14 percent + 6 percent + 25 percent.

However, these assumptions may not be realistic, particularly if significant changes are made to the organization's operations. When performing CVP analysis, it is important to consider the accuracy of these simplifying assumptions. It is always possible to design a more accurate and complex CVP model. But the benefits of obtaining more accurate data from a complex CVP model must outweigh the costs of developing such a model.

Margin of Safety

Question: Managers often like to know how close expected sales are to the break-even point. As defined earlier, the excess of projected sales over the break-even point is called the margin of safety. How is the margin of safety calculated for multiple-product and service organizations?

Answer: Let's return to Amy's Accounting Service and assume that Amy expects annual sales of $822,222, which results in expected profit of $250,000. Given a break-even point of $266,667, the margin of safety in sales dollars is calculated as follows:

Margin of safety=Projected sales − Break-even sales$555,555=$822,222 − $266,667

Thus sales revenue can drop by $555,555 per year before the company begins to incur a loss.

Key Takeaways

- The key formula used to calculate the break-even or target profit point **in units** for a company with multiple products is as follows. Simply set the target profit to $0 for break-even calculations, or to the appropriate profit dollar amount for target profit calculations.

  Total fixed costs + Target profitWeighted average contribution margin per unit

- The formula used to find the break-even point or target profit in **sales dollars** for companies with multiple products or service is as follows. Simply set the "Target Profit" to $0 for break-even calculations, or to the appropriate profit dollar amount for target profit calculations:

  Total fixed costs + Target profitWeighted Average contribution margin ratio

Review Problem 6.3

Ott Landscape Incorporated provides landscape maintenance services for three types of clients: commercial, residential, and sports fields. Financial projections for this coming year for the three segments are as follows:

	Commercial	Residential	Sports Fields	Total
Sales	$2,100,000	$1,000,000	$1,900,000	$5,000,000
Variable costs	1,800,000	800,000	1,400,000	4,000,000
Contribution margin	$ 300,000	$ 200,000	$ 500,000	$1,000,000
Fixed costs				200,000
Operating profit				$ 800,000

Assume the sales mix remains the same at all levels of sales.

1. How much must Ott Landscape have in total sales dollars to break even?
2. How much must Ott Landscape have in total sales dollars to earn an annual profit of $1,500,000?

3. What is the margin of safety, assuming projected sales are $5,000,000 as shown previously?

Solution to Review Problem 6.3

1. Sales of $1,000,000 are required to break even:
   Total fixed costs + Target profitWeighted average contribution margin ratio*=$200,000+$00.20=$1,000,000 in sales
   *Weighted average contribution margin ratio = $1,000,000 ÷ $5,000,000 = 20 percent or 0.20.
2. Sales of $8,500,000 are required to make a profit of $1,500,000:
   Total fixed costs + Target profitWeighted average contribution margin ratio=$200,000+$1,500,0000.20=$8,500,000 in sales
3. The margin of safety is $4,000,000 in sales:
   Margin of safety=Projected sales − Break-even sales$4,000,000 in sales=$5,000,000−$1,000,000

6.3 USING COST-VOLUME-PROFIT MODELS FOR SENSITIVITY ANALYSIS

Learning Objective

1. Use sensitivity analysis to determine how changes in the cost-volume-profit equation affect profit.

Question: We can use the cost-volume-profit (CVP) financial model described in this chapter for single-product, multiple-product, and service organizations to perform sensitivity analysis, also called what-if analysis. How is sensitivity analysis used to help managers make decisions?

Answer: Sensitivity analysis shows how the CVP model will change with changes in any of its variables (e.g., changes in fixed costs, variable costs, sales price, or sales mix). The focus is typically on how changes in variables will alter profit.

Sensitivity Analysis: An Example

To illustrate sensitivity analysis, let's go back to Snowboard Company, a company that produces one snowboard model. The assumptions for Snowboard were as follows:

Sales price per unit	$ 250
Variable cost per unit	150
Fixed costs per month	50,000
Target profit	30,000

Recall from earlier calculations that the break-even point is 500 units, and Snowboard must sell 800 units to achieve a target profit of $30,000. Management believes a goal of 800 units is overly optimistic and settles on a best guess of 700 units in monthly sales. This is called the "base case." The base case is summarized as follows in contribution margin income statement format:

Sales	$175,000	(700 units x $250)
Variable costs	105,000	(700 units x $150)
Contribution margin	$ 70,000	
Fixed costs	50,000	(Given)
Operating profit	$ 20,000	

Question: Although management believes the base case is reasonably accurate, it is concerned about what will happen if certain variables change. As a result, you are asked to address the following questions from management (you are now performing sensitivity analysis!). Each scenario is independent of the others. Unless told otherwise, assume that the variables used in the base case remain the same. How do you answer the following questions for management?

1. How will profit change if the sales price increases by $25 per unit (10 percent)?
2. How will profit change if sales volume decreases by 70 units (10 percent)?
3. How will profit change if fixed costs decrease by $15,000 (30 percent) and variable cost increases $15 per unit (10 percent)?

Answer: The CVP model shown in Figure 6.6 "Sensitivity Analysis for Snowboard Company" answers these questions. Each column represents a different scenario, with the first column showing the base case and the remaining columns providing answers to the three questions posed by management. The top part of Figure 6.6 "Sensitivity Analysis for Snowboard Company" shows the value of each variable based on the scenarios presented previously, and the bottom part presents the results in contribution margin income statement format.

		Scenario 1	Scenario 2	Scenario 3
	Base Case	Price Increase 10%	Sales Volume Decrease 10%	Fixed Costs Decrease 30%; Variable Cost Increase 10%
Variable values				
Sales price per unit	$ 250	$ 275	$ 250	$ 250
Variable cost per unit	$ 150	$ 150	$ 150	$ 165
Monthly fixed costs	$ 50,000	$ 50,000	$ 50,000	$ 35,000
Volume of sales	700 units	700 units	630 units	700 units
CVP model results				
Sales	$175,000	$ 192,500	$157,500	$175,000
Variable costs	105,000	105,000	94,500	115,500
Contribution margin	$ 70,000	$ 87,500	$ 63,000	$ 59,500
Fixed costs	50,000	50,000	50,000	35,000
Operating profit	$ 20,000	$ 37,500	$ 13,000	$ 24,500
Dollar change in profit from base case		$ 17,500*	($ 7,000)	$ 4,500
Percent change in profit from base case		87.5%**	(35.0%)	22.5%

Figure 6.6 Sensitivity Analysis for Snowboard Company

[a] $17,500 = $37,500 − $20,000.

[b] 87.5 percent = $17,500 ÷ $20,000.

Carefully review Figure 6.6 "Sensitivity Analysis for Snowboard Company". The column labeled *Scenario 1* shows that increasing the price by 10 percent will increase profit 87.5 percent ($17,500). Thus profit is highly sensitive to changes in sales price. Another way to look at this is that for every one percent *increase* in sales price, profit will *increase* by 8.75 percent, or for every one percent *decrease* in sales price, profit will *decrease* by 8.75 percent.

The column labeled *Scenario 2* shows that decreasing sales volume 10 percent will decrease profit 35 percent ($7,000). Thus profit is also highly sensitive to changes in sales volume. Stated another way, every one percent *decrease* in sales volume will *decrease* profit by 3.5 percent; or every one percent *increase* in sales volume will *increase* profit by 3.5 percent.

When comparing Scenario 1 with Scenario 2, we see that Snowboard Company's profit is more sensitive to changes in sales price than to changes in sales volume, although changes in either will significantly affect profit.

The column labeled *Scenario 3* shows that decreasing fixed costs by 30 percent and increasing variable cost by 10 percent will increase profit 22.5 percent ($4,500). (Perhaps Snowboard Company is considering moving toward less automation and more direct labor!)

Computer Application

Using Excel to Perform Sensitivity Analysis

The accountants at Snowboard Company would likely use a spreadsheet program, such as Excel, to develop a CVP model for the sensitivity analysis shown in Figure 6.6 "Sensitivity Analysis for Snowboard Company". An example of how to use Excel to prepare the CVP model shown in Figure 6.6 "Sensitivity Analysis for Snowboard Company" is presented as follows. Notice that the basic data are entered at the top of the spreadsheet (*data entry section*), and the rest of the information is driven by formulas. This allows for quick sensitivity analysis of different scenarios.

Using the base case as an example, sales of $175,000 (cell D14) are calculated by multiplying the $250 sales price per unit (cell D5) by 700 units (cell D8). Variable costs of $105,000 (cell D15) are calculated by multiplying the $150 variable cost per unit (cell D6) by 700 units (cell D8). Fixed costs of $50,000 come from the top section (cell D7). The contribution margin of $70,000 is calculated by subtracting variable costs

from sales, and profit of $20,000 is calculated by subtracting fixed costs from the contribution margin.

	A B	C	D	E	F	G	H I
1		**Data Entry Section**					
2			**Base Case**	**Scenario (1)**	**Scenario (2)**	**Scenario (3)**	
3		**Variable**		**Price Increase 10%**	**Sales volume decrease 10%**	**Fixed costs decrease 30%; variable cost increase 10%**	
5		Sales price per unit	$250	$275	$250	$250	
6		Variable cost per unit	$150	$150	$150	$165	
7		Monthly fixed cost	$50,000	$50,000	$50,000	$35,000	
8		Volume of sales (units)	700	700	630	700	
11		**Snowboard Company**					
12		**Sensitivity Analysis Result**					
14		Sales	$175,000	$192,500	$157,500	$175,000	
15		Variable costs	105,000	105,000	94,500	115,500	
16		Contribution margin	$70,000	$87,500	$63,000	$59,500	
17		Fixed costs	50,000	50,000	50,000	35,000	
18		Operating profit	$20,000	$37,500	$13,000	$24,500	
20		Dollar change in profit from base case		$17,500	($7,000)	$4,500	
22		Percent change in profit from base case		87.50%	(35%)	22.50%	

Expanding the Use of Sensitivity Analysis

Question: Although the focus of sensitivity analysis is typically on how changes in variables will affect profit (as shown in Figure 6.6 "Sensitivity Analysis for Snowboard Company"), accountants also use sensitivity analysis to determine the impact of changes in variables on the break-even point and target profit. How is sensitivity analysis used to evaluate the impact changes in variables will have on break-even and target profit points?

Answer: Let's look at an example for Snowboard Company. Assume the company is able to charge $275 per unit, instead of $250 per unit. How many units must Snowboard Company sell to break even? The following calculation is based on the shortcut formula presented earlier in the chapter:

Q=(F + Target Profit)÷(S − V)Q=($50,000+$0)÷($275−$150)Q=$50,000÷$125Q=400 units

Thus if the sales price per unit increases from $250 to $275, the break-even point decreases from 500 units (calculated earlier) to 400 units, which is a decrease of 100 units.

How would this same increase in sales price change the required number of units sold to achieve a profit of $30,000? We apply the same shortcut formula:

Q=(F + Target Profit)÷(S − V)Q=($50,000+$30,000)÷($275−$150)Q=$80,000÷$125Q=640 units

Thus if the sales price per unit increases from $250 to $275, the number of units sold to achieve a profit of $30,000 decreases from 800 units (calculated earlier) to 640 units, which is a decrease of 160 units.

Business in Action 6.2

Performing Sensitivity Analysis for a Brewpub

Three entrepreneurs in California were looking for investors and banks to finance a new brewpub. Brewpubs focus on two segments: food from the restaurant segment, and freshly brewed beer from the beer production segment. All parties involved in the process of raising money—potential investors and banks, as well as the three entrepreneurs (i.e., the owners)—wanted to know what the new business's projected profits would be. After months of research, the owners created a financial model that provided this information. Projected profits were slightly more than $300,000 for the first year (from sales of $1.95 million) and were expected to increase in each of the next four years.

One of the owners asked, "What if our projected revenues are too high? What will happen to profits if sales are lower than we expect? After all, we will have debt of well over $1 million, and I don't want anyone coming after my personal assets if the business doesn't have the money to pay!" Although all three owners felt the financial model was reasonably accurate, they decided to find the break-even point and the resulting margin of safety.

Because a brewpub does not sell "units" of a specific product, the owners found the break-even point in sales dollars. The owners knew the contribution margin ratio and all fixed costs from the financial model. With this information, they were able to calculate the break-even point and margin of safety. The worried owner was relieved to discover that sales could drop over 35 percent from initial projections before the brewpub incurred an operating loss.

Key Takeaway

- Sensitivity analysis shows how the cost-volume-profit model will change with changes in any of its variables. Although the focus is typically on how changes in variables affect profit, accountants often analyze the impact on the break-even point and target profit as well.

Review Problem 6.4

This problem is an extension of Note 6.28 "Review Problem 6.2". Recall that International Printer Machines (IPM) builds three computer printer models: Inkjet, Laser, and Color Laser. Base case information for these three products is as follows:

	Inkjet	Laser	Color Laser	Total
Selling price per unit	$250	$400	$1,600	
Variable cost per unit	$100	$150	$ 800	
Expected unit sales (annual)	12,000	6,000	2,000	20,000
Sales mix	60 percent	30 percent	10 percent	100 percent

Total annual fixed costs are $5,000,000. Assume that each scenario that follows is independent of the others. Unless stated otherwise, the variables are the same as in the base case.

1. Prepare a contribution margin income statement for the base case. Use the format shown in Figure 6.5 "Income Statement for Amy's Accounting Service".
2. How will total profit change if the Laser sales price increases by 10 percent? (Hint: Use the format shown in Figure 6.5 "Income Statement for Amy's Accounting Service", and compare your result with requirement 1.)
3. How will total profit change if the Inkjet sales volume decreases by 4,000 units and the sales volume of other products remains the same?
4. How will total profit change if fixed costs decrease by 20 percent?

Solution to Review Problem 6.4

1. Base Case:

	Inkjet	Laser	Color Laser	Total
Sales	$3,000,000	$2,400,000	$3,200,000	$8,600,000
Variable costs	1,200,000	900,000	1,600,000	3,700,000
Contribution margin	$1,800,000	$1,500,000	$1,600,000	$4,900,000
Fixed costs				5,000,000
Operating loss				($ 100,000)

2. Laser sales price increases 10 percent:

	Inkjet	Laser	Color Laser	Total
Sales	$3,000,000	$2,640,000	$3,200,000	$8,840,000
Variable costs	1,200,000	900,000	1,600,000	3,700,000
Contribution margin	$1,800,000	$1,740,000	$1,600,000	$5,140,000
Fixed costs				5,000,000
Operating profit				$ 140,000

   Total profit would increase $240,000 (from *loss* of $100,000 in base case to *profit* of $140,000 in this scenario).

3. Inkjet sales volume decreases 4,000 units:

	Inkjet	Laser	Color Laser	Total
Sales	$2,000,000	$2,400,000	$3,200,000	$7,600,000
Variable costs	800,000	900,000	1,600,000	3,300,000
Contribution margin	$1,200,000	$1,500,000	$1,600,000	$4,300,000
Fixed costs				5,000,000
Operating loss				($ 700,000)

Total profit would decrease $600,000 (from *loss* of $100,000 in base case to *loss* of $700,000 in this scenario).

4. Fixed costs decrease 20 percent:

	Inkjet	Laser	Color Laser	Total
Sales	$3,000,000	$2,400,000	$3,200,000	$8,600,000
Variable costs	1,200,000	900,000	1,600,000	3,700,000
Contribution margin	$1,800,000	$1,500,000	$1,600,000	$4,900,000
Fixed costs				4,000,000
Operating profit				$ 900,000

Total profit would increase $1,000,000 (from *loss* of $100,000 in base case to profit of $900,000 in this scenario).

6.4 IMPACT OF COST STRUCTURE ON COST-VOLUME-PROFIT ANALYSIS

Learning Objective

1. Understand how cost structure affects cost-volume-profit sensitivity analysis.

Question: Describing an organization's cost structure helps us to understand the amount of fixed and variable costs within the organization. What is meant by the term cost structure?

Answer: Cost is the term used to describe the proportion of fixed and variable costs to total costs. For example, if a company has $80,000 in fixed costs and $20,000 in variable costs, the cost structure is described as 80 percent fixed costs and 20 percent variable costs.

Question: Operating leverage *refers to the level of fixed costs within an organization. How do we determine if a company has high operating leverage?*

Answer: Companies with a relatively high proportion of fixed costs have high operating leverage. For example, companies that produce computer processors, such as **NEC** and **Intel**, tend to make large investments in production facilities and equipment and therefore have a cost structure with high fixed costs. Businesses that rely on direct labor and direct materials, such as auto repair shops, tend to have higher variable costs than fixed costs.

Operating leverage is an important concept because it affects how sensitive profits are to changes in sales volume. This is best illustrated by comparing two companies with identical sales and profits but with different cost structures, as we do in Figure 6.7 "Operating Leverage Example". High Operating Leverage Company (HOLC) has relatively high fixed costs, and Low Operating Leverage Company (LOLC) has relatively low fixed costs.

	High Operating Leverage Company (HOLC)		Low Operating Leverage Company (LOLC)	
Sales	$500,000	100%	$500,000	100%
Variable costs	100,000	20	350,000	70
Contribution margin	$400,000	80	$150,000	30
Fixed costs	300,000	60	50,000	10
Operating profit	$100,000	20	$100,000	20

Figure 6.7 Operating Leverage Example

One way to observe the importance of operating leverage is to compare the break-even point in sales dollars for each company. HOLC needs sales of $375,000 to break even (= $300,000 ÷ 0.80), whereas LOLC needs sales of $166,667 to break even (= $50,000 ÷ 0.30).

Question: Why don't all companies strive for low operating leverage to lower the break-even point?

Answer: In Figure 6.7 "Operating Leverage Example", LOLC looks better up to the sales point of $500,000 and profit of $100,000. However, once sales exceed $500,000, HOLC will have higher profit than LOLC. This is because every additional dollar in sales will provide $0.80 in profit for HOLC (80 percent contribution margin ratio), and only $0.30 in profit for LOLC (30 percent contribution margin ratio). If a company is relatively certain of increasing sales, then it makes sense to have higher operating leverage.

Financial advisers often say, "the higher the risk, the higher the potential profit," which can also be stated as "the higher the risk, the higher the potential *loss*." The same applies to operating leverage. Higher operating leverage can lead to higher profit. However, high operating leverage companies that encounter declining sales tend to feel the negative impact more than companies with low operating leverage.

To prove this point, let's assume both companies in Figure 6.7 "Operating Leverage Example" experience a 30 percent *decrease* in sales. HOLC's profit would decrease by $120,000 (= 30 percent × $400,000 contribution margin) and LOLC's profit would decrease by $45,000 (= 30 percent × $150,000 contribution margin). HOLC would certainly feel the pain more than LOLC.

Now assume both companies in Figure 6.7 "Operating Leverage Example" experience a 30 percent *increase* in sales. HOLC's profit would increase by $120,000 (= 30 percent × $400,000 contribution margin) and LOLC's profit would increase by $45,000 (= 30 percent × $150,000 contribution margin). HOLC benefits more from increased sales than LOLC.

Key Takeaway

- The cost structure of a firm describes the proportion of fixed and variable costs to total costs. Operating leverage refers to the level of fixed costs within an organization. The term "high operating leverage" is used to describe companies with relatively high fixed costs. Firms with high operating leverage tend to profit more from increasing sales, and lose more from decreasing sales than a similar firm with low operating leverage.

Review Problem 6.5

What are the characteristics of a company with high operating leverage, and how do these characteristics differ from those of a company with low operating leverage?

Solution to Review Problem 6.5

Companies with high operating leverage have a relatively high proportion of fixed costs to total costs, and their profits tend to be much more sensitive to changes in sales than their low operating leverage counterparts. Companies with low operating leverage have a relatively low proportion of fixed costs to total costs, and their profits tend to be much less sensitive to changes in sales than their high operating leverage counterparts.

6.5 USING A CONTRIBUTION MARGIN WHEN FACED WITH RESOURCE CONSTRAINTS

Learning Objective

1. Use an alternative form of contribution margin when faced with a resource constraint.

Question: Many companies have limited resources in such areas as labor hours, machine hours, facilities, and materials. These constraints will likely affect a company's ability to produce goods or provide services. When a company that produces multiple products faces a constraint, managers often calculate the contribution margin per unit of constraint in addition to the contribution margin per unit. The contribution margin per unit of constraint *is the contribution margin per unit divided by the units of constrained resource required to produce one unit of product. How is this measure used by managers to make decisions when faced with resource constraints?*

Answer: Let's examine the Kayaks-For-Fun example introduced earlier in the chapter. The company produces two kayak models, River and Sea. Based on the information shown, Kayaks-For-Fun would prefer to sell more of the River model because it has the highest contribution margin per unit.

	River	Sea
Selling price	$500	$600
Variable cost	100	450
Contribution margin	$400	$150

Kayaks-For-Fun has a total of 320 labor hours available each month. The specialized skills required to build the kayaks makes it difficult for management to find additional workers. Assume the River model requires 4 labor hours per unit and the Sea model requires 1 labor hour per unit (most of the variable cost for the Sea model is related to expensive materials required for production). Kayaks-For-Fun sells everything it produces. Given its labor hours constraint, the company would prefer to maximize the contribution margin per labor hour.

	River	Sea
Contribution margin per unit	$400	$150
Divided by labor hours per unit	÷ 4	÷1
Contribution margin per labor hour	$100	$150

Based on this information, Kayaks-For-Fun would prefer to sell the Sea model because it provides a contribution margin per labor hour of $150 versus $100 for the River model. The company would prefer only to make the Sea model, which would yield a total contribution margin of $48,000 (= $150 × 320 hours). If the River model were the only model produced, the total contribution margin to the company would be $32,000 (= $100 × 320 hours).

Analysis such as this often leads to further investigation. It may be that Kayaks-For-Fun can find additional labor to alleviate this resource constraint. Or perhaps the production process can be modified in a way that reduces the labor required to build the River model (e.g., through increased automation). Whatever the outcome, companies with limited resources are wise to calculate the contribution margin per unit of constrained resource.

Key Takeaway

- Many organizations operate with limited resources in areas such as labor hours, machine hours, facilities, or materials. The contribution margin per unit of constraint is a helpful measure in determining how constrained resources should be utilized.

Review Problem 6.6

This review problem is based on the information for Kayaks-For-Fun presented previously. Assume Kayaks-For-Fun found additional labor, thereby eliminating this resource constraint. However, the company now faces limited available machine hours. It has a total of 3,000 machine hours available each month. The River model requires 16 machine hours per unit, and the Sea model requires 10 machine hours per unit.

1. Calculate the contribution margin per unit of constrained resource for each model.
2. Which model would Kayaks-For-Fun prefer to sell to maximize overall company profit?

Solution to Review Problem 6.6

1.

	River	Sea
Contribution margin per unit	$400	$150
Divided by machine hours per unit	÷16	÷10
Contribution margin per machine hour	$ 25	$ 15

2. Kayaks-For-Fun would prefer to sell the River model because it provides a contribution margin per machine hour of $25 compared to $15 for the Sea model. If only the River model were sold, the total contribution margin would be $75,000 (= $25 × 3,000 machine hours). If only the Sea model were sold, the total contribution margin would be $45,000 (= $15 × 3,000 machine hours).

6.6 INCOME TAXES AND COST-VOLUME-PROFIT ANALYSIS

Learning Objective

1. Understand the effect of income taxes on cost-volume-profit analysis.

Question: Some organizations, such as not-for-profit entities and governmental agencies, are not required to pay income taxes. However, most for-profit organizations must pay income taxes on their profits. How do we find the target profit in units or sales dollars for organizations that pay income taxes?

Answer: Three steps are required:

Step 1. Determine the desired target profit *after taxes* **(i.e., after accounting for income taxes).**

Step 2. Convert the desired target profit after taxes to the target profit *before taxes***.**

Step 3. Use the target profit *before taxes* **in the appropriate formula to calculate the target profit in units or sales dollars.**

Using Snowboard Company as an example, the assumptions are as follows:

Sales price per unit	$ 250
Variable cost per unit	150
Fixed costs per month	50,000
Target profit	30,000

Assume also that the $30,000 target profit is the monthly profit desired *after taxes* and that Snowboard has a tax rate of 20 percent.

Step 1. Determine the desired target profit *after taxes***.**

Snowboard's management wants to know how many units must be sold to earn a profit of $30,000 after taxes. Target profit *before taxes* will be higher than $30,000, and we calculate it in the next step.

Step 2. Convert the desired target profit after taxes to the target profit *before taxes***.**

The formula used to solve for target profit *before taxes* is as follows.

Key Equation

Target profit *before taxes* = Target profit *after taxes* ÷ (1 − tax rate)

Using Snowboard Company's data, the formula would read as follows:

Target profit before taxes=$30,000÷(1−0.20)Target profit before taxes=$37,500

Step 3. Use the target profit *before taxes* **in the appropriate formula to calculate the target profit in units or sales dollars.**

The formula used to solve for target profit in units is

Total fixed costs + Target profitSelling price per unit − Variable cost per unit

For Snowboard Company, it would read as follows:

Target profit in units=($50,000+$37,500)÷($250−$150)=$87,500÷$100=875 units

This answer is confirmed in the following contribution margin income statement.

	Amount	Calculation
Sales	$218,750	(875 units × $250)
Variable costs	131,250	(875 units × $150)
Contribution margin	$ 87,500	(875 units × $100)
Fixed costs	50,000	(given)
Profit before taxes	$ 37,500	
Income taxes	7,500	($37,500 profit before taxes x 20%)
Profit after taxes	$ 30,000	

Key Takeaway

- Companies that incur income taxes must follow three steps to find the break-even point or target profit.
  Step 1. Determine the desired target profit after taxes.
  Step 2. Convert the desired target profit after taxes to target profit before taxes using the following formula:
  Target profit *before taxes* = Target profit *after taxes* ÷ (1 − tax rate)
  Step 3. Use the target profit before taxes from step 2 in the appropriate target profit formula to calculate the target profit in units or in sales dollars.

Review Problem 6.7

This review problem is based on the information for Snowboard Company. Assume Snowboard's tax rate remains at 20 percent.

1. Use the three steps described in this section to determine how many *units* Snowboard Company must sell to earn a monthly profit of $50,000 after taxes.
2. Use the three steps to determine the *sales dollars* Snowboard needs to earn a monthly profit of $60,000 after taxes.

Solution to Review Problem 6.7

1. The three steps to determine how many units must be sold to earn a target profit after taxes are as follows:
   Step 1. Determine the desired target profit *after taxes***.**
   Management wants a profit of $50,000 after taxes and needs to know how many units must be sold to earn this profit.
   Step 2. Convert the desired target profit after taxes to the target profit *before taxes***.**
   The formula used to solve for target profit *before taxes* is
   Target profit before taxes=Target profit after taxes÷ (1−tax rate)Target profit before taxes=$50,000÷(1−0.20)Target profit before taxes=$62,500
   Step 3. Use the target profit *before taxes* **in the appropriate formula to calculate the target profit in units.**

The formula to solve for target profit in units is

Total fixed costs + Target profitSelling price per unit −Variable cost per unit

For Snowboard Company, it would read as follows:

Target profit in units=($50,000+$62,500)÷ ($250−$150)=$112,500÷$100=1,125 units

2. The three steps to determine how many sales dollars are required to achieve a target profit after taxes are as follows:

   Step 1. Determine the desired target profit *after taxes*.

   Management wants a profit of $60,000 after taxes and needs to know the sales dollars required to earn this profit.

   Step 2. Convert the desired target profit after taxes to target profit *before taxes*.

   The formula used to solve for target profit *before taxes* is

   Target profit before taxes=Target profit after taxes÷ (1−tax rate)Target profit before taxes=$60,000÷(1−0.20)Target profit before taxes=$75,000

   Step 3. Use the target profit *before taxes* **in the appropriate formula to calculate the target profit in sales dollars.**

   The formula used to solve for target profit in sales dollars is

   Total fixed costs + Target profitContribution margin ratio

Target profit in sales dollars=($50,000+$75,000)÷($100÷$250)=$125,000÷0.40=$312,500 in sales

6.7 USING VARIABLE COSTING TO MAKE DECISIONS

Learning Objective
1. Understand how managers use variable costing to make decisions.

In Chapter 2 "How Is Job Costing Used to Track Production Costs?", we discussed how to report manufacturing costs and nonmanufacturing costs following U.S. Generally Accepted Accounting Principles (U.S. GAAP). Under U.S. GAAP, all nonmanufacturing costs (selling and administrative costs) are treated as period costs because they are expensed on the income statement in the period in which they are incurred. All costs associated with production are treated as product costs, including direct materials, direct labor, and fixed and variable manufacturing overhead. These costs are attached to inventory as an asset on the balance sheet until the goods are sold, at which point the costs are transferred to cost of goods sold on the income statement as an expense. This method of accounting is called absorption costing because *all* manufacturing overhead costs (fixed and variable) are *absorbed* into inventory until the goods are sold. (The term *full costing* is also used to describe absorption costing.)

Question: Although absorption costing is used for external reporting, managers often prefer to use an alternative costing approach for internal reporting purposes called variable costing. What is variable costing, and how does it compare to absorption costing?

Answer: Variable costing requires that all *variable* production costs be included in inventory, and all *fixed* production costs (fixed manufacturing overhead) be reported as period costs. Thus all fixed production costs are expensed as incurred.

The only difference between absorption costing and variable costing is in the treatment of fixed manufacturing overhead. Using absorption costing, fixed manufacturing overhead is reported as a *product cost*. Using variable costing, fixed manufacturing overhead is reported as a *period cost*. Figure 6.8 "Absorption Costing Versus Variable Costing" summarizes the similarities and differences between absorption costing and variable costing.

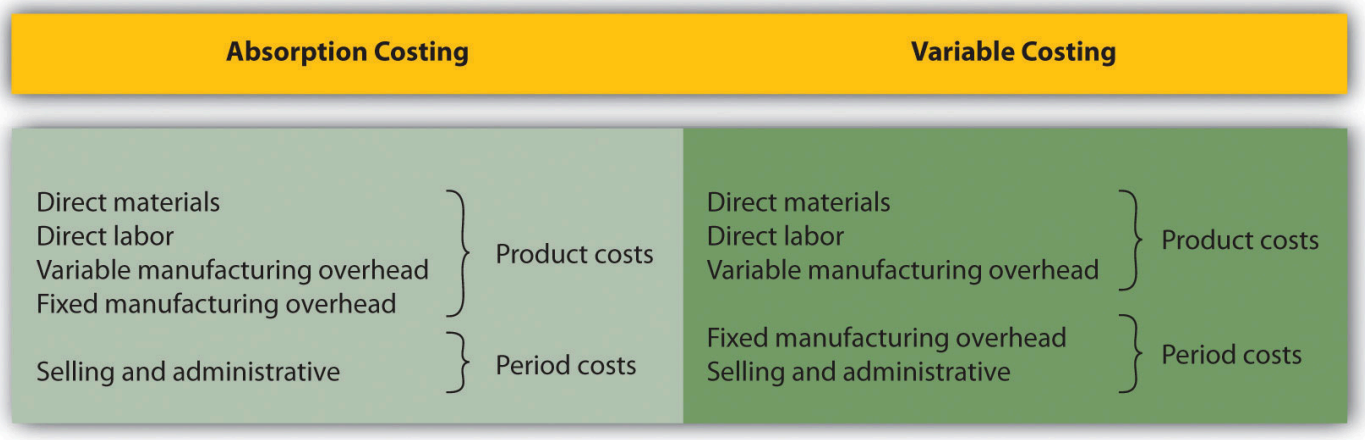


Figure 6.8 Absorption Costing Versus Variable Costing

Impact of Absorption Costing and Variable Costing on Profit

Question: If a company uses just-in-time inventory, and therefore has no beginning or ending inventory, profit will be exactly the same regardless of the costing approach used. However, most companies have units of product in inventory at the end of the reporting period. How does the use of absorption costing affect the value of ending inventory?

Answer: Since absorption costing includes fixed manufacturing overhead as a product cost, all products that remain in ending inventory (i.e., are unsold at the end of the period) include a portion of fixed manufacturing overhead costs as an asset on the balance sheet. Since variable costing treats fixed manufacturing overhead costs as period costs, all fixed manufacturing overhead costs are expensed on the income statement when incurred. Thus if the quantity of units produced exceeds the quantity of units sold, absorption costing will result in higher profit.

We illustrate this concept with an example. The following information is for Bullard Company, a producer of clock radios:

Monthly production		10,000 units
Sales price		$25 per unit
Variable production cost per unit		
Direct materials	$4	
Direct labor	1	$7 per unit
Manufacturing overhead	2	
Fixed production costs		$40,000 each month; $4 per unit at 10,000 units of production
Variable selling and administrative cost		$3 per unit
Fixed selling and administrative cost		$20,000 each month

Assume Bullard has no finished goods inventory at the beginning of month 1. We will look at absorption costing versus variable costing for three different scenarios:

- Month 1 scenario: 10,000 units produced *equals* 10,000 units sold
- Month 2 scenario: 10,000 units produced is *greater than* 9,000 units sold
- Month 3 scenario: 10,000 units produced is *less than* 11,000 units sold

Month 1: Number of Units Produced Equals Number of Units Sold

Question: During month 1, Bullard Company sells all 10,000 units produced during the month. How does operating profit compare using absorption costing and variable costing when the number of units produced equals the number of units sold?

Answer: Figure 6.9 "Number of Units Produced Equals Number of Units Sold" presents the results for each costing method. Notice that the absorption costing income statement is called a traditional income statement, and the variable costing income statement is called a contribution margin income statement.

As you review Figure 6.9 "Number of Units Produced Equals Number of Units Sold", notice that when the number of units produced equals the number sold, profit totaling $90,000 is identical for both costing methods. With absorption costing, fixed manufacturing overhead costs are fully expensed because all units produced are sold (there is no ending inventory). With variable costing, fixed manufacturing overhead costs are treated as period costs and therefore are always expensed in the period incurred. Because all other costs are treated the same regardless of the costing method used, profit is identical when the number of units produced and sold is the same.

Month 1

Absorption Costing (Traditional Income Statement)		Variable Costing (Contribution Margin Income Statement)		
Sales	$250,000[a]	Sales		$250,000[a]
Cost of goods sold	110,000[b]	Variable costs		
Gross margin	$140,000	Cost of goods sold	$70,000[c]	
Selling and administrative costs	50,000[d]	Selling and administrative costs	30,000[e]	
Operating profit	$ 90,000	Total variable costs		100,000
		Contribution margin		$150,000
		Fixed costs		
		Cost of goods sold	$40,000[f]	
		Selling and administrative costs	20,000[g]	
		Total fixed costs		60,000
		Operating profit		$ 90,000

Figure 6.9 Number of Units Produced Equals Number of Units Sold a $250,000 = $25 × 10,000 units sold. b $110,000 = ($4 per unit fixed production cost × 10,000 units sold) + ($7 per unit variable production cost × 10,000 units sold). c $70,000 = $7 per unit variable production cost × 10,000 units sold. d $50,000 = $20,000 fixed selling and admin. cost + ($3 per unit variable selling and admin. cost × 10,000 units sold). e $30,000 = $3 per unit variable selling and admin. cost × 10,000 units sold. f Variable costing treats fixed manufacturing overhead as a period cost. Thus all fixed manufacturing overhead costs are expensed in the period incurred regardless of the level of sales. g Given.

Month 2: Number of Units Produced Is Greater Than Number of Units Sold

Question: During month 2, Bullard Company produces 10,000 units but sells only 9,000 units. How does operating profit compare using absorption costing and variable costing when the number of units produced is greater than the number of units sold?

Answer: Figure 6.10 "Number of Units Produced Is Greater Than Number of Units Sold" presents the results for each costing method. Notice that absorption costing results in higher profit. When absorption costing is used, a portion of fixed manufacturing overhead costs remains in ending inventory as an asset on the balance sheet until the goods are sold. However, variable costing requires that all fixed manufacturing overhead costs be expensed as incurred regardless of the level of sales. Thus when more units are produced than are sold, variable costing results in higher costs and lower profit.

The difference in profit between the two methods of $4,000 (= $79,000 − $75,000) is attributed to the $4 per unit fixed manufacturing overhead cost assigned to the 1,000 units in ending inventory using absorption costing ($4,000 = $4 × 1,000 units).

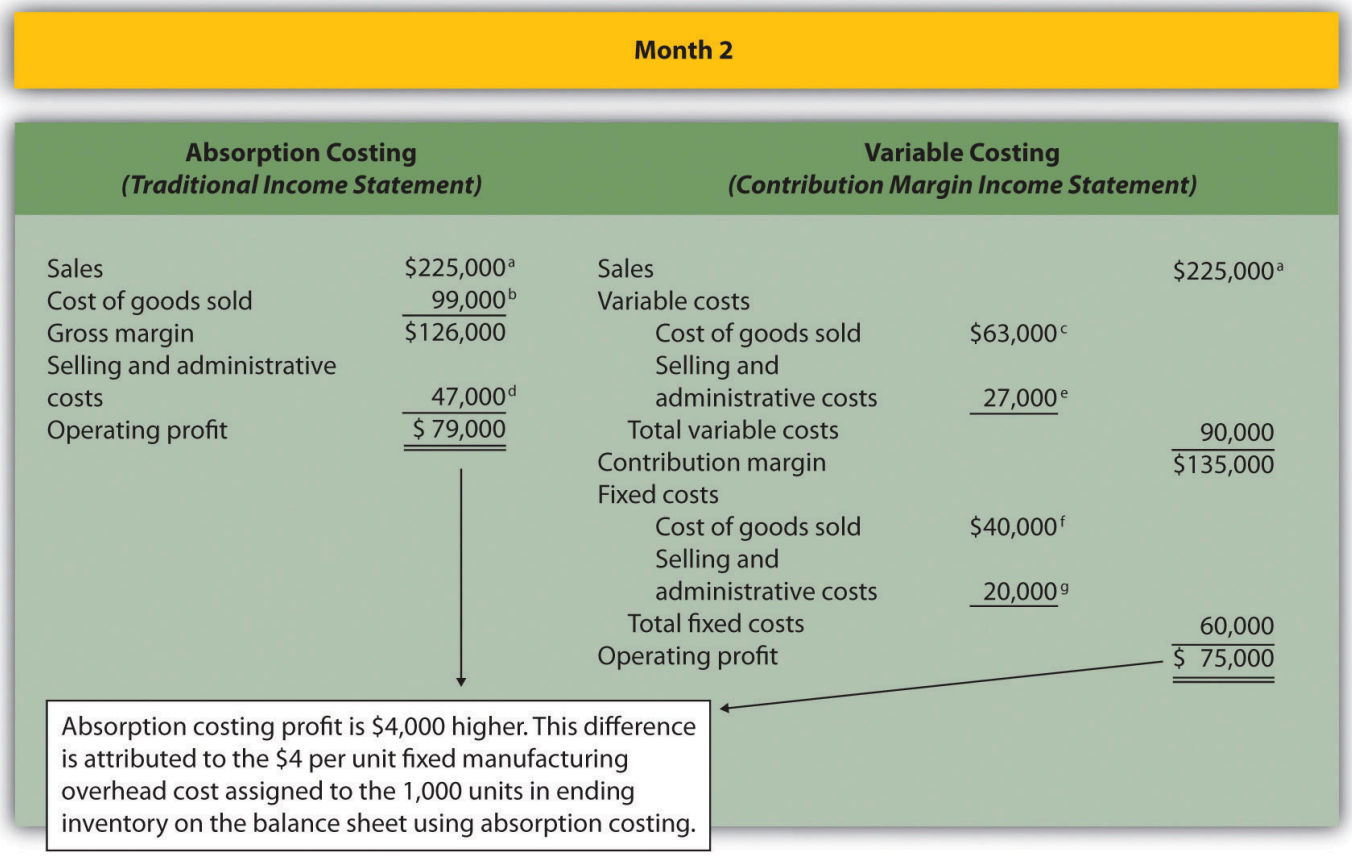


Figure 6.10 Number of Units Produced Is Greater Than Number of Units Sold a $225,000 = $25 × 9,000 units sold. b $99,000 = ($4 per unit fixed production cost × 9,000 units sold) + ($7 per unit variable production cost × 9,000 units sold). c $63,000 = $7 per unit variable production cost × 9,000 units sold. d $47,000 = $20,000 fixed selling and admin. cost + ($3 per unit variable selling and admin. cost × 9,000 units sold). e $27,000 = $3 per unit variable selling and admin. cost × 9,000 units sold. f Variable costing always treats fixed manufacturing overhead as a period cost. Thus all fixed manufacturing overhead costs are expensed in the period incurred regardless of the level of sales. g Given.

Month 3: Number of Units Produced Is Less Than Number of Units Sold

Question: During month 3, Bullard Company produces 10,000 units but sells 11,000 units (1,000 units were left over from month 2 and therefore were in inventory at the beginning of month 3). How does operating profit compare using absorption costing and variable costing when the number of units produced is less than the number of units sold?

Answer: Figure 6.11 "Number of Units Produced Is Less Than Number of Units Sold" presents the results for each costing method. Using variable costing, the $40,000 in fixed manufacturing overhead costs continues to be expensed when incurred. However, using absorption costing, the entire $40,000 is expensed because all 10,000 units produced were sold; an additional $4,000 related to the 1,000 units produced last month and pulled from inventory this month is also expensed. Thus when fewer units are produced than are sold, absorption costing results in higher costs and lower profit.

The difference in profit between the two methods of $4,000 (= $105,000 − $101,000) is attributed to the $4 per unit fixed manufacturing overhead cost assigned to the 1,000 units in inventory on the balance sheet at the end of month 2 and recorded as cost of goods sold during month 3 using absorption costing ($4,000 = $4 × 1,000 units).

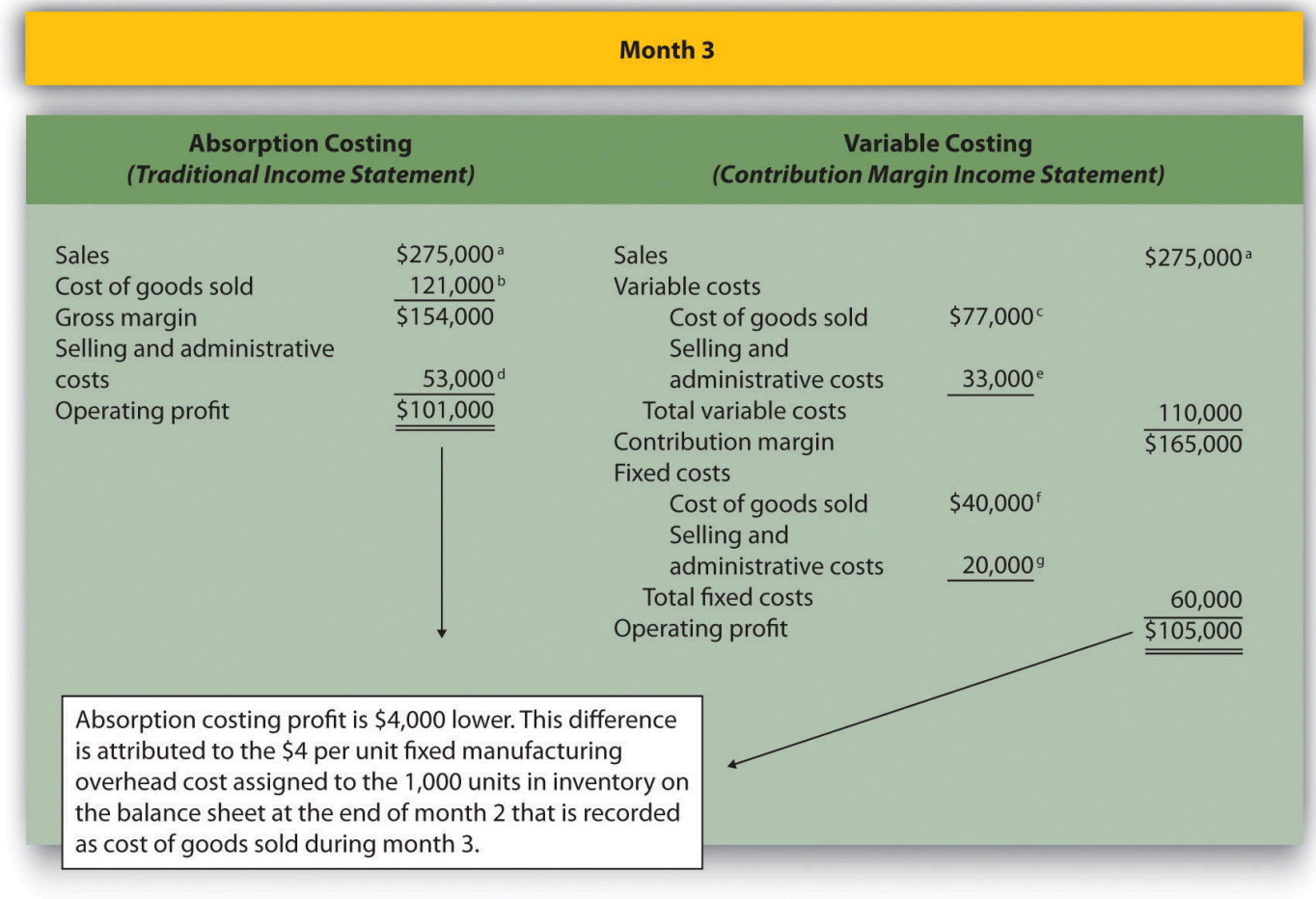


Figure 6.11 Number of Units Produced Is Less Than Number of Units Sold a $275,000 = $25 × 11,000 units sold. b $121,000 = ($4 per unit fixed production cost × 11,000 units sold) + ($7 per unit variable production cost × 11,000 units sold). c $77,000 = $7 per unit variable production cost × 11,000 units sold. d $53,000 = $20,000 fixed selling and admin. cost + ($3 per unit variable selling and admin. cost × 11,000 units sold). e $33,000 = $3 per unit variable selling and admin. cost × 11,000 units sold. f Variable costing always treats fixed manufacturing overhead as a period cost. Thus all fixed manufacturing overhead costs are expensed in the period incurred regardless of the level of sales. g Given.

Advantages of Using Variable Costing

Question: Why do organizations use variable costing?

Answer: Variable costing provides managers with the information necessary to prepare a contribution margin income statement, which leads to more effective cost-volume-profit (CVP) analysis. By separating variable and fixed costs, managers are able to determine contribution margin ratios, break-even points, and target profit points, and to perform sensitivity analysis. Conversely, absorption costing meets the requirements of U.S. GAAP, but is not as useful for internal decision-making purposes.

Another advantage of using variable costing internally is that it prevents managers from increasing production solely for the purpose of inflating profit. For example, assume the manager at Bullard Company will receive a bonus for reaching a certain profit target but expects to be $15,000 short of the target. The company uses absorption costing, and the manager realizes increasing production (and therefore increasing inventory levels) will increase profit. The manager decides to produce 20,000 units in month 4, even though only 10,000 units will

be sold. Half of the $40,000 in fixed production cost ($20,000) will be included in inventory at the end of the period, thereby lowering expenses on the income statement and increasing profit by $20,000. At some point, this will catch up to the manager because the company will have excess or obsolete inventory in future months. However, in the short run, the manager will increase profit by increasing production. This strategy does not work with variable costing because all fixed manufacturing overhead costs are expensed as incurred, regardless of the level of sales.

Key Takeaway

- As shown in Figure 6.8 "Absorption Costing Versus Variable Costing", the only difference between absorption costing and variable costing is in the treatment of fixed manufacturing overhead costs. Absorption costing treats fixed manufacturing overhead as a product cost (included in inventory on the balance sheet until sold), while variable costing treats fixed manufacturing overhead as a period cost (expensed on the income statement as incurred).

  When comparing absorption costing with variable costing, the following three rules apply: (1) When units produced equals units sold, profit is the same for both costing approaches. (2) When units produced is greater than units sold, absorption costing yields the highest profit. (3) When units produced is less than units sold, variable costing yields the highest profit.

Review Problem 6.8

Winter Sports, Inc., produces snowboards. The company has no finished goods inventory at the beginning of year 1. The following information pertains to Winter Sports, Inc.,:

Annual production		100,000 units
Sales price		$200 per unit
Variable production cost per unit		
Direct materials	$60	
Direct labor	30	$130 per unit
Manufacturing overhead	40	
Fixed production costs		$500,000 each year; $5 per unit at 100,000 units of production
Variable selling and administrative cost		$10 per unit
Fixed selling and administrative cost		$800,000 each year

1. All 100,000 units produced during year 1 are sold during year 1.

1. Prepare a traditional income statement assuming the company uses absorption costing.
2. Prepare a contribution margin income statement assuming the company uses variable costing.

2. Although 100,000 units are produced during year 2, only 80,000 are sold during the year. The remaining 20,000 units are in finished goods inventory at the end of year 2.
    1. Prepare a traditional income statement assuming the company uses absorption costing.
    2. Prepare a contribution margin income statement assuming the company uses variable costing.

Solution to Review Problem 6.8

1. Traditional income statement (absorption costing), year 1:

Sales	$20,000,000[a]
Cost of goods sold	13,500,000[b]
Gross margin	$ 6,500,000
Selling and administrative costs	1,800,000[c]
Operating profit	$ 4,700,000

[a] $20,000,000 = $200 × 100,000 units sold.
[b] $13,500,000 = ($5 per unit fixed production cost × 100,000 units sold) + ($130 per unit variable production cost × 100,000 units sold).
[c] $1,800,000 = $800,000 fixed selling and admin. cost + ($10 per unit variable selling and admin. cost × 100,000 units sold).

2. Contribution margin income statement (variable costing), year 1:

Sales		$20,000,000[a]
Variable costs		
Cost of goods sold	$13,000,000[b]	
Selling and administrative costs	1,000,000[c]	
Total variable costs		14,000,000
Contribution margin		6,000,000
Fixed costs		
Cost of goods sold	$ 500,000[d]	
Selling and administrative costs	800,000[e]	
Total fixed costs		1,300,000
Operating profit		$ 4,700,000

[a] $20,000,000 = $200 × 100,000 units sold.
[b] $13,000,000 = $130 per unit variable production cost × 100,000 units sold.
[c] $1,000,000 = $10 per unit variable selling and admin. cost × 100,000 units sold.
[d] Variable costing treats fixed manufacturing overhead as a period cost. Thus all fixed

manufacturing overhead costs are expensed in the period incurred regardless of the level of sales.

[e] Given.

1. Traditional income statement (absorption costing), year 2:

Sales	$16,000,000[a]
Cost of goods sold	10,800,000[b]
Gross margin	$ 5,200,000
Selling and administrative costs	1,600,000[c]
Operating profit	$ 3,600,000

[a] $16,000,000 = $200 × 80,000 units sold.

[b] $10,800,000 = ($5 per unit fixed production cost × 80,000 units sold) + ($130 per unit variable production cost × 80,000 units sold).

2. Contribution margin income statement (variable costing), year 2:

Sales		$16,000,000[a]
Variable costs		
Cost of goods sold	$10,400,000[b]	
Selling and administrative costs	800,000[c]	
Total variable costs		11,200,000
Contribution margin		$ 4,800,000
Fixed costs		
Cost of goods sold	$ 500,000[d]	
Selling and administrative costs	800,000[e]	
Total fixed costs		1,300,000
Operating profit		$ 3,500,000

[a] *$16,000,000 = $200 × 80,000 units sold.*

[b] *$10,400,000 = $130 per unit variable production cost × 80,000 units sold.*

[c] *$800,000 = $10 per unit variable selling and admin. cost × 80,000 units sold.*

[d] *Variable costing treats fixed manufacturing overhead as a period cost. Thus all fixed manufacturing overhead costs are expensed in the period incurred regardless of the level of sales.*

[e] *Given.*

End-of-Chapter Exercises

Questions

1. Describe the components of the profit equation.
2. What is the difference between a variable cost and a fixed cost? Provide examples of each.

3. You are asked to find the break-even point in units and in sales dollars. What does this mean?
4. You are asked to find the target profit in units and in sales dollars. What does this mean?
5. For a company with one product, describe the equation used to calculate the break-even point or target profit in (a) units, and (b) sales dollars.
6. Distinguish between contribution margin per unit and contribution margin ratio.
7. What does the term *margin of safety* mean? How might management use this information?
8. Review Note 6.16 "Business in Action 6.1" How do airlines measure break-even points? In 2001, which airline had the lowest break-even point?
9. How does the break-even point equation change for a company with multiple products or services compared to a single-product company?
10. Describe the assumptions made to simplify the cost-volume-profit analysis described in the chapter.
11. What is sensitivity analysis and how might it help those performing cost-volume-profit analysis?
12. Review Note 6.37 "Business in Action 6.2" What were the owners concerned about with regards to projected profits? What were the results of the calculations made to address the owners' concerns?
13. If you are asked to review the cost structure of an organization, what are you being asked to do?
14. When might the contribution margin per unit of constraint be more effective than the contribution margin per unit for making decisions?
15. Describe the three steps used to calculate the target profit for companies that incur income tax costs.
16. Describe the difference between absorption costing and variable costing.
17. Why do some organizations use variable costing?

Brief Exercises

18. **Planning at Snowboard Company.** Refer to the dialogue at Snowboard Company presented at the beginning of the chapter. What information is Recilia, vice president of sales, requesting from Lisa, the company accountant? How does Recilia plan on using this information?
19. **Contribution Margin Calculations.** Ace Company sells lawn mowers for $200 per unit. Variable cost per unit is $40, and fixed costs total $4,000. Find (a) the contribution margin per unit, and (b) the contribution margin ratio.
20. **Weighted Average Contribution Margin Calculation.** Radio Control, Inc., sells radio controlled cars for $300 per unit representing 80 percent of total sales, and radio controlled boats for $400 per unit representing 20 percent of total sales. Variable cost per unit is $150 for cars and $300 for boats. Find (a) the contribution margin per unit for each product, and (b) the weighted average contribution margin per unit.
21. **Sensitivity Analysis, Sales Price.** Refer to the base case for Snowboard Company presented in the first column of Figure 6.6 "Sensitivity Analysis for Snowboard Company". Assume the unit sales price decreases by 10 percent. Calculate (a) the new projected profit, (b) the dollar change in profit from the base case, and (c) the percent change in profit from the base case.
22. **Sensitivity Analysis, Unit Sales.** Refer to the base case for Snowboard Company presented in the first column of Figure 6.6 "Sensitivity Analysis for Snowboard Company". Assume the number of units sold increases by 10 percent. Calculate (a) the new projected profit, (b) the dollar change in profit from the

base case, and (c) the percent change in profit from the base case.

23. **Operating Leverage.** High operating leverage means:
    1. The company has relatively low fixed costs.
    2. The company has relatively high fixed costs.
    3. The company will have to sell *more* units than a comparable company with low operating leverage to break even.
    4. The company will have to sell *fewer* units than a comparable company with low operating leverage to break even.
    5. Both (2) and (3) are correct.
    6. Both (1) and (4) are correct.
24. **Contribution Margin per Unit of Constraint.** Paint Toys Company sells paint ball guns for $100 per unit. Variable cost is $60 per unit. Each paint ball gun requires 1.25 machine hours and 2.00 direct labor hours to produce. Calculate the contribution margin (a) per unit, (b) per machine hour, and (c) per direct labor hour.
25. **Target Profit with Taxes.** Management of Lakewood Company would like to achieve a target profit after taxes of $300,000. The company's income tax rate is 40 percent. What target profit before taxes is required to achieve the $300,000 after-tax profit desired by management?
26. **Absorption Costing Versus Variable Costing.** Describe the difference between absorption costing and variable costing. Which approach yields the highest profit when the units produced are greater than the units sold? Explain.

Exercises: Set A

27. **Break-Even Point and Target Profit Measured in Units (Single Product).** Nellie Company has monthly fixed costs totaling $100,000 and variable costs of $20 per unit. Each unit of product is sold for $25.
    Required:
    1. Calculate the contribution margin per unit.
    2. Find the break-even point in units.
    3. How many units must be sold to earn a monthly profit of $40,000?
28. **Break-Even Point and Target Profit Measured in Sales Dollars (Single Product).** Nellie Company has monthly fixed costs totaling $100,000 and variable costs of $20 per unit. Each unit of product is sold for $25 (these data are the same as the previous exercise):
    Required:
    1. Calculate the contribution margin ratio.
    2. Find the break-even point in sales dollars.
    3. What amount of sales dollars is required to earn a monthly profit of $60,000?
29. **Margin of Safety (Single Product).** Nellie Company has monthly fixed costs totaling $100,000 and variable costs of $20 per unit. Each unit of product is sold for $25 (these data are the same as the previous exercise). Assume Nellie Company expects to sell 24,000 units of product this coming month.
    Required:
    1. Find the margin of safety in units.

2. Find the margin of safety in sales dollars.

30. **Break-Even Point and Target Profit Measured in Units (Multiple Products).** Hi-Tech Incorporated produces two different products with the following monthly data.

	Cell	GPS	Total
Selling price per unit	$100	$400	
Variable cost per unit	$ 40	$240	
Expected unit sales	21,000	9,000	30,000
Sales mix	70 percent	30 percent	100 percent
Fixed costs			$1,800,000

Assume the sales mix remains the same at all levels of sales.

Required:

1. Calculate the weighted average contribution margin per unit.
2. How many units in total must be sold to break even?
3. How many units of each product must be sold to break even?
4. How many units in total must be sold to earn a monthly profit of $180,000?
5. How many units of each product must be sold to earn a monthly profit of $180,000?

31. **Break-Even Point and Target Profit Measured in Sales Dollars (Multiple Products).** Hi-Tech Incorporated produces two different products with the following monthly data (these data are the same as the previous exercise).

	Cell	GPS	Total
Selling price per unit	$100	$400	
Variable cost per unit	$ 40	$240	
Expected unit sales	21,000	9,000	30,000
Sales mix	70 percent	30 percent	100 percent
Fixed costs			$1,800,000

Assume the sales mix remains the same at all levels of sales.

Required:

Round your answers to the nearest hundredth of a percent and nearest dollar where appropriate. (An example for percentage calculations is 0.434532 = 0.4345 = 43.45 percent; an example for dollar calculations is $378.9787 = $379.)

1. Using the information provided, prepare a contribution margin income statement for the month similar to the one in Figure 6.5 “Income Statement for Amy’s Accounting Service”.
2. Calculate the weighted average contribution margin ratio.
3. Find the break-even point in sales dollars.
4. What amount of sales dollars is required to earn a monthly profit of $540,000?
5. Assume the contribution margin income statement prepared in requirement **a** is the company’s base case. What is the margin of safety in sales dollars?

32. **Changes in Sales Mix.** Hi-Tech Incorporated produces two different products with the following monthly data (these data are the same as the previous exercise).

	Cell	GPS	Total
Selling price per unit	$100	$400	
Variable cost per unit	$ 40	$240	
Expected unit sales	21,000	9,000	30,000
Sales mix	70 percent	30 percent	100 percent
Fixed costs			$1,800,000

Required:

1. If the sales mix shifts to 50 percent Cell and 50 percent GPS, would the break-even point in units increase or decrease? Explain. (Detailed calculations are not necessary but may be helpful in confirming your answer.)
2. Go back to the original projected sales mix. If the sales mix shifts to 80 percent Cell and 20 percent GPS, would the break-even point in units increase or decrease? Explain. (Detailed calculations are not necessary but may be helpful in confirming your answer.)

33. **CVP Sensitivity Analysis (Single Product).** Bridgeport Company has monthly fixed costs totaling $200,000 and variable costs of $40 per unit. Each unit of product is sold for $50. Bridgeport expects to sell 30,000 units each month (this is the base case).

Required:

For each of the independent situations in requirements **b** through **d**, assume that the number of units sold remains at 30,000.

1. Prepare a contribution margin income statement for the base case.
2. Refer to the base case. What would the operating profit be if the unit sales price increases 10 percent?
3. Refer to the base case. What would the operating profit be if the unit variable cost decreases 20 percent?
4. Refer to the base case. What would the operating profit be if total fixed costs decrease 20 percent?

34. **CVP Sensitivity Analysis (Multiple Products).** Gonzalez Company produces two different products that have the following monthly data (this is the base case).

	Cruiser	Racer	Total
Selling price per unit	$300	$1,200	
Variable cost per unit	$120	$ 720	
Expected unit sales	1,400	600	2,000
Sales mix	70 percent	30 percent	100 percent
Fixed costs			$180,000

Required:

For each of the independent situations in requirements **b** through **d**, assume that total sales remains at 2,000 units.

1. Prepare a contribution margin income statement.
2. Refer to the base case. What would the operating profit be if the Cruiser sales price (1) increases 20 percent, or (2) decreases 20 percent?
3. Refer to the base case. What would the operating profit be if the Cruiser sales volume increases 400 units with a corresponding decrease of 400 units in Racer sales?
4. Refer to the base case. What would the operating profit be if total fixed costs increase five percent? Does this increase in fixed costs result in higher operating leverage or lower operating leverage? Explain.

35. **Contribution Margin with Resource Constraints.** CyclePath Company produces two different products that have the following price and cost characteristics.

	Bicycle	Tricycle
Selling price per unit	$200	$100
Variable cost per unit	$120	$ 50

Management believes that pushing sales of the Bicycle product would maximize company profits because of the high contribution margin per unit for this product. However, only 50,000 labor hours are available each year, and the Bicycle product requires 4 labor hours per unit while the Tricycle model requires 2 labor hours per unit. The company sells everything it produces.

Required:

1. Calculate the contribution margin per unit of constrained resource for each model.
2. Which model would CyclePath prefer to sell to maximize overall company profit? Explain.

36. **Target Profit Measured in Units (with Taxes).** Optical Incorporated has annual fixed costs totaling $6,000,000 and variable costs of $350 per unit. Each unit of product is sold for $500. Assume a tax rate of 20 percent.

Required:

Use the three steps described in the chapter to determine how many units must be sold to earn an annual profit of $100,000 after taxes. (Round to the nearest unit.)

37. **Target Profit Measured in Sales Dollars (with Taxes).** Optical Incorporated has annual fixed costs totaling $6,000,000 and variable costs of $350 per unit. Each unit of product is sold for $500. Assume a tax rate of 20 percent (these data are the same as the previous exercise).

Required:

Use the three steps described in the chapter to determine the sales dollars required to earn an annual profit of $150,000 after taxes.

38. **Absorption Costing Versus Variable Costing.** Technic Company produces portable CD players. The company has no finished goods inventory at the beginning of year 1. The following information pertains to Technic Company.

Annual production		50,000 units
Sales price		$40 per unit
Variable production cost per unit		
Direct materials	$10	
Direct labor	3	$25 per unit
Manufacturing overhead	12	
Fixed production costs		$150,000 each year; $3 per unit at 50,000 units of production
Variable selling and administrative cost		$1 per unit
Fixed selling and administrative cost		$100,000 each year

Required:

1. All 50,000 units produced during year 1 are sold during year 1.
    1. Prepare a traditional income statement assuming the company uses absorption costing.
    2. Prepare a contribution margin income statement assuming the company uses variable costing.
2. Although 50,000 units are produced during year 2, only 40,000 are sold during the year. The remaining 10,000 units are in finished goods inventory at the end of year 2.
    1. Prepare a traditional income statement assuming the company uses absorption costing.
    2. Prepare a contribution margin income statement assuming the company uses variable costing.

Exercises: Set B

39. **Break-Even Point and Target Profit Measured in Units (Single Product).** Phan Incorporated has annual fixed costs totaling $6,000,000 and variable costs of $350 per unit. Each unit of product is sold for $500.

    Required:

    1. Calculate the contribution margin per unit.
    2. Find the break-even point in units.
    3. How many units must be sold to earn an annual profit of $750,000?

40. **Break-Even Point and Target Profit Measured in Sales Dollars (Single Product).** Phan Incorporated

has annual fixed costs totaling $6,000,000 and variable costs of $350 per unit. Each unit of product is sold for $500 (these data are the same as the previous exercise).

Required:

1. Calculate the contribution margin ratio.
2. Find the break-even point in sales dollars.
3. What amount of sales dollars is required to earn an annual profit of $300,000?

41. **Margin of Safety (Single Product).** Phan Incorporated has annual fixed costs totaling $6,000,000 and variable costs of $350 per unit. Each unit of product is sold for $500 (these data are the same as the previous exercise). Assume Phan Incorporated expects to sell 51,000 units of product this coming year.

Required:

1. Find the margin of safety in units.
2. Find the margin of safety in sales dollars.

42. **Break-Even Point and Target Profit Measured in Units (Multiple Products).** Advanced Products Company produces three different CDs with the following annual data.

	Music	Data	DVD	Total
Selling price per unit	$10	$4	$12	
Variable cost per unit	$ 3	$1	$ 3	
Expected unit sales	8,000	10,000	22,000	40,000
Sales mix	20 percent	25 percent	55 percent	100 percent
Fixed costs				$205,900

Assume the sales mix remains the same at all levels of sales.

Required:

(Round all answers to the nearest cent and nearest unit where appropriate.)

1. Calculate the weighted average contribution margin per unit.
2. How many units in total must be sold to break even?
3. How many units of each product must be sold to break even?
4. How many units in total must be sold to earn an annual profit of $200,000?
5. How many units of each product must be sold to earn an annual profit of $200,000?

43. **Break-Even Point and Target Profit Measured in Sales Dollars (Multiple Products).** Advanced Products Company produces three different CDs with the following annual data (these data are the same as the previous exercise).

	Music	Data	DVD	Total
Selling price per unit	$10	$4	$12	
Variable cost per unit	$ 3	$1	$ 3	
Expected unit sales	8,000	10,000	22,000	40,000
Sales mix	20 percent	25 percent	55 percent	100 percent
Fixed costs				$205,900

Assume the sales mix remains the same at all levels of sales.

Required:

Round your answers to the nearest hundredth of a percent and nearest dollar where appropriate. (An example for percentage calculations is 0.434532 = 0.4345 = 43.45 percent; an example for dollar calculations is $378.9787 = $379.)

1. Using the information provided, prepare a contribution margin income statement similar to the one in Figure 6.5 "Income Statement for Amy's Accounting Service".
2. Calculate the weighted average contribution margin ratio.
3. Find the break-even point in sales dollars.
4. What amount of sales dollars is required to earn an annual profit of $200,000?
5. Assume the contribution margin income statement prepared in requirement **a** is the company's base case. What is the margin of safety in sales dollars?

44. **Changes in Sales Mix.** Advanced Products Company produces three different CDs with the following annual data (these data are the same as the previous exercise).

	Music	Data	DVD	Total
Selling price per unit	$10	$4	$12	
Variable cost per unit	$ 3	$1	$ 3	
Expected unit sales	8,000	10,000	22,000	40,000
Sales mix	20 percent	25 percent	55 percent	100 percent
Fixed costs				$205,900

Required:

If the sales mix shifts more toward the Data product than the other two products, would the break-even point in units increase or decrease? Explain. (Detail calculations are not necessary, but may be helpful in confirming your answer.)

45. **CVP Sensitivity Analysis (Single Product).** Skyler Incorporated has monthly fixed costs of $1,000,000 and variable costs of $24 per unit. Each unit of product is sold for $120. Skyler expects to sell 15,000 units each month (this is the base case).

Required:

For each of the independent situations in requirements **b** through **d**, assume that the number of units sold remains at 15,000. (Round to the nearest cent where appropriate.)

1. Prepare a contribution margin income statement for the base case.
2. Refer to the base case. What would the operating profit be if the unit sales price decreases 10 percent?
3. Refer to the base case. What would the operating profit be if the unit variable cost increases 10 percent?
4. Refer to the base case. What would the operating profit be if total fixed costs decrease 20 percent?

46. **CVP Sensitivity Analysis (Multiple Products).** CyclePath Company produces two different products that have the following annual data (this is the base case).

	Bicycle	Tricycle	Total
Selling price per unit	$200	$100	
Variable cost per unit	$120	$ 50	
Expected unit sales	5,000	20,000	25,000
Sales mix	20 percent	80 percent	100 percent
Fixed costs			$1,000,000

Required:

For each of the independent situations in requirements **b** through **d**, assume that total sales remains at 25,000 units.

1. Prepare a contribution margin income statement for the base case.
2. Refer to the base case. What would the operating profit be if the Tricycle sales price (1) increases 10 percent, or (2) decreases 10 percent?
3. Refer to the base case. What would the operating profit be if Bicycle sales volume decreases 500 units and there is a corresponding increase of 500 units in Tricycle sales?
4. Refer to the base case. What would the operating profit be if total fixed costs decrease 10 percent? Does this decrease in fixed costs result in higher operating leverage or lower operating leverage? Explain.

47. **Contribution Margin with Resource Constraints.** CyclePath Company produces two different products that have the following price and cost characteristics.

	Bicycle	Tricycle
Selling price per unit	$200	$100
Variable cost per unit	$120	$ 50

Management believes that pushing sales of the Bicycle product would maximize company profits because of the high contribution margin per unit for this product. However, only 23,000 machine hours are available each year, and the Bicycle product requires 2 machine hours per unit while the Tricycle model requires 1 machine hour per unit. The company sells everything it produces.

Required:

1. Calculate the contribution margin per unit of constrained resource for each model.
2. Which model would CyclePath prefer to sell to maximize overall company profit? Explain.

48. **Target Profit Measured in Units (with Taxes).** Martis Company has annual fixed costs totaling $4,000,000 and variable costs of $300 per unit. Each unit of product is sold for $400. Assume a tax rate of 20 percent.

Required:

Use the three steps described in the chapter to determine how many units must be sold to earn an annual profit of $500,000 after taxes. (Round to the nearest unit.)

49. **Target Profit Measured in Sales Dollars (with Taxes).** Martis Company has annual fixed costs totaling $4,000,000 and variable costs of $300 per unit. Each unit of product is sold for $400. Assume a tax rate of 20 percent (these data are the same as the previous exercise).

Required:

Use the three steps described in the chapter to determine the sales dollars required to earn an annual profit of $1,000,000 after taxes.

50. **Absorption Costing Versus Variable Costing.** Photo Company produces digital cameras. The company has no finished goods inventory at the beginning of year 1. The following information pertains to Photo Company.

Annual production		60,000 units
Sales price		$80 per unit
Variable production cost per unit		
Direct materials	$12	
Direct labor	8	$30 per unit
Manufacturing overhead	10	
Fixed production costs		$240,000 each year; $4 per unit at 60,000 units of production
Variable selling and administrative cost		$2 per unit
Fixed selling and administrative cost		$80,000 each year

Required:

1. All 60,000 units produced during year 1 are sold during year 1.
    1. Prepare a traditional income statement assuming the company uses absorption costing.
    2. Prepare a contribution margin income statement assuming the company uses variable costing.
2. Although 60,000 units are produced during year 2, only 40,000 are sold during the year. The remaining 20,000 units are in finished goods inventory at the end of year 2.
    1. Prepare a traditional income statement assuming the company uses absorption costing.
    2. Prepare a contribution margin income statement assuming the company uses variable costing.

Problems

51. **CVP and Sensitivity Analysis (Single Product).** Madera Company has annual fixed costs totaling $120,000 and variable costs of $3 per unit. Each unit of product is sold for $15. Madera expects to sell 12,000 units this year (this is the base case).

Required:

1. Find the break-even point in units.
2. How many units must be sold to earn an annual profit of $50,000? (Round to the nearest unit.)
3. Find the break-even point in sales dollars.
4. What amount of sales dollars is required to earn an annual profit of $70,000?
5. Find the margin of safety in units and in sales dollars.
6. Prepare a contribution margin income statement for the base case.
7. What will the operating profit (loss) be if the sales price decreases 30 percent? (Assume total sales remains at 12,000 units, and round to the nearest cent where appropriate.)
8. Go back to the base case. What will the operating profit (loss) be if the variable cost per unit increases 10 percent? (Assume total sales remains at 12,000 units, and round to the nearest cent where appropriate.)

52. **CVP Analysis and Cost Structure (Single Product).** Riviera Incorporated produces flat panel televisions. The company has annual fixed costs totaling $10,000,000 and variable costs of $600 per unit. Each unit of product is sold for $1,000. Riviera expects to sell 70,000 units this year.

    Required:

    1. Find the break-even point in units.
    2. How many units must be sold to earn an annual profit of $2,000,000?
    3. Find the break-even point in sales dollars.
    4. What amount of sales dollars is required to earn an annual profit of $500,000?
    5. Find the margin of safety in units.
    6. Find the margin of safety in sales dollars.
    7. How much will operating profit change if fixed costs are 15 percent higher than anticipated? Would this increase in fixed costs result in higher or lower operating leverage? Explain.

53. **CVP Analysis with Taxes (Single Product).** Riviera Incorporated produces flat panel televisions. The company has annual fixed costs totaling $10,000,000 and variable costs of $600 per unit. Each unit of product is sold for $1,000. Riviera expects to sell 70,000 units this year (this is the same data as the previous problem). Assume a tax rate of 30 percent.

    Required:

    Round all calculations to the nearest dollar and nearest unit where appropriate.

    1. How many units must be sold to earn an annual profit of $2,000,000 after taxes?
    2. What amount of sales dollars is required to earn an annual profit of $500,000 after taxes?
    3. Refer to requirement **a**. What would happen to the number of units required to earn $2,000,000 in operating profit if the company were a non-profit organization that did not incur income taxes? Explain. (Detailed calculations are not necessary but may be helpful in confirming your answer.)

54. **CVP Analysis and Sales Mix (Multiple Products).** Sierra Books Incorporated produces two different products with the following monthly data (this is the base case).

	Text	Lecture Notes	Total
Selling price per unit	$100	$12	
Variable cost per unit	$ 60	$ 3	
Expected unit sales	21,000	14,000	35,000
Sales mix	60 percent	40 percent	100 percent
Fixed costs			$750,000

Assume the sales mix remains the same at all levels of sales except for requirement **i**.

Required:

Round to the nearest unit of product, hundredth of a percent, and nearest cent where appropriate. (An example for unit calculations is 3,231.15 = 3,231; an example for percentage calculations is 0.434532 = 0.4345 = 43.45 percent; an example for dollar calculations is $378.9787 = $378.98.)

1. Calculate the weighted average contribution margin per unit.
    1. How many units in total must be sold to break even?
    2. How many units of each product must be sold to break even?
    1. How many units in total must be sold to earn a monthly profit of $100,000?
    2. How many units of each product must be sold to earn a monthly profit of $100,000?
2. Using the base case information, prepare a contribution margin income statement for the month similar to the one in Figure 6.5 "Income Statement for Amy's Accounting Service".
3. Calculate the weighted average contribution margin ratio.
4. Find the break-even point in sales dollars.
5. What amount of sales dollars is required to earn a monthly profit of $80,000?
6. Assume the contribution margin income statement prepared in requirement **d** is the company's base case. What is the margin of safety in sales dollars?
7. If the sales mix shifts more toward the Text product than the Lecture Notes product, would the break-even point in units increase or decrease? Explain. (Detail calculations are not necessary, but may be helpful in confirming your answer.)

55. **CVP Analysis and Cost Structure (Service Company).** Conway Electrical Services provides services to two types of clients: residential and commercial. The company's contribution margin income statement for the year is shown (this is the base case). Fixed costs are known in total, but Conway does not allocate fixed costs to each department.

	Residential	Commercial	Total
Sales	$600,000	$900,000	$1,500,000
Variable costs	100,000	275,000	375,000
Contribution margin	$500,000	$625,000	$1,125,000
Fixed costs			600,000
Operating profit			$ 525,000

Required:

1. Find the break-even point in sales dollars.
2. What is the margin of safety in sales dollars?

3. What amount of sales dollars is required to earn an annual profit of $750,000?
4. Refer to the base case shown previously. What would the operating profit be if the Commercial variable costs are 20 percent higher than originally anticipated? How does this increase in Commercial variable costs impact the operating leverage of the company?

56. **CVP and Sensitivity Analysis, Resource Constraint (Multiple Products).** Hobby Shop Incorporated produces three different models with the following annual data (this is the base case).

	Plane	Car	Boat	Total
Selling price per unit	$20	$14	$24	
Variable cost per unit	$ 5	$ 7	$ 8	
Expected unit sales	30,000	50,000	20,000	100,000
Sales mix	30 percent	50 percent	20 percent	100 percent
Fixed costs				$650,000

Assume the sales mix remains the same at all levels of sales except for requirements **i** and **j**.

Required:

Round to the nearest unit of product, hundredth of a percent, and nearest cent where appropriate. (An example for unit calculations is 3,231.151 = 3,231; an example for percentage calculations is 0.434532 = 0.4345 = 43.45 percent; an example for dollar calculations is $378.9787 = $378.98.)

1. Calculate the weighted average contribution margin per unit.
    1. How many units in total must be sold to break even?
    2. How many units of each product must be sold to break even?
    1. How many units in total must be sold to earn an annual profit of $500,000?
    2. How many units of each product must be sold to earn an annual profit of $500,000?
2. Using the base case information, prepare a contribution margin income statement for the year similar to the one in Figure 6.5 "Income Statement for Amy's Accounting Service".
3. Calculate the weighted average contribution margin ratio.
4. Find the break-even point in sales dollars.
5. What amount of sales dollars is required to earn an annual profit of $400,000?
6. Go back to the base case contribution margin income statement prepared in requirement **d**. What would the operating profit be if the Plane sales price (1) increases 10 percent, or (2) decreases 10 percent? (Assume total sales remains at 100,000 units.)
7. Go back to the base case contribution margin income statement prepared in requirement **d**. If the sales mix shifts more toward the Car product than to the other two products, would the break-even point in units increase or decrease? (Detailed calculations are not necessary.) Explain.
8. Assume the company has a limited number of labor hours available in production, and management would like to make efficient use of these labor hours. The Plane product requires 4 labor hours per unit, the Car product requires 3 labor hours per unit, and the Boat product requires 5 hours per unit. The company sells everything it produces. Based on this information, calculate the contribution margin per labor hour for each model (round to the nearest cent), and determine the top two models the company would prefer to sell to maximize overall

company profit.

57. **Absorption Costing Versus Variable Costing.** Wall Tech Company produces wood siding. The company has no finished goods inventory at the beginning of year 1. The following information pertains to Wall Tech Company.

Annual production		200,000 units
Sales price		$30 per unit
Variable production cost per unit		
Direct materials	$8	$15 per unit
Direct labor	3	
Manufacturing overhead	4	
Fixed production costs		$1,000,000 each year; $5 per unit at 200,000 units of production
Variable selling and administrative cost		$2 per unit
Fixed selling and administrative cost		$800,000 each year

Required:

1. All 200,000 units produced during year 1 are sold during year 1.
    1. Prepare a traditional income statement assuming the company uses absorption costing.
    2. Prepare a contribution margin income statement assuming the company uses variable costing.
2. Although 200,000 units are produced during year 2, only 170,000 units are sold during the year. The remaining 30,000 units are in finished goods inventory at the end of year 2.
    1. Prepare a traditional income statement assuming the company uses absorption costing.
    2. Prepare a contribution margin income statement assuming the company uses variable costing.
3. Although 200,000 units are produced during year 3, a total of 230,000 units are sold during the year. The 30,000 units remaining in inventory at the end of year 2 are sold during year 3.
    1. Prepare a traditional income statement assuming the company uses absorption costing.
    2. Prepare a contribution margin income statement assuming the company uses variable costing.

4. Analyze the results in years 1 through 3 (requirements **a** through **c**).

One Step Further: Skill-Building Cases

58. **Internet Project: CVP Analysis.** Using the Internet, go to the Web site for **Nordstrom, Inc.** (http://www.nordstrom.com), and select *investor relations*. Find the most recent annual report and print the income statement (called the *consolidated statements of earnings*).

    Required:

    1. Calculate the gross profit percentage (also called the *gross margin percentage*) by dividing the gross profit by net sales.
    2. Explain how the gross profit percentage is different than the contribution margin ratio (no calculations are necessary)?

59. **Decision Making: Automated Versus Labor Intensive Production.** Wood Furniture, Inc., builds high-quality wood desks. Management of the company is considering going from a labor-intensive process of building desks to an automated process that requires expensive machinery and equipment. If the company moves to an automated process, variable production costs will decrease (direct materials, direct labor, and variable manufacturing overhead) due to improved efficiency, and fixed production costs will increase as a result of additional depreciation costs. The costs predicted for the coming year are shown. The selling price is expected to be $900 per unit for both processes.

	Labor-Intensive Process	**Automated Process**
Variable cost of goods sold	$490 per unit	$290 per unit
Fixed cost of goods sold (annual)	$1,000,000	$2,600,000
Variable selling and administrative	$10 per unit	$10 per unit
Fixed selling and admin. (annual)	$400,000	$400,000

    Required:

    1. Calculate the break-even point in units assuming that (1) the labor-intensive process is used, and (2) the automated process is used.
    2. Explain why there is such a significant difference in break-even points between the labor-intensive process and the automated process.
    3. Assume Wood Furniture, Inc., expects to produce and sell 8,000 units this coming year and is certain sales will grow by at least 10 percent per year in future years. Calculate the expected operating profit assuming that (1) the labor intensive process is used, and (2) the automated process is used.
    4. Using requirement **c** as a guide, explain whether management should stay with the labor-intensive process or switch to an automated process.

60. **Group Activity: Sensitivity Analysis and Decision Making.** Performance Sports produces inflatable rafts used for river rafting. Sales have grown slowly over the years, and cost increases are causing Performance Sports to incur losses. Financial data for the most recent year are shown.

Sales		$2,600,000	(= $2,000 x 1,300 units)
Variable costs			
Cost of goods sold	$1,040,000		(= $800 x 1,300 units)
Selling and administrative costs	390,000		(= $300 x 1,300 units)
Total variable costs		1,430,000	
Contribution margin		$1,170,000	
Fixed costs			
Cost of goods sold	$800,000		
Selling and administrative costs	400,000		
Total fixed costs		1,200,000	
Operating loss		($ 30,000)	

Members of the management group at Performance Sports arrived at these three possible courses of action to return the company to profitability (each scenario is independent of the others):

1. Increase the sales price for each raft by 10 percent, which will cause a 5 percent drop in sales volume. Although sales volume will drop 5 percent, the group believes the increased sales price will more than offset the drop in rafts sold.
2. Decrease the sales price for each raft by 10 percent, which will cause an 8 percent increase in sales volume. Although the sales price will drop by 10 percent, the group believes an increase in rafts sold will more than offset the sales price reduction.
3. Increase advertising costs by $200,000, which will increase sales volume by 15 percent. Although fixed selling and administrative costs will increase by $200,000, the group believes the increase in rafts sold will more than offset the increase in advertising costs.

Required:

Form groups of two to four students and assign one of the three options listed previously to each group. Each group must perform the following requirements:

1. Calculate the projected operating profit (loss) for the option assigned, and determine whether the option is acceptable.
2. Discuss and document the advantages and disadvantages of the option assigned.
3. As a class, discuss each option based on the findings of your group.

61. **Sensitivity Analysis Using Excel.** Refer to the information for Performance Sports in Skill-Building Case 60. Prepare an Excel spreadsheet to calculate the operating profit (loss) for the base case and for each of the three scenarios presented in the case. Using the spreadsheet in the *Computer Application* box in this chapter as a guide, include "data entry" and "sensitivity analysis results" sections, and combine variable cost of goods sold and selling and administrative costs on one line and fixed cost of goods sold and selling and administrative costs on another line.

62. **Ethics: Increasing Production to Boost Profit.** Hauser Company produces heavy machinery used for snow removal. Over half of the production costs incurred by Hauser are related to fixed manufacturing overhead. Although the company has maximum production capacity of 20,000 units per year, only 2,000 units were produced and sold during year 1, yielding $25 million in operating losses. As required by U.S. GAAP, the company uses absorption costing.

At the beginning of year 2, the board of directors fired the president of the company and began searching for a new president who was willing to make substantial changes to get the company turned around. One candidate, Paul Glezner, indicated he could turn the company around within a year. He felt the company was producing too few products, and could benefit from increased production. The members of the board of directors were impressed and considered Paul's contract demands: $10,000 in base annual salary, plus 30 percent of operating profit. Paul made it clear he would help the company for year 2, but intended to move on after the year ended.

Management of Hauser Company approached you with Paul's offer and asked you to determine whether the offer is reasonable.

Required:

1. Assume the company's sales will remain close to 2,000 units in year 2. How does Paul intend to "turn the company around" during year 2?
2. Why do you think Paul insists on leaving the company after year 2?
3. What type of costing system would you recommend Hauser Company use during year 2? Explain.

Comprehensive Case

63. **CVP and Sensitivity Analysis for a Brewpub.** As described in Note 6.37 "Business in Action 6.2", three entrepreneurs were looking for private investors and financial institutions to fund a new brewpub near Sacramento, California. This brewpub was to be called Roseville Brewing Company (RBC).

Brewpubs provide two products to customers: food from the restaurant segment, and freshly brewed beer from the beer production segment. Both segments are typically in the same building, which allows customers to see the beer brewing process.

After months of research, the three entrepreneurs created a financial model that showed the following projections for the first year of operations:

Sales		
Beer sales	$ 781,200	
Food sales	1,074,150	
Other sales	97,650	
Total sales		$1,953,000
Cost of sales		525,358
Gross margin		$1,427,642
Marketing and administrative expenses		1,125,430
Operating profit		$ 302,212

In the process of pursuing capital (cash) through private investors and financial institutions, they were asked several questions. The following is a sample of the questions most commonly asked:

- What is the break-even point?
- What sales dollars will be required to make $200,000? To make $500,000?
- Is the product mix reasonable? (Beer tends to have a higher contribution margin ratio than food, and therefore product mix assumptions are critical to profit projections.)

- What happens to operating profit if the product mix shifts?
- How will changes in price affect operating profit?
- How much does a pint of beer cost to produce?

It became clear that the initial financial model was not adequate for answering these questions. After further research, the entrepreneurs created another financial model that provided the following information for the first year of operations. (Notice that operating profit of $302,212 is the same as in the first model.)

Sales		
Beer sales (40% of total sales)	$ 781,200	
Food sales (55% of total sales)	1,074,150	
Other sales (5% of total sales)	97,650	
Total sales		$1,953,000
Variable costs		
Cost of sales		
Beer (15% of beer sales)	$117,180	
Food (35% of food sales)	375,953	
Other (33% of other sales)	32,225	
Wages of employees (25% of sales)	488,250	
Supplies (1% of sales)	19,530	
Utilities (3% of sales)	58,590	
Other: credit card and miscellaneous (2% of sales)	39,060	
Total variable costs		1,130,788
Contribution margin		$ 822,212
Fixed costs		
Salaries: manager, chef, brewer, and so on	$140,000	
Equipment and building maintenance	30,000	
Advertising	20,000	
Other: cleaning, menus, and miscellaneous	40,000	
Insurance and accounting	40,000	
Property taxes	24,000	
Depreciation	94,000	
Debt service (interest on debt)	132,000	
Total fixed costs		520,000
Operating profit		$ 302,212

Required:

Round your answers to the nearest hundredth of a percent and nearest dollar where appropriate. (An example for percentage calculations is 0.434532 = 0.4345 = 43.45 percent; an example for dollar calculations is $378.9787 = $379.)

1. What were potential investors and financial institutions concerned about when asking the questions listed previously?
2. Why was the first financial model inappropriate for answering most of the questions asked by investors and bankers? Be specific.
3. Suppose you are deciding whether to invest in RBC. Which financial ratio would you use to check the reasonableness of RBC's projected operating profit as compared with that of similar businesses?
4. Why is it difficult to answer the question "How much does a pint of beer cost to produce?" Which costs would you include in answering this question?
5. Perform CVP analysis by answering the following questions:
    1. What is the break-even point in sales dollars for RBC?
    2. What is the margin of safety in sales dollars for RBC?
    3. Why is it not possible for RBC to find the break-even point in units?
    4. What sales dollars would be required to achieve an operating profit of $200,000 and of $500,000? What assumptions are made in these calculations?
6. Assume total revenue remains the same, but the product mix changes so that each of the three revenue categories is weighted as follows: food 70 percent, beer 25 percent, other 5 percent. Prepare a contribution margin income statement to reflect these changes. How will this shift in product mix affect operating profit?
7. Although the financial model is important, what other strategic factors should RBC and its investors consider?

3.4: Methods for Improving Product & Service Design

DTUBROADCAST: THOMAS J. HOWARD'S "INTEGRATED PRODUCT DEVELOPMENT"

Watch *Integrated Product Development* to get an overview of the product development process and the need to improve product and service design. The video is interesting because the speaker walks you through his experience of designing a product for a company. An integrated product development process that includes steps for improving products and services that already exist is important.

One or more interactive elements has been excluded from this version of the text. You can view them online here:
https://pressbooks.nscc.ca/operationsmanagement2/?p=177#oembed-1

OPEN IDEO FOR IDEO: "INTRODUCTION TO IDEO"

Watch this video about OpenIDEO. This provides information on additional methods for improving product and service design using DQ. IDEO is an exemplar for the innovation process. This website provides you access to a platform that can provide you many tools and connections as you move forward in your career.

One or more interactive elements has been excluded from this version of the text. You can view them online here:
https://pressbooks.nscc.ca/operationsmanagement2/?p=177#oembed-2

10.7 PRODUCT DEVELOPMENT

Learning Objective

1. Describe the process of developing a product that meets customer needs.

Like PowerSki, every organization—whether it produces goods or provides services—sees Job 1 as furnishing customers with quality products. The success of a business depends on its ability to identify the unmet needs of consumers and to develop products that meet those needs at a low cost.[1] In other words, effective product development results in goods and services that can be sold at a profit. In addition, it results in high-quality products that not only satisfy consumer needs but also can be developed in a timely, cost-efficient manner. Accomplishing these goals entails a collaborative effort by individuals from all areas of an organization: operations management (including representatives from engineering, design, and manufacturing), marketing, accounting, and finance. In fact, companies increasingly assign representatives from various functional areas who work together as a project team throughout the product development processes. This approach allows individuals with varied backgrounds and experience to provide input as the product is being developed.

PRODUCT DEVELOPMENT IS A RISKY PROPOSITION

Not surprisingly, developing profitable products is difficult, and the success rate is low. On average, for every successful product, a company has twelve failures. At this rate, the firms on the *Fortune* 1000 list waste over $60 billion a year in research and development[34] There are several reasons why product development is such a risky proposition:

- *Trade-offs*. You might, for instance, be able to make your jogging shoes lighter than your competitors', but if you do, they probably won't wear as well. They could be of higher quality, but that will make them more costly (they might price themselves out of the market).
- *Time pressure*. Developing a product can require hundreds of decisions that must be made quickly and with imperfect information.
- *Economics*. Because developing a product requires a lot of time and money, there's always pressure to make sure that the project not only results in a successful product but also gets it to market at the most opportune time. Failure to be first to market with an otherwise desirable new product can cost a company a great deal of money.

Even so, organizations continue to dedicate immense resources to developing new products. Your supermarket, for example, can choose from about one hundred thousand items to carry on its shelves—including twenty thousand *new* products every year. Unfortunately, the typical supermarket can stock only thirty thousand products.[6]

1. [2]
2. Karl Ulrich and Steven Eppinger, *Product Design and Development*, 2nd ed. (New York: Irwin McGraw-Hill, 2000), 3.
3. .[5]
4.
5. Tony Ulwick and John A. Eisenhauer, "Predicting the Success or Failure of a New Product Concept," *The Management Roundtable*,http://www.roundtable.com/Event_Center/I@WS/I@WS_paper3.html (accessed May 11, 2006).
6. [7]
7. Steve Hannaford, "Slotting Fees and Oligopolies," http://www.oligopolywatch.com/2003/05/08.html (accessed May 11, 2006).

VIDEO CLIP

One or more interactive elements has been excluded from this version of the text. You can view them online here:
https://pressbooks.nscc.ca/operationsmanagement2/?p=177#oembed-3

Even the mighty Coca-Cola has had its share of failures—New Coke, anyone?

THE PRODUCT DEVELOPMENT PROCESS

The product development process is a series of activities by which a product idea is transformed into a final product. It can be broken down into the seven steps summarized in Figure 10.6 "The Product Development Process".

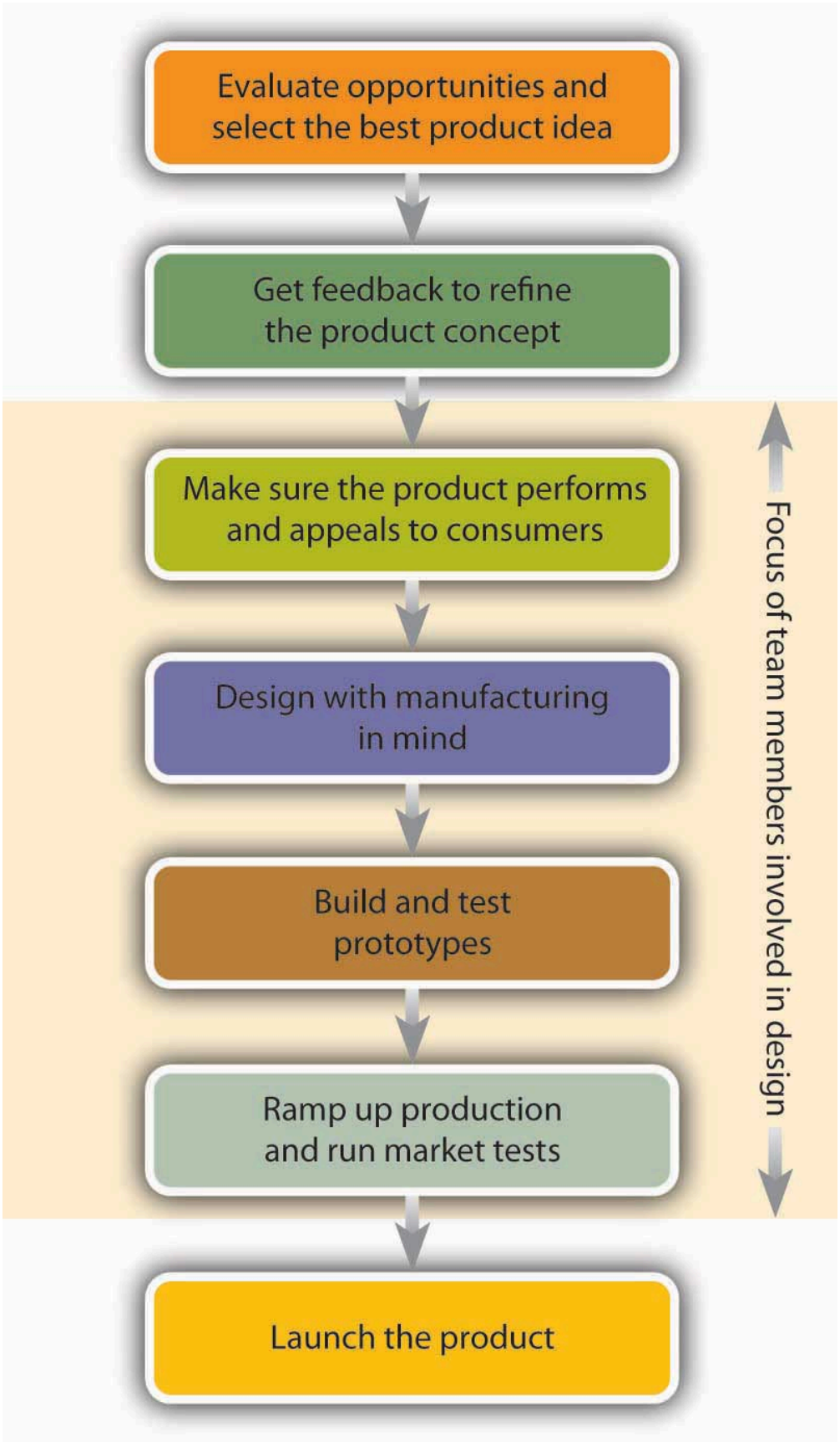

Evaluate opportunities and select the best product idea
Get feedback to refine the product concept
Make sure the product performs and appeals to consumers
Design with manufacturing in mind
Build and test prototypes
Ramp up production and run market tests
Launch the product
Focus of team members involved in design

Figure 10.6 The Product Development Process

Evaluate Opportunities and Select the Best Product Idea

If you're starting your first business, you might have only one product idea. But existing organizations often have several ideas for new products, as well as improvements to existing ones. Where do they come from? They can come from individuals within the organization or from outside sources, such as customers. Typically, various ideas are reviewed and evaluated by a team of individuals, who identify the most promising ideas for development. They may rely on a variety of criteria: Does the proposed product fill an unmet need of our customers? Will enough people buy our product to make it commercially successful? Do we have the resources and expertise to make it?

Get Feedback to Refine the Product Concept

From the selected product idea, the team generates an initial product concept that describes what the product might look like and how it might work. Members talk both with other people in the organization and with potential buyers to identify customer needs and the benefits that consumers will get from the product. They study the industry in which the product will be sold and investigate competing products. They brainstorm various *product designs*—that is, the specifications for how the product is to be made, what it's to look like, and what performance standards it's to meet.

Based on information gathered through this process, the team will revise the product concept, probably pinpointing several alternative models. Then they'll go back to potential customers and get their feedback on both the basic concept and the various alternatives. Based on this feedback, the team will decide what the product will look like, how it will work, and what features it will have.

Make Sure the Product Performs and Appeals to Consumers

The team then decides how the product will be made, what components it will require, and how it will be assembled. It will decide whether the product should be made in-house or outsourced to other companies. For products to be made in-house, the team determines where parts will be obtained. During this phase, team members are involved in design work to ensure that the product will be appealing, safe, and easy to use and maintain.

Design with Manufacturing in Mind

As a rule, there's more than one way to make any product, and some methods are more expensive than others. During the next phase, therefore, the team focuses its attention on making a high-quality product at the lowest possible cost, working to minimize the number of parts and simplify the components. The goal is to build both quality and efficiency into the manufacturing process.

Build and Test Prototypes

A prototype In the next phase, prototypes are produced and tested to make sure that the product meets the customer needs that it's supposed to. The team usually begins with a preliminary prototype from which, based on feedback from potential customers, a more sophisticated model will then be developed. The process of building and testing prototypes will continue until the team feels comfortable that it has fashioned the best possible

product. The final prototype will be extensively tested by customers to identify any changes that need to be made before the finished product is introduced.

Ramp Up Production and Run Market Tests

During the production ramp-up stage, employees are trained in manufacturing and assembly processes. Products turned out during this phase are carefully inspected for residual flaws. Samples are often demonstrated or given to potential customers for testing and feedback.

Launch the Product

In the final stage, the firm starts ongoing production and makes the product available for widespread distribution.

Key Takeaways

- The success of a business depends on its ability to identify the unmet needs of consumers and to develop products that meet those needs at a reasonable cost.
- Accomplishing these goals requires a collaborative effort by individuals from all areas of the organization: operations management (including representatives from engineering, design, and manufacturing), marketing, accounting, and finance.
- Representatives from these various functional areas often work together as **project teams** throughout the **product development process**, which consists of a series of activities that transform a product idea into a final product.
- This process can be broken down into seven steps:
    1. Evaluate opportunities and select the best product mix
    2. Get feedback to refine the **product concept** that describes what the product might look like and how it might work
    3. Make sure that the product performs and appeals to consumers
    4. Design with manufacturing in mind to build both quality and efficiency into the manufacturing process
    5. Build and test **prototypes**, or physical models of the product
    6. Run market tests and enter the **ramp-up stage** during which employees are trained in the production process
    7. Launch the product

Exercise

(AACSB) Analysis

Use your imagination to come up with a hypothetical product idea. Now, identify the steps you'd take to design, develop, and bring your product to market.

3.5: Process Selection

IDS355: OPERATIONS MANAGEMENT WIKISPACE: "CHAPTER 14, SUMMARY: MRP AND ERP

Review the information related to the use of manufacturing resource planning and enterprise resource planning. Both are useful within the organization. Resources are necessary to successful operations. One challenge that every manager faces is the decision of resource utilization. Pay attention to the benefits and requirements. Review the questions at the end of the summary. After answering the questions, compare your answers to the author's answers.

CHAPTER 14: MRP & ERP

MRP

Items with dependent demand are items in which demand is derived from plans to make certain products (things like raw materials, parts, and assemblies). Example: The parts and materials that go into the making a car. Dependent demand tends to be "lumpy" whereas independent demand is fairly stable. **MRP** is a computer program that translates finished product requirements into time-phased requirements for each dependent demand items. The Bill of Materials, one of the three primary inputs of MRP, is useful because it is a list of all the assemblies, sub-assemblies, parts, and raw materials that are needed to produce one unit of a finished product.

In addition to MRP, this chapter provides information about ERP, which has an MRP core. **ERP**, which stands for "Enterprise Resource Planning" provides an expanded effort to integrate standardized record keeping that will permit information sharing among numerous dimensions of a business in order to direct the system more effectively. An ERP system typically has modular hardware and software units and "services" that communicate on a local area network.

An important issue in inventory management is determining a lot size to order or produce in independent and independent demand items. **Lot sizing** refers to choosing a lot size for ordering or production. For independent demand items managers use economic order sizes and economic production quantities. For dependent demand systems managers can choose larger variety plans to determine the lot sizes. Dependent demand tends to be sporadic or "lumpy". The goal of independent demand and dependent demand systems is to minimize the sum of ordering cost and holding cost.

MRP Input

MRP uses three primary sources for information: master schedule, bill-of-materials file, and an inventory records file. **Master schedule** relates to product demand and timeline. It states what end items need to be produced, when they are needed and how much are needed. **Bill of materials** relates to product composition. It lists all of the raw materials, parts, sub-assemblies and assemblies required to manufacture one item. **Inventory records** relate to inventory. They consist of status information on an item sorted by time period. Status information consists of gross requirements, scheduled receipts and expected amount on hand.

MRP Output

MRP systems have capabilities of providing management with a wide range of outputs. These typically include primary reports and secondary reports. Primary Reports – production and inventory planning and control are part of primary reports. They usually include: Planned orders – a schedule indicating the amount and timing of future orders

Order releases – authorizing the execution of planned orders

Changes to planned orders – revisions of due dates or order quantities/ cancellation of orders.

Secondary Reports – performance control, planning, and exceptions belong to secondary reports

Performance-control reports – measure deviations from plans such as deliveries and stockouts, as well as providing info that can be used to assess cost performance.

Planning reports – predict future inventories, procurement contracts and data for future assessment of material requirements.

Exception reports – recognizes inconsistencies within the report such as errors in overdue or late orders, etc. pg 661

BENEFITS AND REQUIREMENTS OF MRP

Benefits

MRP enables managers to: determine the quantities for a given order size, know when to release orders for each component, and to be alerted when items need attention. Other benefits of MRP include:

1) Low levels of in process inventories
2) The Ability to keep track of material requirements
3) The ability to evaluate capacity requirements generated by a given master schedule
4) A means of allocating production time
5) The ability to easily determine inventory usage by backflushing.

Backflushing is a procedure in which an end item's bill of materials (BOM) is periodically exploded to determine the quantities of the various components that were used to make the item. The people who are typical users of a MRP system in a typical manufacturing company are production managers, purchasing managers, inventory managers, and customer representatives.The benefits of MRP depend primarily on the use of computer to maintain up-to-date information on material requirement.

Requirements

The benefits of MRP primarily depend on the ability to maintain up-to-date and accurate information. In order to implement and operate an effective MRP system, it is necessary to have:

1) a computer and the necessary software programs to handle computations and maintain records
2) Accurate and up-to date master schedules, Bills of materials, Inventory records
3) Integrity of file data.

MRP II

Manufacturing Resources Planning II developed in the 1980s after manufacturers realized MRP had additional needs. MRP II expanded the use of MRP by adding features essential to the use of other functional areas, marketing and finance to enable the use of short-range capacity requirements. Material requirements are essential for the use of MRP II. MRP II systems are good at simulation and help answer "what if" questions i.e.,

to foresee the consequences of their options and other alternatives. With the new function areas added, the manufacturing company is able to develop a master production schedule. MRP generates the materials needed and schedules the requirements, where managers can obtain a more detailed capacity requirements. **Capacity requirements** is the process of determining short-range capacity requirements.

MRP Considerations

MRP Inputs: The master schedule should cover a period that is at least equivalent to the *cumulative lead time* (the sum of the lead times that sequential phases of a process require, from ordering of parts or raw materials to completion of final assembly.)
Safety Stock: Needed in case there is variability due to bottleneck processes causing shortages, shortages caused by late orders and/or fabrications, or assembly lines are longer than expected.
Safety Time: Used when lead times vary to allow tasks to be completed well ahead of schedule to eliminate the probability of shortage.
Lot-for-Lot (L4L) ordering: The order or run size is set equal to the demand for that period.
Economic Order Quantity (EOQ): Can lead to minimum costs if usage of item is fairly uniform.
Fixed Period Ordering: Provides coverage for some predetermined number of periods.
System Stability: Without stability, changes in order quantity and/or timing can render material requirements plans virtually useless.
System Nervousness: How a system reacts to changes.

This chapter goes into detail about the advantages and nature of MRP processing, as well as describing the applications of MRP in different industries. The chapter then describes the evolution of MRP to MRPII, which expanded the scale of materials planning. MRPII gave managers the ability to ask "what if" questions, and provided them with a more precise decision making tool. In addition to MRP, enterprise resource planning (ERP) or the "third generation," is also described. ERP gave companies the ability to incorporate all departments and functions company-wide on a single system. The benefits of ERP are substantial; however, it must be noted that high training, maintenance, and initial start up costs are too high.

QUESTIONS:

1. The choosing of a lot size for ordering or __ is considered lot sizing. p.g. 662
a. production
b. delivery
c. cost
d. inventory
e. None of the above

[reveal-answer q="992895"]Show Answer[/reveal-answer]
[hidden-answer a="992895"]

ANSWER: a. production

[/hidden-answer]

2. The model that leads to minimum costs,when the usage is fairly uniform is: p.g. 662
a. economic order quantity model
b. fixed-period ordering
c. lot-for-lot ordering

d. independent demand
e. dependent demand
[reveal-answer q=”890362"]Show Answer[/reveal-answer]
[hidden-answer a=”890362"]

ANSWER: a. Economic order quantity model

[/hidden-answer]
3. The primary goal of management is to minimize cost of ? p.g. 662
a. production
b. delivery
c. good
d. inventory
e. All of the Above
[reveal-answer q=”132886"]Show Answer[/reveal-answer]
[hidden-answer a=”132886"]

ANSWER: d. inventory

[/hidden-answer]
4. What is the simplest method of lot sizing? p.g. 662
a. Lot for lot ordering
b. economic order quantity model
c. fixed-period ordering
d. independent demand
e. dependent demand
[reveal-answer q=”135977"]Show Answer[/reveal-answer]
[hidden-answer a=”135977"]

ANSWER: a. lot for lot ordering

[/hidden-answer]
5. Which type of ordering provides coverage for some predetermined number of periods? p.g. 662
a. lot for lot ordering
b. economic order quantity model
c. fixed period ordering
d. independent demand
e. dependent demand
[reveal-answer q=”521233"]Show Answer[/reveal-answer]
[hidden-answer a=”521233"]

ANSWER: c. fixed period ordering

[/hidden-answer]
6. MPR is designed to answer all of the questions **except**: p.g. 649
a. How much is needed?

b. What is the time constraint?
c. When is it needed?
d. What is needed?
e. None of the above
[reveal-answer q="369275"]Show Answer[/reveal-answer]
[hidden-answer a="369275"]

ANSWER: b. what is the time constraint?

[/hidden-answer]
7. A Master Schedule contains which of the following?:
A. Which end items are to be produced
B. When end items will be needed
C. What quality of end items will be needed
D. All of the above
E. A and B only
[reveal-answer q="771881"]Show Answer[/reveal-answer]
[hidden-answer a="771881"]

Answer: E (pg 650) quantity, not quality.

[/hidden-answer]
8. Restructuring the bill of materials, so that multiple occurrences of a component will coincide with the lowest level at which the component occurs is known as:
A. one-level coding
B. component minimizing
C. low-level coding
D. MRP minimization
E. None of the above
[reveal-answer q="642912"]Show Answer[/reveal-answer]
[hidden-answer a="642912"]

Answer: C (pg 653)

[/hidden-answer]
9. All of the following are Primary Reports **except**:
A. Planning Reports
B. Planned Orders
C. Changes
D. Order Releases
E. None of the above
[reveal-answer q="187281"]Show Answer[/reveal-answer]
[hidden-answer a="187281"]

Answer: A (pg 661)

[/hidden-answer]

10. What is the expanded approach to production resource planning that involves other areas of a firm in the planning process and enables capacity requirements planning?

A. ERP
B. MRP II
C. DRP II
D. MRP Extended
E. None of the above

[reveal-answer q="149063"]Show Answer[/reveal-answer]
[hidden-answer a="149063"]

Answer: B (pg 664)

[/hidden-answer]

11. ERP software provides:

A. A system to capture and make data available in real time
B. A capability to assess the feasibility of a proposed plan
C. A set of tools for planning and monitoring business processes to achieve goals of the organization
D. A and C
E. None of the above

[reveal-answer q="321180"]Show Answer[/reveal-answer]
[hidden-answer a="321180"]

Answer: D (pg 669)

[/hidden-answer]

12. Which of the following is **NOT** included in the billing of materials?

A. raw materials
B. labor hours
C. parts
D. subassemblies
E. assemblies processes

[reveal-answer q="659198"]Show Answer[/reveal-answer]
[hidden-answer a="659198"]

Answer: B, 638

[/hidden-answer]

13. What is a product structure tree?

A. visual depiction of the requirements in a bill of materials where all components are listed by levels
B. visual depiction of the requirements in a master schedule where all products are listed by demand.
C. visual depiction of the requirements in inventory records where all components are listed by status.
D. all of the above
E. none of the above

[reveal-answer q=”449298"]Show Answer[/reveal-answer]
[hidden-answer a=”449298"]

Answer: A, 638

[/hidden-answer]
14. Which of the following is NOT a primary source of information for MRP?
A. master schedule
B. inventory records
C. bill of materials
D. planned orders
E. all of the above are not primary sources of information for MRP
[reveal-answer q=”408497"]Show Answer[/reveal-answer]
[hidden-answer a=”408497"]

Answer: D, 637

[/hidden-answer]
15. The sum of the lead times required by sequential phases of a process is known as:
A. LTSP
B. critical path
C. cumulative lead time
D. master schedule
E. horizon plan
[reveal-answer q=”406808"]Show Answer[/reveal-answer]
[hidden-answer a=”406808"]

Answer: C, 638

[/hidden-answer]
16. What is an advantage of a regenerative system?
A. reflecting changes as they occur
B. less processing costs
C. up-to-date information for planning purposes
D. none of the above
E. B and C
[reveal-answer q=”891477"]Show Answer[/reveal-answer]
[hidden-answer a=”891477"]

Answer: B, 663

[/hidden-answer]
17. What are classified as the main reports used by management?
A. Planning Reports
B. Performance-Control Reports
C. Exception Reports

D. Primary Reports
E. Secondary Reports
[reveal-answer q=”220831"]Show Answer[/reveal-answer]
[hidden-answer a=”220831"]

Answer: D p.661

[/hidden-answer]
18. Primary Reports include which of the following?
A. Planned Orders
B. Order releases
C. Changes to planned orders
D. All the above
E. Only A and C
[reveal-answer q=”489631"]Show Solution[/reveal-answer]
[hidden-answer a=”489631"]

Answer: D p.661

[/hidden-answer]
19. Secondary Reports include which of the following?
A. Performance-control reports
B. Planning Reports
C. Exception Reports
D. All the above
E. Only A & B
[reveal-answer q=”696537"]Show Answer[/reveal-answer]
[hidden-answer a=”696537"]

Answer: D p.661

[/hidden-answer]
20. What major function is involved with Planning Reports?
A. Evaluating system operations
B. Calling attention to major discrepancies in orders
C. Forecasting Future Inventory Requirement Decisions
D. All of the Above
E. None of the Above
[reveal-answer q=”597436"]Show Answer[/reveal-answer]
[hidden-answer a=”597436"]

Answer: C p.661

[/hidden-answer]
21. Which report contains production and inventory planning and control?
A. Primary Report

B. Secondary Report
C. Planning Report
D. Exception Report
E. Performance-Control Report
[reveal-answer q="417141"]Show Answer[/reveal-answer]
[hidden-answer a="417141"]

Answer: A p.661

[/hidden-answer]
22. What is the most expensive of the following processes?
A. MRP
B. MRPII
C. ERP
D. They all cost the same
E. A & B only
[reveal-answer q="961005"]Show Answer[/reveal-answer]
[hidden-answer a="961005"]

Answer: C p.661

[/hidden-answer]
23. What recognizes inconsistencies within the report such as errors in overdue or late orders, etc?
A. Performance-control reports
B. Planning reports
C. Planned orders
D. Exception Reports
E. B & C only
[reveal-answer q="867258"]Show Answer[/reveal-answer]
[hidden-answer a="867258"]

Answer: D p.661

[/hidden-answer]
24. Which of the following is not a benefit of an MRP system?
A. The ability to keep track of material requirements
B. A means of allocating production time
C. The ability to easily determine inventory usage by backflushing
D. High Levels of in process inventory
E. All of the above are benefits of an MRP system
[reveal-answer q="32959"]Show Answer[/reveal-answer]
[hidden-answer a="32959"]

Answer: D (Page 663)

[/hidden-answer]

25. is a procedure in which an end item's bill of material is periodically exploded to determine the quantities of the various components that were used to make the items.
A. Backloading
B. Backflushing
C. Backwashing
D. Backflowing
E. None of the above
[reveal-answer q="3859"]Show Answer[/reveal-answer]
[hidden-answer a="3859"]

Answer: B (Page 663)

[/hidden-answer]
26. The benefit of an MRP system depends on the ability to have large amounts of unorganized information readily accessible.
A. True
B. False
[reveal-answer q="371069"]Show Answer[/reveal-answer]
[hidden-answer a="371069"]

Answer: False (Page 663)

[/hidden-answer]
27. Which of the following is one of the requirements for an MRP system?
A. A computer
B. Accurate and up to date information
C. Integrity of data
D. None of the Above
E. All of the Above
[reveal-answer q="653783"]Show Answer[/reveal-answer]
[hidden-answer a="653783"]

Answer: E (Page 664)

[/hidden-answer]
28. Which of the following is/are (a) factor(s) that causes problems in an MRP system?
A. assumption of constant lead times
B. products being produced differently from the bill of materials
C. failure to alter a bill of materials when customizing a product
D. Inaccurate forecast
E. All of the above
[reveal-answer q="391977"]Show Answer[/reveal-answer]
[hidden-answer a="391977"]

Answer: E (Page 664)

[/hidden-answer]

29. In addition to manufacturing resources needed for the master production plan, what else is the financial department in charge of?

A. Amount of resources
B. Timing
C.Work Time
D. A & B
E. B & C

[reveal-answer q=”584859"]Show Answer[/reveal-answer]
[hidden-answer a=”584859"]

Answer: D. (Page 638)

[/hidden-answer]

30. MRP II has restrictions and times where they can make changes to the orders/production. What is this called?

A. Time Series
B. Time Fences
C. Time Based System
D. Time Based Strategy
E. None of the above

[reveal-answer q=”548173"]Show Answer[/reveal-answer]
[hidden-answer a=”548173"]

Answer: B. (Page 666)

[/hidden-answer]

31. Manufacturing Company generates the Master Schedule according to

A.What is possible
B. What is Demanded
C. What is Given
D. What is Needed
E. None of the above

[reveal-answer q=”939084"]Show Answer[/reveal-answer]
[hidden-answer a=”939084"]

Answer: D (Page 637)

[/hidden-answer]

32.What is the percentage of capacity requirement for the machine, if 150 units of Product A are scheduled, when the machines standard time is 1.9 hours and labor standard time of 2.3 hours?

A. 72.4%
B. 82.6%
C.12.10%

D.10.6%
E. None of the above
[reveal-answer q="589381"]Show Answer[/reveal-answer]
[hidden-answer a="589381"]

Answer B. (Page 656)

[/hidden-answer]
33. MRP is essential in establishing requirements for capacity, but it also has a downfall. What is it?
A. Cannot aggregate demand from all sources
B. Cannot plan for amount of requirements and timing
C. Cannot distinguish between a feasible Master Schedule and a nonfeasible schedule.
D Cannot make changes to the Master Schedule once it is in process.
E. None of the above
[reveal-answer q="135154"]Show Answer[/reveal-answer]
[hidden-answer a="135154"]

Answer: C (Page 654)

[/hidden-answer]
34 . _ is the sum of the lead times that sequential phases of a process require, from ordering of parts or raw materials to completion of final assembly.
a. Overall lead time
b. Safety time
c. Cumulative lead time
d. Completion time
e. Slack
[reveal-answer q="925872"]Show Answer[/reveal-answer]
[hidden-answer a="925872"]

Answer: C.(p.g 650)

[/hidden-answer]
35. Which ordering method would you use if the use of the item is fairly uniform?
a. Economic order quantity model
b. L4L
c. Fixed Period Ordering
d. BOM
e. Automated Ordering
[reveal-answer q="938404"]Show Answer[/reveal-answer]
[hidden-answer a="938404"]

Answer: A..(p.g. 662)

[/hidden-answer]
question must have 5 choices

36. System sensitivity is how a system reacts to changes.
a. True
b. False
[reveal-answer q="104330"]Show Answer[/reveal-answer]
[hidden-answer a="104330"]

Answer: B.(need number page of answer)

[/hidden-answer]
37. The concept of safety time is often used when...
a. There is variability due to bottleneck processes causing shortages
b. Used when lead times vary
c. Shortages caused by late orders and/or fabrications
d. Assembly lines are longer than expected
e. All of the above
[reveal-answer q="218444"]Show Answer[/reveal-answer]
[hidden-answer a="218444"]

Answer: B.(need number page of answer)

[/hidden-answer]
38. The master schedule should cover a period that is at least equivalent to the...
a. CRP
b. Closed loop MRP
c. Time buckets
d. Cumulative lead time
e. Cumulative lead time subtracted by time buckets
[reveal-answer q="757488"]Show Answer[/reveal-answer]
[hidden-answer a="757488"]

Answer: D.(p.g. 650)

[/hidden-answer]
39. What is considered the "third generation of manufacturing software."
a. Y2K
b. MRP
c. MRPII
d. ERP
e. None of the above
[reveal-answer q="973921"]Show Answer[/reveal-answer]
[hidden-answer a="973921"]

Answer: D (P.668)

[/hidden-answer]
40. Which of the following is **NOT** a feature of MRP?

a. Planned-order releases
b. Calculating component requirements
c. Master scheduling
d. Time-phasing of requirements
e. All choices are a feature of MRP
[reveal-answer q="939052"]Show Answer[/reveal-answer]
[hidden-answer a="939052"]

Answer: C (P.654)

[/hidden-answer]
41. Which of the following is true of ERP?
a. Low start up cost
b. Requires intensive employee training
c. Low maintenance cost
d. Non time consuming
e. All choice are false
[reveal-answer q="881688"]Show Answer[/reveal-answer]
[hidden-answer a="881688"]

Answer: B (P.670)

[/hidden-answer]
42. Which of the following is **NOT** true of MRP?
a. Requires a computer and the necessary software programs to handle computations and maintain records
b. Requires at least one hundred working computers
c. Requires accurate and up to date inventory records
d. Requires accurate and up to date master schedules and records
e. Integrity of file data
[reveal-answer q="252758"]Show Answer[/reveal-answer]
[hidden-answer a="252758"]

Answer: B (P.650)

[/hidden-answer]
43. What is ERP?
a. Entry Resource Pricing systems
b. The second generation manufacturing program
c. enterprise Resource Planning
d. Enterprise Report Planning
e. All the Above
[reveal-answer q="733204"]Show Answer[/reveal-answer]
[hidden-answer a="733204"]

Answer: C (P.668)

[/hidden-answer]

WIKIPEDIA: "METHODS OF PRODUCTION"

Read this source. Different types of production can be used within a manufacturing organization. This source provides information about these types of production. Pay particular attention to the batch and flow production.

METHODS OF PRODUCTION

Production methods fall into three main categories; however, all production methods can be assisted with CAM and CAD equipment (Computer Aided Manufacture and Computer Aided Design – respectively).

JOB PRODUCTION AND PROTOTYPE PRODUCTION

Job Production is used when a product is produced with the labor of one or few workers and is scarcely used for bulk and large scale production. It is mainly used for one-off products or prototypes, as it is inefficient; however, quality is greatly enhanced with job production compared to other methods. Individual wedding cakes and made-to-measure suits are examples of job production. New small firms often use job production before they get a chance or have the means to expand. Job Production is highly motivating for workers because it gives the workers an opportunity to produce the whole product and take pride in it.

BOUTIQUE MANUFACTURING

Contrary to jobbing production, the method Boutique Manufacturing is suitable for the production of very small to small batches, i.e. orders of a few units up to several dozens of similar or equal goods. The workflow organization of a Boutique Manufacturing entity can be a mixture of both jobbing and batch production but involves higher standardization than job production. Boutique Manufacturing is often organized with single workplaces or production cells carrying out a number of subsequent production steps until completion of certain components or even the whole product; large assembly lines are generally not used. The flexibility and variety of products able to be produced in the entity therefore are much higher than with the more standardized method of batch production.

BATCH PRODUCTION

Batch production is the method used to produce or process any product in groups or batches where the products in the batch go through the whole production process together. An example would be when a bakery produces each different type of bread separately and each object (in this case, bread) is not produced continuously. Batch production is used in many different ways and is most suited to when there is a need for a quality/quantity balance. This technique is probably the most commonly used method for organizing manufacture and promotes specialist labor, as very often batch production involves a small number of persons. Batch production occurs when

many similar items are produced together. Each batch goes through one stage of the production process before moving onto next stage.

FLOW PRODUCTION

Flow production (Process Production) is also a very common method of production. Flow production is when the product is built up through many segregated stages; the product is built upon at each stage and then passed directly to the next stage where it is built upon again. The production method is financially the most efficient and effective because there is less of a need for skilled workers.

COMPUTER AIDED MANUFACTURE AND COMPUTER AIDED DESIGN

Computer Aided Design (CAD) is the use of a wide range of computer-based software tools that assist engineers and architects alike.

WIKIPEDIA: "CONTINUOUS PRODUCTION"

Read this source to explore the way that continuous production works in a manufacturing environment. This is important because often operations managers must make choice about what type of method is appropriate given the requirements of the business.

CONTINUOUS PRODUCTION

Continuous usually means operating 24 hours per day, seven days per week with infrequent maintenance shutdowns, such as semi-annual or annual. Some chemical plants can operate for more than one or two years without a shutdown. Blast furnaces can run four to ten years without stopping. **Continuous production** is a flow production method used to manufacture, produce, or process materials without interruption. Continuous production is called a **continuous process** or a **continuous flow process** because the materials, either dry bulk or fluids that are being processed are continuously in motion, undergoing chemical reactions or subject to mechanical or heat treatment. Continuous processing is contrasted with batch production.

COMMON PROCESSESS

Some common continuous processes are the following:

- Oil refining
- Chemicals
- Synthetic fibers
- Fertilizers
- Pulp and paper

- Blast furnace (iron)
- Metal smelting
- Power stations
- Natural gas processing
- Sanitary waste water treatment
- Continuous casting of steel
- Rotary kilns for calcining lime or cement
- Float glass

Production workers in continuous production commonly work in rotating shifts.

Processes are operated continuously for practical as well as economic reasons. Most of these industries are very capital intensive and the management is therefore very concerned about lost operating time.

Shutting down and starting up many continuous processes typically results in off quality product that must be reprocessed or disposed of. Many tanks, vessels and pipes cannot be left full of materials because of unwanted chemical reactions, settling of suspended materials or crystallization or hardening of materials. Also, cycling temperatures and pressures from starting up and shutting down certain processes (line kilns, boilers, blast furnaces, pressure vessels, etc.) may cause metal fatigue or other wear from pressure or thermal cycling.

In the more complex operations there are sequential shut down and start up procedures that must be carefully followed in order to protect personnel and equipment. Typically a start up or shut down will take several hours.

Continuous processes use process control to automate and control operational variables such as flow rates, tank levels, pressures, temperatures and machine speeds.

SEMI-CONTINUOUS PROCESSES

Many processes such as assembly lines and light manufacturing that can be easily shut down and restarted are today considered semi-continuous. These can be operated for one or two shifts if necessary.

HISTORY

The oldest continuous flow processes is the blast furnace for producing pig iron. The blast furnace is intermittently charged with ore, fuel and flux and intermittently tapped for molten pig iron and slag; however, the chemical reaction of reducing the iron and silicon and later oxidizing the silicon is continuous.

Semi-continuous processes, such as machine manufacturing of cigarettes, were called “continuous” when they appeared.

Many truly continuous processes of today were originally batch operations.

The Fourdrinier paper machine, patented in 1799, was one of the earliest of the industrial revolution era continuous manufacturing processes. It produced a continuous web of paper that was formed, pressed, dried and reeled up in a roll. Previously paper had been made in individual sheets.

Another early continuous processes was Oliver Evans’es flour mill (ca. 1785), which was fully automated.

Early chemical production and oil refining was done in batches until process control was sufficiently developed to allow remote control and automation for continuous processing. Processes began to operate continuously during the 19th century. By the early 20th century continuous processes were common.

SHUT-DOWNS

In addition to performing maintenance, shut downs are also when process modifications are performed. These include installing new equipment in the main process flow or tying-in or making provisions to tie-in sub-processes or equipment that can be installed while the process is operating.

Shut-downs of complicated processes may take weeks or months of planning. Typically a series of meetings takes place for co-ordination and planning. These typically involve the various departments such as maintenance, power, engineering, safety and operating units.

All work is done according to a carefully sequenced schedule that incorporates the various trades involved, such as pipe-fitters, millwrights, mechanics, laborers, etc., and the necessary equipment (cranes, mobile equipment, air compressors, welding machines, scaffolding, etc.) and all supplies (spare parts, steel, pipe, wiring, nuts and bolts) and provisions for power in case power will also be off as part of the outage. Often one or more outside contractors perform some of the work, especially if new equipment is installed.

Safety

Safety meetings are typically held before and during shutdowns. Other safety measures include providing adequate ventilation to hot areas or areas where oxygen may become depleted or toxic gases may be present and checking vessels and other enclosed areas for adequate levels of oxygen and insure absence of toxic or explosive gases. Any machines that are going to be worked on must be electrically disconnected, usually through the motor starter, so that it cannot operate. It is common practice to put a padlock on the motor starter, which can only be unlocked by the person or persons who is or are endangered by performing the work. Other disconnect means include removing couplings between the motor and the equipment or by using mechanical means to keep the equipment from moving. Valves on pipes connected to vessels that workers will enter are chained and locked closed, unless some other means is taken to insure that nothing will come through the pipes.

CONTINUOUS PROCESSOR (EQUIPMENT)

Continuous Production can be supplemented using a **Continuous Processor**. Continuous Processors are designed to mix viscous products on a continuous basis by utilizing a combination of mixing and conveying action. The Paddles within the mixing chamber (barrel) are mounted on two co-rotating shafts that are responsible for mixing the material. The barrels and paddles are contoured in such a way that the paddles create a self-wiping action between themselves minimizing buildup of product except for the normal operating clearances of the moving parts. Barrels may also be heated or cooled to optimize the mixing cycle. Unlike an extruder, the Continuous Processor void volume mixing area is consistent the entire length of the barrel ensuring better mixing and little to no pressure build up. The Continuous Processor works by metering powders, granules, liquids, etc. into the mixing chamber of the machine. Several variables allow the Continuous Processor to be versatile for a wide variety of mixing operations:

1. Barrel Temperature
2. Agitator speed
3. Fed rate, accuracy of feed
4. Retention time (function of feed rate and volume of product within mixing chamber)

Continuous Processors are used in the following processes:

- Compounding
- Mixing
- Kneading
- Shearing
- Crystallizing
- Encapsulating

The Continuous Processor has an unlimited material mixing capabilities but, it has proven its ability to mix:

- Plastics
- Adhesives
- Pigments
- Composites
- Candy
- Gum
- Paste
- Toners
- Peanut Butter
- Waste Products

WIKIPEDIA: "BATCH PROCESSING"

Read this source to explore the history and usefulness of batch processing in a manufacturing company. Consider how batch processing is used in today's manufacturing environments.

BATCH PROCESSING

Batch processing is the execution of a series of programs ("jobs") on a computer without manual intervention.

Jobs are set up so they can be run to completion without human interaction. All input parameters are predefined through scripts, command-line arguments, control files, or job control language. This is in contrast to "online" or interactive programs which prompt the user for such input. A program takes a set of data files as input, processes the data, and produces a set of output data files. This operating environment is termed as "batch processing" because the input data are collected into *batches* or sets of records and each batch is processed as a unit. The output is another *batch* that can be reused for computation.

BENEFITS

Batch processing has these benefits:

- It can shift the time of job processing to when the computing resources are less busy.
- It avoids idling the computing resources with minute-by-minute manual intervention and supervision.
- By keeping high overall rate of utilization, it amortizes the computer, especially an expensive one.
- It allows the system to use different priorities for interactive and non-interactive work.
- Rather than running one program multiple times to process one transaction each time, batch processes will run the program only once for many transactions, reducing system overhead.

HISTORY

Batch processing has been associated with mainframe computers since the earliest days of electronic computing in the 1950s. There were a variety of reasons why batch processing dominated early computing. One reason is that the most urgent business problems for reasons of profitability and competitiveness were primarily accounting problems, such as billing. Billing may conveniently be performed as a batch-oriented business process, and practically every business must bill, reliably and on-time. Also, every computing resource was expensive, so sequential submission of batch jobs on punched cards matched the resource constraints and technology evolution at the time. Later, interactive sessions with either text-based computer terminal interfaces or graphical user interfaces became more common. However, computers initially were not even capable of having multiple programs loaded into the main memory.

Batch processing is still pervasive in mainframe computing, but practically all types of computers are now capable of at least some batch processing, even if only for "housekeeping" tasks. That includes UNIX-based computers, Microsoft Windows, Mac OS X (whose foundation is the BSD Unix kernel), and even smartphones. Even as computing in general becomes more pervasive, batch processing is unlikely to lose its significance.

MODERN SYSTEMS

Batch applications are still critical in most organizations in large part because many common business processes are amenable to batch processing. While online systems can also function when manual intervention is not desired, they are not typically optimized to perform high-volume, repetitive tasks. Therefore, even new systems usually contain one or more batch applications for updating information at the end of the day, generating reports, printing documents, and other non-interactive tasks that must complete reliably within certain business deadlines.

Modern batch applications make use of modern batch frameworks such as Jem The Bee, Spring Batch or implementations of JSR 352 written for Java, and other frameworks for other programming languages, to provide the fault tolerance and scalability required for high-volume processing. In order to ensure high-speed processing, batch applications are often integrated with grid computing solutions to partition a batch job over a large number of processors, although there are significant programming challenges in doing so. High volume batch processing places particularly heavy demands on system and application architectures as well. Architectures that feature strong input/output performance and vertical scalability, including modern mainframe computers, tend to provide better batch performance than alternatives.

Scripting languages became popular as they evolved along with batch processing.

BATCH WINDOW

A *batch window* is "a period of less-intensive online activity", when the computer system is able to run batch jobs without interference from online systems.

Many early computer systems offered only batch processing, so jobs could be run any time within a 24-hour day. With the advent of transaction processing the online applications might only be required from 9:00 a.m. to 5:00 p.m., leaving two shifts available for batch work, in this case the batch window would be sixteen hours. The problem is not usually that the computer system is incapable of supporting concurrent online and batch work, but that the batch systems usually require access to data in a consistent state, free from online updates until the batch processing is complete.

In a bank, for example, so-called *end-of-day (EOD)* jobs include interest calculation, generation of reports and data sets to other systems, printing statements, and payment processing.

As requirements for online systems uptime expanded to support globalization, the Internet, and other business requirements the batch window shrank and increasing emphasis was placed on techniques that would require online data to be available for a maximum amount of time.

COMMON BATCH PROCESSING USAGE

Databases

Batch processing is also used for efficient bulk database updates and automated transaction processing, as contrasted to interactive online transaction processing (OLTP) applications. The extract, transform, load (ETL) step in populating data warehouses is inherently a batch process in most implementations.

Images

Batch processing is often used to perform various operations with digital images such as resize, convert, watermark, or otherwise edit image files.

Conversions

Batch processing may also be used for converting computer files from one format to another. For example, a batch job may convert proprietary and legacy files to common standard formats for end-user queries and display.

NOTABLE BATCH SCHEDULING AND EXECUTION ENVIRONMENTS

UNIX utilizes **cron** and **at** facilities to allow for scheduling of complex job scripts. Windows has a job scheduler. Most high-performance computing clusters use batch processing to maximize cluster usage.

The IBM mainframe z/OS operating system or platform has arguably the most highly refined and evolved set of batch processing facilities owing to its origins, long history, and continuing evolution. Today such systems commonly support hundreds or even thousands of concurrent online and batch tasks within a single operating system image. Technologies that aid concurrent batch and online processing include Job Control Language (JCL), scripting languages such as REXX, Job Entry Subsystem (JES2 and JES3),Workload Manager (WLM), Automatic Restart Manager (ARM), Resource Recovery Services (RRS), DB2 data sharing, Parallel Sysplex, unique performance optimizations such as HiperDispatch, I/O channel architecture, and several others.

UNIT 3 DISCUSSION, PART 2

#1
You have been hired as a consultant for a company that wants to manufacture high-end bicycles. The owners of the new business have designed a bike that can be sold to cyclists that choose to compete. They have asked you to provide an evaluation and recommendation of the best manufacturing process. Use the information from this unit to write a recommendation to the owners. Include support for your choices.

Unit 3 Activity and Grading Rubric

In this activity, you will continue working on your operations management plan by addressing how the current state of the economy will affect your business, and applying the Transformation Model that you learned about in this unit.

Learning Outcome

Apply the "TransformationModel" as a construct for understanding the relationship between the inputs, processes, and outputs of an organization.

Specifications:

- 2-3 page paper
- Created in a Word document
- Follows APA, 6th edition formatting
- Includes a Reference page for cited sources

Instructions: You will continue on with your Operations Management plan. In this section of the activity, you will incorporate the Transformation Model. Examine the concept from the readings in this unit, and determine how this model will assist you in setting strategy for the operation of your company whether it be a service or manufacturing based organization.

Link: Prentice Hall, Inc.: "e-Business Plan: Operations"

Instructions: Please read the article linked above. The article's sections on "Writing an Operations Plan" and "Content of an Operations Plan" can be used as a guide for developing your own operations management plan. You DO NOT have to use the sections/elements presented under each heading, but the more you can address, the more developed you final plan will be.

Terms of Use: Please respect the copyright and terms of use for the webpage linked above.

For this activity, you will write a 2–3 page paper describing the ways in which your company will utilize logistics to help promote aspects of the "informal economy" (i.e. job creation/growth, salaries/wages or economic benefits to the local and/or surrounding communities). Use at least 4 scholarly sources to answer the following questions as you compose your paper:

1. How might the current economic situation with the job market, wage

rate, or other economic factor impact your organization in a positive or negative sense?

2. Will current economic conditions impact the ways in which you will transform your initial operations to reach the overall operation management plan goal? For example, will economic conditions require you to change your source of supply? The criteria you desire for hiring employees? Or even the market you intend to serve?

Please score your paper or have a friend score your paper using the following “rubric,” or “scoring guide.” The levels will equate to the following
letter grades:
4 = A; 3 = B; 2 = C; 1 = D; and 0 = F

Level	Criterion
	Research and Documentation (40%)
4	The paper should utilize references from peer-reviewed/scholarly sources to address the activity questions. The paper's research should reflect the use of peer-reviewed/scholarly publications. A minimum of four scholarly/peer-reviewed publications should be used to support your content. References should come from scholarly sources (i.e. textbooks, scholarly articles, etc.). Any in-text citations MUST be cited in APA format using the APA Manual 6th edition. You should also include a References page, also in APA format, at the end of your paper to cite any sources used.
3	The paper uses at least three scholarly sources to support your content, but it does not meet the minimum requirement for 4 sources.
2	Three or more popular sources (i.e. newspapers, internet sites, magazines, etc.) make up a majority of the references to support your content. The paper lacks credible, scholarly sources and does not meet the minimum number of sources required.
1	The paper includes one or two sources. The paper lacks the use of credible, scholarly sources and may focus on using popular sources. The number of sources used does not meet the minimum requirement (4 sources) and the resources used may not fully support the content of your paper.
0	The paper fails to cite referenced sources, or does not include any research or sources to support ideas. The paper is based off of non-original content.
	Analysis and Argument (40%)
4	Your paper addresses the questions in the instructions with the use of supporting evidence and specific details and explanation. You effectively address the following:1. How might the current economic situation with the job market, wage rate, or other economic factor impact your organization in a positive or negative sense? 2. Will current economic conditions impact the ways in which you will transform your initial operations to reach the overall operation management plan goal? For example, will economic conditions require you to change your source of supply? The criteria you desire for hiring employees? Or even the market you intend to serve?
3	The content addresses only some of the questions presented in the instructions section and reflects minimal original thought and /or critical analysis relative to the business.
2	The content is vague and is weakly supported by researched evidence. The essay lacks critical analysis relative to the business.
1	The content does not address the required elements; ideas presented are not supported by research or critical analysis.
0	There is a lack of critical analysis for the operation management plan, and/or the essay does not address the business content from the Unit 1 Activity.
	Grammar/Style (15%)
4	The content contains a maximum of two grammatical, citation, and punctuation errors. The ideas are concise and presented in a logical manner that is easy for the reader to follow.
3	The content contains three or four grammatical, citation, punctuation, and/or spelling errors. The sentence structure flows in a concise, logical manner.
2	The paper contains more than four grammatical, citation, punctuation and/or spelling errors that distract the reader from the comprehension of ideas being presented.

1	The paper demonstrates poor writing skills, reflected by lack of syntax and proper grammar, which makes ideas difficult to communicate. Ideas are not presented in a logical manner that is easy to follow.	
0	The paper contains numerous grammatical, citation, punctuation, and/or spelling errors.	
	Format (5%)	
4	The paper should properly formatted (paragraph style, margins, etc.), using the APA Manual, 6th edition. The content is typed in MS Word format, labeled with the student's name and the activity title/unit number, and a reference section to cite any outside sources used.	
3	The paper meets most of the requirements for formatting, using the APA Manual, 6th edition, though may contain some errors.	
2	The paper lacks proper formatting, based on the APA Manual, 6th edition, and it may use another style of formatting (i.e. MLA, Chicago, etc.).	
1	The paper is typed in a format other than MS Word. A style of formatting other than APA may be used, or there are numerous formatting errors that distract the reader's comprehension.	
0	The formatting does not comply with the APA Manual, 6th edition and is not created in MS Word.	

UNIT 4: QUALITY MANAGEMENT

Unit 4: Quality Management

Quality management is a primary concern in operations departments. Though all employees and managers should be concerned with maintaining quality, most firms host a team dedicated to ensuring the quality of production. Quality management can come in any number of different forms. Quality control usually involves the random sampling of products coming off the line (with the goal of ensuring that all products are up to standards). This may be for compliance reasons (such as in meat production) or for quality service (such as checking the seams in the leather of a Rolls Royce car). Other quality managers are concerned with the quality of the production process itself: are all employees being productive? Is there a bottleneck in the production process? These focuses on efficiency are especially important for products with low margins. In this unit, you will learn about a few of the pioneers in total quality management as well as the processes used to control quality in manufacturing and service organizations.

Unit 4 Learning Outcomes

Upon successful completion of this unit, you will be able to:

- explain quality management and apply quality management principles to continuous improvement in operations management;
- define total quality management;
- describe W. Edwards Deming's impact on quality management;
- evaluate the operational costs associated with a decision to focus on continuous quality improvement versus maintenance of the status quo; and
- explain how statistical process control assesses process variations to measure quality.

4.1: Productivity and Total Quality Management

THE COST OF QUALITY: A SELF-CHECK EXERCISE

By
John Stewart

In many ways, quality is very expensive. There are multiple categories of costs associated with quality management. Understanding these costs is the first step in designing an argument of why the investment is an important one. Complete this assessment of your understanding of Cost of Quality concepts. The activity is self-graded.

In this interactive object, learners check their knowledge of concepts related to the cost of ensuring quality in manufacturing as they relate to the categories of appraisal, prevention, internal failures, and external failures.

Activity Link: https://www.wisc-online.com/learn/career-clusters/business-management-and-administration/qlt1904/the-cost-of-quality-a-self-check-exercise

QUALITY MANAGEMENT SERVICES: "WHAT IS QUALITY MANAGEMENT SYSTEM?"

This video describes the integrated system necessary to create a quality management system within an organization. Just using the word quality can be confusing for managers. Understanding what quality is and how it should be approached is challenging. Designing a systematic way to approach management of quality is fundamentally important to successfully controlling quality.

One or more interactive elements has been excluded from this version of the text. You can view them online here:
https://pressbooks.nscc.ca/operationsmanagement2/?p=189#oembed-1

BOUNDLESS: *BUSINESS*, "CHAPTER 10, SECTION 2, PART 2: TQM"

Read this page. This page explores the nature of total quality management (TQM) and the necessity of use in the operations environment. TQM is one of the bedrock approaches to quality management. You will see many of the components of TQM in other quality management approaches. This approach is important because of the focus on a continuous cycle of improving the quality of a product, service, or process.

TQM

Total quality management (TQM) is an integrative philosophy of management for continuously improving the quality of products and processes.

LEARNING OBJECTIVE

- Explain the principles of Total Quality Management (TQM)

KEY POINTS

- TQM functions on the premise that the quality of products and processes is the responsibility of everyone who is involved with the creation or consumption of the goods or services offered by an organization.
- Satisfying the customer involves making sure both internal and external customers are happy.
- The internal suppliers are the subordinates who answer to a particular supervisor. Satisfying them involves giving them the tools and motivation they need to do their jobs.
- It is important to go beyond satisfaction, making the customer – and supplier – feel important and valued, and part of the process.
- "Lean" focuses on eliminating the wasteful use of time, energy or resources, and instead focusing activities completely on the creation of value.
- The focus of the Six Sigma management strategy is to reduce defect by minimizing variation in processes.

TERMS

- **poka-yoke**: A methodology of using low-cost techniques to error-proof production processes.
- **Total Quality Management (TQM):** A strategic approach to management aimed at embedding awareness of quality in all organizational processes.

EXAMPLE

- 'Lean' is based on the Toyota Production System, which aimed to minimize overburden, inconsistency and waste. It was developed between 1948-1975, and was a precursor to lean manufacturing.

FULL TEXT

Total Quality Management (TQM) is an integrative philosophy of management for continuously improving the quality of products and processes.

Overview

TQM functions on the premise that the quality of products and processes is the responsibility of everyone involved in the creation or consumption of the goods or services the organization offers. TQM capitalizes on the involvement of management, the workforce, suppliers, and even customers in order to meet or exceed customer expectations.

Considering the practices of TQM as discussed in six empirical studies, Cua, McKone, and Schroeder (2001) identified nine common TQM practices:

1. Cross-functional product design;
2. Process management;
3. Supplier quality management;
4. Customer involvement;
5. Information and feedback;
6. Committed leadership;
7. Strategic planning;
8. Cross-functional training; and
9. Employee involvement.

Basic Principles of Total Quality Management

The basic principles for the Total Quality Management philosophy of doing business are to satisfy the customer, satisfy the supplier, and continuously improve the business processes.

Satisfy the Customer

The first, and major, TQM principle is to satisfy the customer–the person who pays for the product or service. Customers want to get their money's worth from a product or service they purchase.

Satisfy the Users: If the user of the product is different than the purchaser, then both the user and customer must be satisfied, although the person who pays gets priority.

Company Philosophy: A company that seeks to satisfy the customer by providing them value for what they buy and the quality they expect will get more repeat business, referral business, and reduced complaints and service expenses. Some top companies not only provide quality products but also give extra service to make their customers feel important and valued.

Internal Customers: Within a company, a worker provides a product or service to his or her supervisors. If the person has any influence on the wages the worker receives, that person can be thought of as an internal customer. A worker should have the mindset of satisfying internal customers in order to keep his or her job and to get a raise or promotion.

Chain of Customers:Often in a company, there is a chain of customers–each improving a product and passing

it along until it is finally sold to the external customer. Each worker must not only seek to satisfy the immediate internal customer, but must also look up the chain to try to satisfy the ultimate customer.

Satisfy the Supplier

A second TQM principle is to satisfy the supplier, which is the person or organization from whom you are purchasing goods or services.

External Suppliers: A company must look to satisfy their external suppliers by providing them with clear instructions and requirements and then paying them fairly and on time. It is in the company's best interest that its suppliers provide quality goods or services if the company hopes to provide quality goods or services to its external customers.

Internal Suppliers: A supervisor must try to keep workers happy and productive by providing good task instructions, the tools they need to do their job, and good working conditions. The supervisor must also reward the workers with praise and good pay.

Get Better Work: The reason to do this is to get more productivity out of the workers, as well as to keep the good workers. An effective supervisor with a good team of workers will certainly satisfy his or her internal customers.

Empower Workers: One area of satisfying the internal suppler is by empowering the workers. This means allowing them to make decisions on things that they can control. This not only takes the burden off the supervisor, but it also motivates these internal suppliers to do better work.

Continuous Improvement

The third principle of TQM is continuous improvement. You can never be satisfied with the method used, because there always can be improvements. The competition is always improving, so it is necessary to strive to keep ahead of the game.

Work Smarter, Not Harder: Some companies have tried to improve by making employees work harder. This may be counterproductive, especially if the process itself is flawed. For example, trying to increase worker output on a defective machine may result in more defective parts. Examining the source of problems and delays and then solving those problems is what works best. Often, the process has bottlenecks that are the real cause of the problem. Those are what should be removed.

Worker Suggestions: Workers are often a source of continuous improvements. They can provide suggestions on how to improve a process and eliminate waste or unnecessary work.

Quality Methods: There are also many quality methods, such as just-in-time production, variability reduction, and poka-yoke, that can improve processes and reduce waste.

BOUNDLESS: *BUSINESS*, "CHAPTER 10, SECTION 2, PART 1: PHILOSOPHIES"

Read this description of the quality principles. These principles are important to the focus on and ability to lead an organization toward a culture that embraces continual quality improvement.

PHILOSOPHIES

Quality management adopts a number of management principles that can be used to guide organizations towards improved performance.

LEARNING OBJECTIVE

- Recognize how top management can improve quality performance

KEY POINTS

- There are eight primary quality management principles.
- The principles are the basis of the ISO 9001:2008 quality management system standard.
- One of the permanent quality objectives of an organization should be the continual improvement of its overall performance.

TERMS

- **value**: The degree of importance you give to something.
- **ISO 9001:2008**: The ISO 9000 family of standards are related to quality management systems and designed to help organizations ensure that they meet the needs of customers and other stakeholders while meeting statutory and regulatory requirements related to the product.
- **Quality Management**: Process of ensuring that an organization or product is consistent. It can be considered to have four main components: quality planning, quality control, quality assurance, and quality improvement. Quality management is focused not only on product/service quality, but also the means to achieve it.

EXAMPLE

- In the 1950s and 1960s, Japanese goods were synonymous with cheapness and low quality but over time, their quality initiatives began to be successful, with Japan achieving very high levels of quality in products from the 1970s onward. For example, Japanese cars regularly top the J.D. Power customer satisfaction ratings. In the 1980s, Deming was asked by Ford Motor Company to start a quality initiative after they realized that they were

falling behind Japanese manufacturers. A number of highly successful quality initiatives have been invented by the Japanese (see for example, on this page: Genichi Taguchi, QFD, Toyota Production System. Many of the methods not only provide techniques but also have associated quality culture (i.e., people factors). These methods are now adopted by the same western countries that decades earlier derided Japanese methods.

FULL TEXT

The Principles of Quality Management

Quality management adopts a number of management principles that can be used bytop management to guide their organizations towards improved performance. The principles include:

- Customer focus: Since the organizations depend on their customers, they should understand current and future customer needs, should meet customer requirements, and try to exceed the expectations of customers. An organization attains customer focus when all people in the organization know both the internal and external customers and also what customer requirements must be met to ensure that both the internal and external customers are satisfied.
- Leadership: Leaders of an organization establish unity of purpose and direction of it. They should go for creation and maintenance of such an internal environment, in which people can become fully involved in achieving the organization's quality objective.
- Involvement of people: People at all levels of an organization are the essence of it. Their complete involvement enables their abilities to be used for the benefit of the organization.
- Process approach: The desired result can be achieved when activities and relatedresources are managed in an organization as process.
- System approach to management: An organization's effectiveness and efficiency in achieving its quality objectives are contributed by identifying, understanding, and managing all interrelated processes as a system.
- Continual improvement: One of the permanent quality objectives of an organization should be the continual improvement of its overall performance.
- Factual approach to decision making: Effective decisions are always based on the data analysis and information.
- Mutually beneficial supplier relationships: Since an organization and its suppliers are interdependent, therefore, a mutually beneficial relationship between them increases the ability of both to add value.

These eight principles form the basis for the quality management system standard ISO 9001:2008.

BOUNDLESS: *BUSINESS*, "CHAPTER 10, SECTION 2, PART 3: QUALITY INSPECTIONS AND STANDARDS"

Read this section to better understand the usefulness of quality audits in managing to quality standards. Quality audits are an important part of the quality process. Companies ensure that they are producing a quality product or service by integrating the ISO standards into processes. To ensure that all parts of operations is compliant audits are conducted.

QUALITY INSPECTIONS AND STANDARDS

Companies ensure the quality of products and services by adhering to ISO standards and performing quality audits to ensure compliance.

LEARNING OBJECTIVE

- Recognize the ISO's role in ensuring quality standards

KEY POINTS

- The Quality Management System (QMS) standards were created by the International Organization for Standardization (ISO) in 1987, and are reviewed and updated every few years. These standards are used to certify the processes and systems of an organization, but not the product or service itself.
- In 1994 three major standards were released as part of the ISO 9000:1994 series. Major revisions were made in 2008.
- A quality audit is the systematic examination of a quality system, and is carried out by internal or external auditors. It is a key element in ISO 9001 standards.
- Since 2008, the focus of quality audits has shifted from simply procedural adherence to measuring the effectiveness of actual QMS's.

TERMS

- **ISO 14000:** a set of standards related to environmental management designed to help

organizations reduce the negative environmental effect of their operations, meet legal requirements, and continually improve

- **ISO 9000**: a set of standards related to quality management systems and designed to help organizations ensure that they meet the needs of customers and other stakeholders while meeting statutory and regulatory requirements related to the product
- **Quality Management System (QMS):** The organizational structure, procedures, processes, and resources needed to implement quality management.
- **Quality Audit**: The process of systematic examination of a quality system carried out by an internal or external quality auditor or audit team. It is an important part of an organization's quality management system and is a key element in the ISO quality system standard, ISO 9001.
- **International Organization for Standardization (ISO):** An international standard-setting body composed of representatives from various national standards organizations. Founded on February 23, 1947, the organization promulgates worldwide proprietary, industrial, and commercial standards.

EXAMPLE

- Quality audits and adherence to ISO standards are not just for private corporations; the US Food and Drug Administration requires that medical devices undergo quality auditing, and several countries require quality audits of their educational systems.

FULL TEXT

Quality Standards

The International Organization for Standardization (ISO) created the Quality Management System (QMS) standards in 1987. They were the ISO 9000:1987 series of standards, comprising ISO 9001:1987, ISO 9002:1987, and ISO 9003:1987; which were applicable in different types of industries, based on the type of activity or process (designing, production, or service delivery).

The standards are reviewed every few years by the ISO. The version in 1994 was called the ISO 9000:1994 series; consisting of the ISO 9001:1994, 9002:1994 and 9003:1994 versions.

A major revision occurred in 2008, and the series was called ISO 9000:2000 series. The ISO 9002 and 9003 standards were integrated into one single certifiable standard:ISO 9001:2008. After December 2003, organizations holding ISO 9002 or 9003 standards had to complete a transition to the new standard.

The ISO 9004:2009 document gives guidelines for performance improvement over and above the basic standard

(ISO 9001:2000). This standard provides a measurement framework for improved quality management, similar to and based upon the measurement framework for process assessment.

The Quality Management System standards created by ISO are meant to certify the processes and the system of an organization, not the product or service itself. ISO 9000 standards do not certify the quality of the product or service.

In 2005 the International Organization for Standardization released a standard, ISO 22000, meant for the food industry. This standard covers the values and principles of ISO 9000 and the HACCP standards. It gives one single integrated standard for the food industry and is expected to become more popular in the coming years in the industry.

ISO has also released standards for other industries. For example, Technical Standard TS 16949 defines requirements in addition to those in ISO 9001:2008 specifically for the automotive industry.

ISO has a number of standards that support quality management. One group describes processes (including ISO/IEC 12207 & ISO/IEC 15288), and another describes process assessment and improvement (ISO 15504).

Quality Audits

A quality audit is the process of systematic examination of a quality system carried out by an internal or external quality auditor or audit team. It is an important part of organization's quality management system and is a key element in the ISO quality system standard, ISO 9001.

Quality audits are typically performed at predefined time intervals and ensure that the institution has clearly defined internal system monitoring procedures linked to effective action. This can help determine if the organization complies with the defined quality system processes and can involve procedural or results-based assessment criteria.

With the upgrade of the ISO 9000 series of standards from the 1994 to 2008 series, the focus of the audits has shifted from purely procedural adherence towards measurement of the actual effectiveness of the Quality Management System (QMS) and the results that have been achieved through the implementation of a QMS.

Audits are an essential management tool to be used for verifying objective evidence of processes, to assess how successfully processes have been implemented, for judging the effectiveness of achieving any defined target levels, to provide evidence concerning reduction and elimination of problem areas.

For the benefit of the organisation, quality auditing should not only report non-conformance and corrective actions, but also highlight areas of good practice. In this way, other departments may share information and amend their working practices, which contributes to continual improvement.

Quality audits can be an integral part of compliance or regulatory requirements. One example is the US Food and Drug Administration, which requires quality auditing to be performed as part of its Quality System Regulation (QSR) for medical devices (Title 21 of the US Code of Federal Regulations part 820).

Several countries have adopted quality audits in their higher education system (including New Zealand, Australia, Sweden, Finland, Norway, and the USA). Initiated in the UK, the process is focused primarily on procedural issues rather than on the results or the efficiency of a quality system implementation.

Audits can also be used for safety purposes. Evans and Parker (2008) describe auditing as one of the most powerful safety monitoring techniques and "an effective way to avoid complacency and highlight slowly deteriorating conditions," especially when the auditing focuses not just on compliance but effectiveness.

The processes and tasks that a quality audit involves can be managed using a wide variety of software and self-assessment tools. Some of these relate specifically to quality in terms of fitness for purpose and conformance to standards, while others relate to quality costs or (more accurately) to the cost of poor quality. In analyzing quality costs, a cost of quality audit can be applied across any organization rather than just to conventional production or assembly processes.

BOUNDLESS: *BUSINESS*, " CHAPTER 10, SECTION 2, PART 4: QUALITY CONTROL"

Read this section on the quality control process. Quality control is focused on identifying issues with quality and initiating corrective action. Quality control processes are vital to a healthy quality control function.

QUALITY CONTROL

Quality control is a process that evaluates output against a standard and takes corrective action when output doesn't meet that standard.

LEARNING OBJECTIVE

- Discuss the role of quality control in business

KEY POINTS

- The purpose of quality control is to make sure that certain processes perform to a company's set standards.
- Quality control in relation to customers involves the continuous act of making sure products, designed and manufactured, are produced to meet and exceed customer needs.
- Quality should be measured differently for products and services and judged by their own set of dimensions.
- Controls include product inspection, where every product is visually examined, often with a stereo microscope to perceive fine detail before the product is sold into the external market.
- Responsibility for overall quality lies with top management. Top management must establish strategies, institute programs for quality, and motivate managers and workers.

TERMS

- total quality managementA strategic approach to management aimed at embedding awareness of quality in all organizational processes.
- quality controlA control, such as inspection or testing, introduced into an industrial or business process to ensure quality.

- organizational cultureOrganizational culture is the collective behavior of humans who are part of an organization and the meanings that the people attach to their actions.

EXAMPLE

- Controls include product inspection, where every product is examined visually. Inspectors will be provided with lists and descriptions of unacceptable product defects such as cracks or surface blemishes.

FULL TEXT

Quality can be thought of as the degree to which performance of a product or service meets or exceeds expectations. Quality control is a process that evaluates outputagainst a standard and takes corrective action when output doesn't meet these predetermined standards. Therefore, quality control in relation to customers would be the continuous act of making sure products, designed and manufactured, are produced to meet and exceed the needs of customers. For contract work, particularly work awarded by government agencies, quality control issues are among the top reasons for not renewing a contract.

This approach places an emphasis on three aspects:

- Elements such as controls, job management, defined and well-managed processes, performance and integrity criteria, and identification of records
- Competence, such as knowledge, skills, experience, and qualifications
- Soft elements, such as personnel integrity, confidence, organizational culture,motivation, team spirit, and quality relationships

Controls include product inspection, where every product is examined visually, often using a stereo microscope for fine detail before the product is sold on the external market. Inspectors will be provided with lists and descriptions of unacceptable product defects such as cracks or surface blemishes.

An emphasis on quality control heightened during World War II. At that time quality control evolved to quality assurance and is now better known as a Strategic Approach, a tool for improving not only products but also processes and services. Quality should be measured differently for products and services, and judged by their own set of dimensions. Responsibility for overall quality lies with top management. Top management must establish strategies, institute programs for quality, and motivate managers and workers. Most of the time, managers aim to improve or maintain the quality of an organization as a whole; this is referred to as Total Quality Management(TQM). TQM involves a continual effort for quality improvement by everyone in an organization. The entire supply chain must be involved for an organization to meet and exceed goals of quality control.

IDS355: OPERATIONS MANAGEMENT WIKISPACE: "CHAPTER 9: MANAGEMENT OF QUALITY"

Read this chapter summary. Successful management of quality requires an understanding of the dimensions of product or service quality that add utility for your customers. Pay particular attention to the three awards that are given to recognize outstanding quality.

CHAPTER 9: MANAGEMENT OF QUALITY

Chapter 9 focuses on the importance of quality. It discusses various concepts and tools that can be used to achieve high quality and continuous improvement. Broadly defined, **quality** refers to the ability of a product or service to consistently meet or exceed customer requirements or expectations. Different customers will have different expectations, so a working definition of quality is customer-dependent. When discussing quality one must consider design, production, and service. In a culmination of efforts, it begins with careful assessment of what the customers want, then translating this information into technical specifications to which goods or services must conform. The specifications guide product and service design, process design, production of goods and delivery of services, and service after the sale or delivery.

Some of these consequences of poor quality include loss of business, liability, decreased productivity, and increased costs. However, good quality has its own costs, including prevention, appraisal, and failure. A recent and more effective approach is discovering ways to prevent problems, instead of trying to fix them once they occur.This will ultimately decrease the cost of good quality in the long run.

There are several costs associated with quality:

Appraisal costs – costs of activities designed to ensure quality or uncover defects
Prevention costs – costs of prevention defects from occurring
Failure costs – Costs caused by defective parts or products or by faulty services
Internal failures – failures discovered during production
External failures – failures discovered after delivery to the customer
Return on quality (ROQ) – an approach that evaluates the financial return of investments in quality

Chapter 9 discusses key contributors of quality management and several awards for companies who possess traits of excellent quality management. This chapter defines total quality management (TQM) as a philosophy that involves everyone in the organization in a continual effort to improve quality and achieve customer satisfaction. This philosophy concentrates on continuous improvement and quality at the source. Six sigma is a concept that stresses improving quality, reducing costs, and increasing customer satisfaction. Lastly, this chapter gives several examples of quality tools, which include flowcharts, check sheets, histograms, pareto analysis, scatter diagrams, controls charts, and cause-and-effect diagrams.

Successful management of quality requires that managers have insights on various aspects of quality. These include defining quality in operational terms, understanding the costs and benefits of quality, recognizing the consequences of poor quality and recognizing the need for ethical behavior.

Understanding dimensions that customers use to judge the quality of a product or service helps organizations meet customer expectations.

Dimensions of Product Quality

- **Performance**– *main characteristics of the product*
- **Aesthetics**– *appearance, feel, smell, taste*
- **Special features**– *extra characteristics*
- **Conformance**– *how well the product conforms to design specifications*

• **Reliability**– *consistency of performance*
• **Durability**– *the useful life of the product*
• **Perceived quality**– *indirect evaluation of quality*
• **Service-ability**– *handling of complaints or repairs*

Dimensions of Service Quality

• **Convenience**– *the availability and accessibility of the service*
• **Reliability**– *ability to perform a service dependably, consistently, and accurately*
• **Responsiveness**– *willingness to help customers in unusual situations and to deal with problems*
• ***Time–****the speed with which the service is delivered*
• ***Assurance–****knowledge exhibited by personnel and their ability to convey trust and confidence*
• ***Courtesy–****the way customers are treated by employees*
• ***Tangibles–****the physical appearance of facilities, equipment, personnel, and communication materials*
• ***Consistency–****the ability to provide the same level of good quality repeatedly*

The Determinants of Quality

Quality of Design – intention of designers to include or exclude features in a product or service. The starting point of producing quality in products begins in the "design phase". Designing decisions may involve product or service size, shape and location. When making designs, designers must keep in mind customer wants, production or service capabilities, safety and liability, costs, and other similar considerations.

Quality of conformance- refers to the degree to which goods and services conform to the intent of the designer. Quality of conformance can easily be affected by factors like: capability of equipment used, skills, training, and motivation of workers, extent to which the design lends itself to production, the monitoring process to assess conformance, and the taking of corrective action.

Ease of use – refers to the ease of usage of the product or services for the customers. The term "ease of use" refers to user instructions. Designing a product with "ease of use" increases the chances that the product will be used in its intended design and it will continue to function properly and safely. Without ease of use, companies may lose customers, face sales returns, or legal problems from product injuries. Ease of use also applies to services. Manufacturers must make sure that directions for unpacking, assembling, using, maintaining, and adjusting the product are included. Directions for "What to do when something goes wrong" should also be included. Ease of use makes a consumer very happy and can help retain customers.

Services offered to the customer after delivery. There will be times when products may fail or problems with usage may occur. This is when "Service after delivery" is important through recall and repairs of the product, adjustment, replacement or buys back, or reevaluation of a service.

Having good quality is a **competitive advantage** against others who offer similar products or services in the marketplace.

In addition, good quality can:

- **Raise Company's Reputation**
- **Rationalize Premium Prices**
- **Decrease Liability Costs**
- **Increase Productivity**
- **Increase Customer Loyalty**
- **Increase Customer Satisfaction**

*Consequence's include***:**

- **loss of business and existing market share**

- **legal liability**
- **lack of productivity**
- **increased costs**

Failure to meet quality standards can damage a company's image, reputation or lead to external criticism. In the manufacturing field, the quality of raw materials or equipment can affect the whole manufacturing process. If defects or poor quality are not detected on time, companies may face various costs to solve problems. Discovering and fixing problems on time reduces costs. Quality costs include prevention (prevent defects from occurring by planning system, training and control procedures), appraisal (ensure quality or uncover defects by inspections, testings and audits), and failure (caused by defective parts, products or by faulty services discovered during the production process – internal or after delivery to the customer – external).

Three well- known awards given annually to recognize quality are:

1. Baldrige Award (given by the U.S. government)

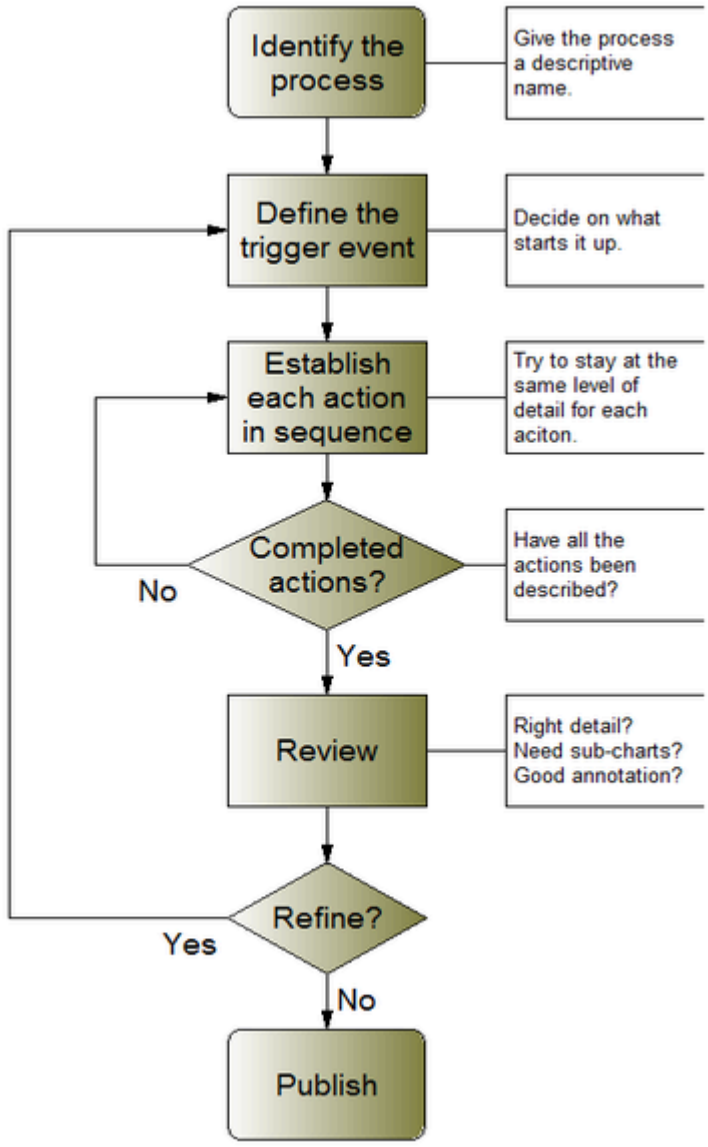
2. European Quality Award

3. Deming Prize (established by the Japanese).

There are also worldwide known quality certifications like ISO 9000 (which is a set of international standards on quality management and quality assurance, critical to international business) and ISO 14000 (a set of international standards for assessing a company's environmental performance).

Total quality management (TQM) is a constant pursuit of quality that involves everyone in an organization. The driving force is customer satisfaction; a key philosophy is continuous improvement. The Japanese use the term *kaizen* to refer to continuous improvement. Training of managers and workers in quality concepts, tools, and procedures is an important aspect of TQM. Teams are an integral part of TQM. Two major aspects of the TQM approach are problem solving and process improvement. Six-sigma programs are a form of TQM. A six-sigma improvement project typically has one or more objectives such as: reducing delivery time, increasing productivity, or improving customer satisfaction. They emphasize the use of statistical and management science tools on selected projects to achieve business results. There are *seven basic quality tools* that an organization can use for problem solving and process improvements. A flowchart is a visual representation of a process. As a problem-solving tool, a flowchart can help investigators in identifying possible points in a process where problems occur. The diamond shapes in the flowchart represent decision points in the process, and the rectangular shapes represent procedures.

They show the direction of "flow" of the steps in the process.arrows

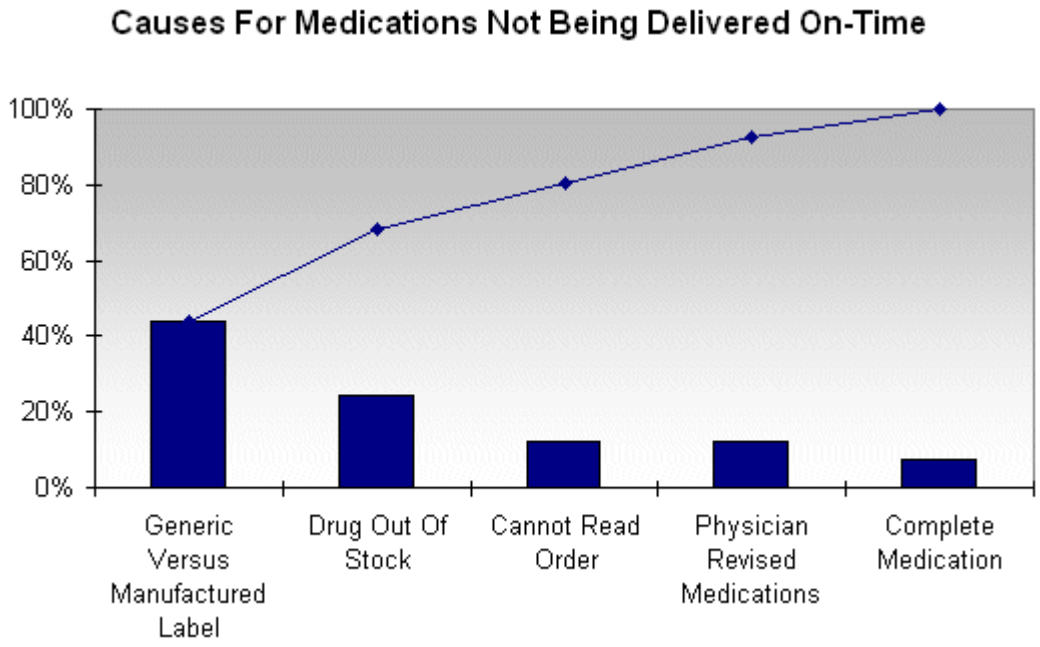


A check sheet is a simple tool frequently used for problem identification. Check sheets provide a format that enables users to record and organize data in a way that facilitates collection and analysis.

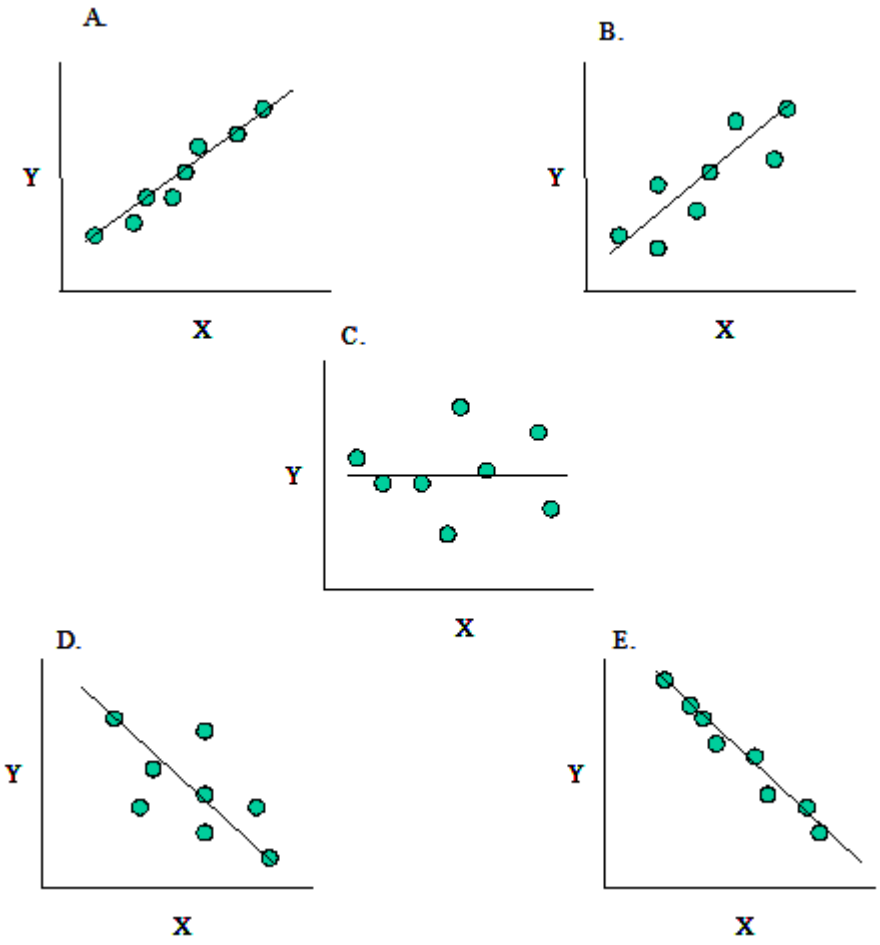
		Type of defect					
Day	Time	Smeared print/other	Out of registration	Paper jam	Uneven inking	Blank print	Total
M	7-8	III	IIII				7
	8-9	I	II	III	IIII		10
	9-10		III				3
	10-11		I	I			2
	11-12						0
	1-2		I	III			4
	2-3				I		1
Total		4	11	7	5	0	27

A histogram can be useful in getting a sense of the distribution of observed values. It is a chart of an empirical frequency distribution.

Pareto analysis is a technique for focusing attention on the most important problem areas. The idea is to classify the cases according to degree of importance, and focus on resolving the most important, leaving

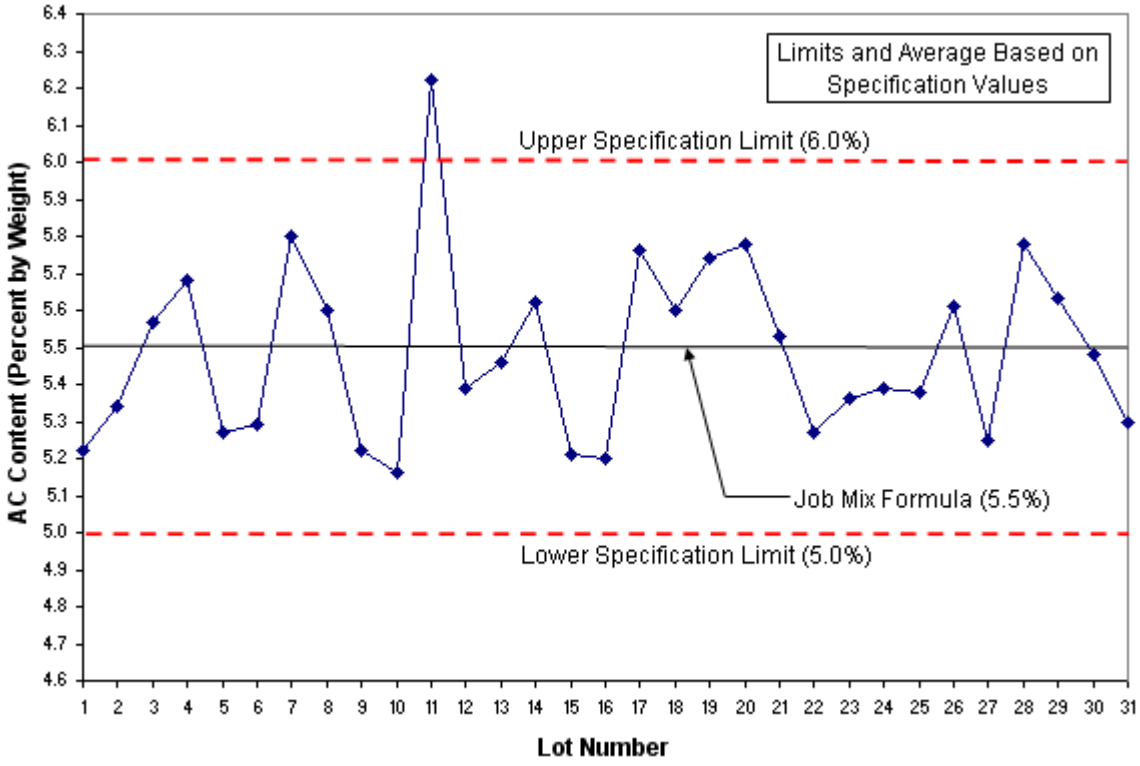


the less important. A scatter diagram can be useful in deciding if there is a correlation between the values of two variables. It is a graph that shows the degree and direction of relationship between two variables. A correlation may

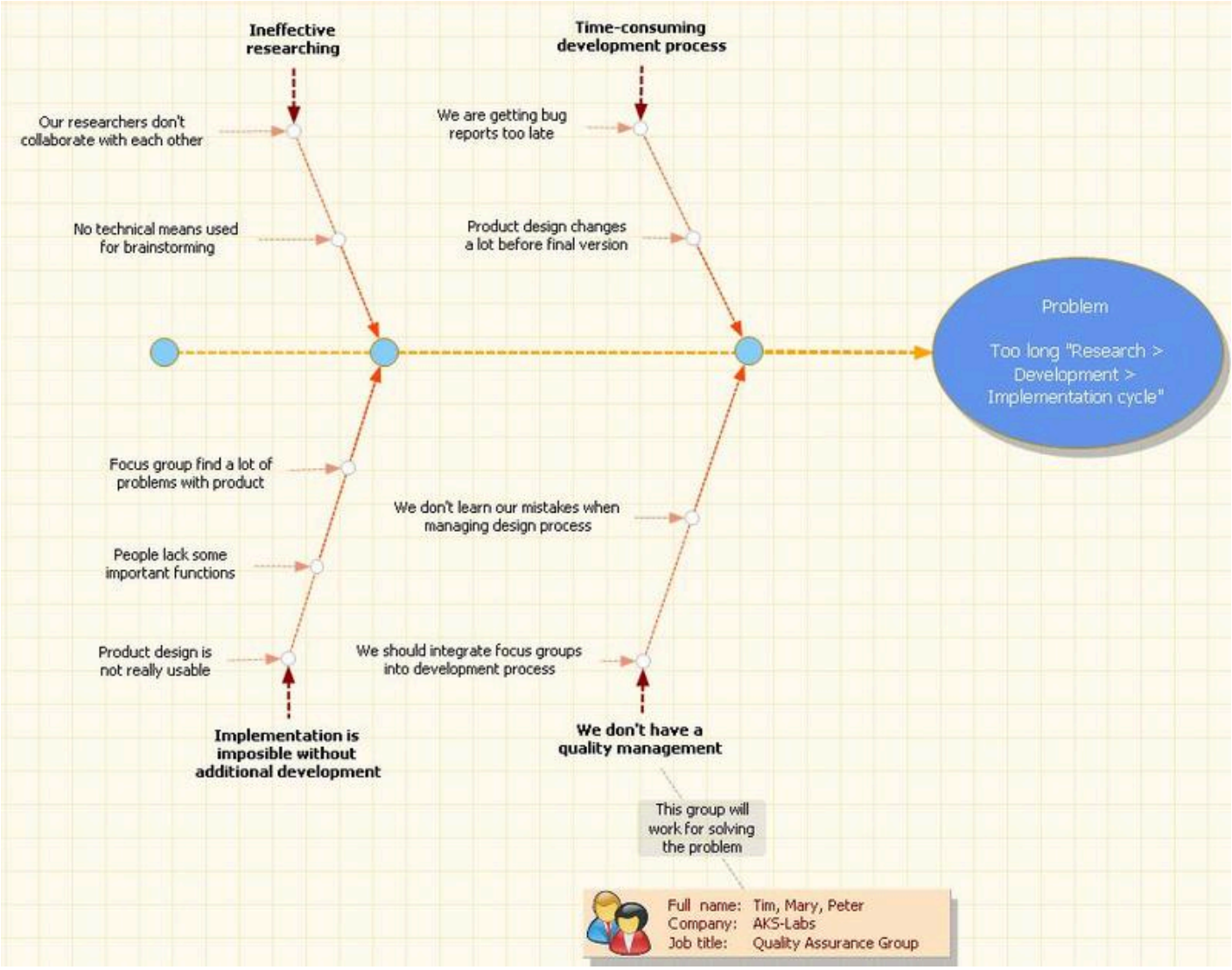


point to a cause of a problem. A control chart can be used to monitor a process to see if the process output is random. It can help detect

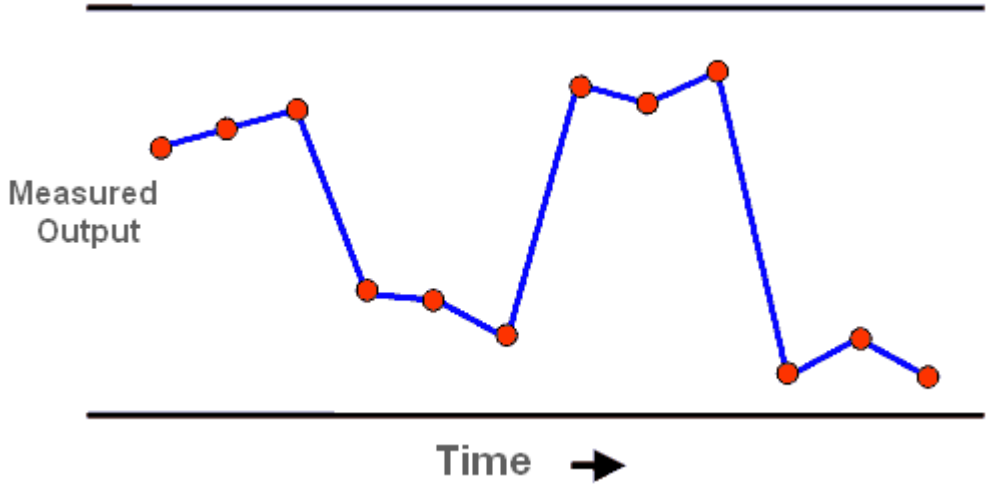
the presence of correctable causes of variation. It is a statistical chart of time-ordered values of sample



statistic. A cause-and-effect diagram offers a structured approach to the search for the possible cause(s) of a problem. It is also known as a *fishbone diagram* because of its shape, or an Ishikawa diagram, after the Japanese professor who developed the approach to aid workers overwhelmed by the number of possible sources of problems when problem solving. This helps to organize problem-solving efforts by identifying categories of factors that might be causing problems.



A run chart can be used to track the values of a variable over time. This can aid in identifying trends or other patterns that may be occurring.



Important People in Quality

• Walter Shewart

– "father of statistical quality control"
– Control charts
– Variance reduction
• **W. Edwards Deming**
– Special vs. common cause variation
– The 14 points
— **Deming Prize**– Prize estabolished by the Japanese and awarded annually to firms that distinguish themselves with quality management programs.
• **Joseph Juran**
– *Quality Control Handbook*, 1951
– Viewed quality as fitness-for-use
– Quality trilogy– quality planning, quality control, quality improvement
• **Armand Feigenbaum**
– Quality is a "total field"
– The customer defines quality
• **Philip B. Crosby**
– Zero defects
– *Quality is Free*, 1979
• **Kaoru Ishikawa**
– Cause-and-effect diagram
– Quality circles
– Recognized the internal customer
• **Genichi Taguchi**
– Taguchi loss function
• **Taiichi Ohno and Shigeo Shingo**
– Developed philosophy and methods of *kaizen*

Contributor	Key Contributions
Shewhart	Control Charts; variance reduction
Deming	14 points; special versus common causes of variation
Juran	Quality is fitness-for-use;quality trilogy
Feigenbaum	Quality is a total field; the customer defines quality
Crosby	Quality is free; zero defects
Ishikawa	Cause-and-effect diagrams; quality circles
Taguchi	Taguchi loss function
Ohno and Shingo	Continuous improvement

DIMENSIONS OF QUALITY

Dimension	Example
Performance	Everything works: fit and finish, ride, handling, acceleration
Aesthetics	Exterior and interior design
Features	Convenience: placement of gauges High tech: GPS system Safety: anti-skid, airbags
Conformance	Car Matches manufacturer's specifications
Reliability	Infrequent need for repairs
Durability	Useful life in miles, resistance to rust
Perceived quality	Top-rated
Serviceability	Ease of repair

An emphasis on quality control heightened during WWII. Quality control then evolved to quality assurance and is now better known as a Strategic Approach, a tool for improving not only products but also processes and services. Quality can be thought of as the degree to which performance of a product or service meets or exceeds expectations. Quality should be measured differently for products and services, and therefore product and service quality are judged on their own set of dimensions. Responsibility for overall quality lies with top management. Top management must establish strategies, institute programs for quality, and motivate managers and workers. Most times managers are on a quest for the quality of an organization as a whole; this is referred to as Total Quality Management (TQM). TQM involves a continual effort for quality improvement by everyone in an organization. So in essence, for an organization to meet and exceed goals of quality control the entire supply chain needs to be involved.

Consequences of poor quality

There are numerous consequences with poor quality products which can affect a business and a customer in many different ways. Whether it is a small or large problem, the magnitude of the problem always affects someone at some point. When a product is designed poorly or lacks in quality, customers recognize that very quickly, and it can quickly lead to a problem for the business. It does not matter whether the company is a product or a service oriented company because poor quality will always, most likely, create negative affects for the firm. Eventaully, the low cost input in the R&D department and the using cheaper materials will lead to loss of business . Therefore, due to the cost associated with satisfying the customer, it is best to fix problems in the design phase rather than dealing with it after it's in the hands of a customer. The sooner the problem with a product or service is identified and remedied, the better!

Methods for Generating Ideas

Additional tools that are useful for problem solving and process control include:

- *Brainstorming*
- *Affinity diagram*
- *Quality circles*
- *Interviewing*
- *Benchmarking*
- *5W2H approach*
    - *Who*
    - *What*
    - *When*

- *Where*
- *Why*
- *How*
- *How much*

Brainstorming is used to communicate thoughts and ideas without any criticism. Everyone has equal input and ideas are shared in order to facilitate problem solving.
Affinity Diagram is used to arrange data into categories that may be analyzed. One of its uses is to group many responses to similar ideas. It uses the right side of the brain (generates ideas) and the left side of brain (analyze and organize).
Quality Circles are usually informal meetings between employees to exchange ideas and concerns about processes.
Interviewing is a tool used by managers to find information from employees through Q & A sessions.
Benchmarking is tool for companies to set standards. It attempts to compare itself to the best in the industry in order to meet or exceed the standard set. Usually uses these steps: 1. Identify process for improvement. 2. Identify organization that is the best at that process. 3. Study that organization. 4. Analyze data. 5. Improve process at your organization.
5W2H approach asks the questions what, why, where, when, who, how, and how much (5 W words and 2 H words). Its purpose is to ask the questions that will lead to improving processes.

Responsibility for Quality

Top Management– has the ultimate responsibility for quality. While they establish strategies for quality, they also institute programs to improve quality; guide, direct, and motivate managers and workers; and set an example by being involved in quality initiatives.
Design– Quality products and services begin with design.

Sales can be lost when the products are not designed well and do not function correctly. Customers get turned off when that happens and may not want to risk buying the same brand again. Liability is an important area because there is the potential for damages or injures that could reflect badly on the company and then damage control will need to be done to repair the company image and reputation. Productivity can be slowed when there are defects and poor quality because time must be spent to redo and fix these issues. Costs can be reduced by up to five times if problems are caught early on in the process, compared to later in the production stages.

Questions to the chapter

1.Which quality certification pertains to set of international standard on quality management and quality assurance?
a) ISO 14000
b) ISO 24700
c) ISO 9000
d). ISO 27000
e) None of the above

[reveal-answer q=”491213"]Show Answer[/reveal-answer]
[hidden-answer a=”491213"]
Answer: C (pg.424)[/hidden-answer]

2.Whose key contribution included the cause-and-effect diagram (fishbone diagram)?
a) Joseph M. Juran
b) Kaoru Ishikawa
c) Armand Feigenbaum

d) Walter Shewhart
e) Genichi Taguchi
[reveal-answer q=”34151"]Show Answer[/reveal-answer]
[hidden-answer a=”34151"]
Answer: B (pg.411)[/hidden-answer]
3.Which cost of quality involves the cost of preventing a defect from occurring?
a) Appraisal Costs
b) Failure Costs
c) Fixing Costs
d) Prevention Costs
e) Internal Costs

[reveal-answer q=”376263"]Show Answer[/reveal-answer]
[hidden-answer a=”376263"]
Answer: D (pg.420)[/hidden-answer]
4.Which failures are discovered after delivery to customer?
a) External
b) Internal
c) Prevention
d) Quality
e) None of the above

[reveal-answer q=”242012"]Show Answer[/reveal-answer]
[hidden-answer a=”242012"]
Answer: A (pg.420-421)[/hidden-answer]
5.Which method for generating ideas is a tool used to organize data into logical categories?
a)Brainstorming
b) Affinity Diagram
c) Quality Circles
d) Interviewing
e) Benchmarking
[reveal-answer q=”424945"]Show Answer[/reveal-answer]
[hidden-answer a=”424945"]
Answer: B (pg.444)[/hidden-answer]
6. Which of the following is a consequence of poor quality?
a) loss of business
b) liability
c) productivity
d) costs
e) all of the above are correct
[reveal-answer q=”896229"]Show Answer[/reveal-answer]
[hidden-answer a=”896229"]
Answer: e) all of the above are correct PG. 418[/hidden-answer]
7. Which of the following is true of the benefits of good quality?
a) enhanced reputation for quality
b) reduced productivity
c) lower liability cost

d) higher liability cots
e) both a & c are correct
[reveal-answer q=”675392"]Show Answer[/reveal-answer]
[hidden-answer a=”675392"]
Answer: e) both a & c are correct pg. 418[/hidden-answer]

8. The cost to fix a problem at the design or production stage, compared to at an earlier stage costs how many times more?

a) one time
b) two times
c) three times
d) four times
e) five times
[reveal-answer q=”446997"]Show Answer[/reveal-answer]
[hidden-answer a=”446997"]
Answer e) five times PG 419[/hidden-answer]

10. Productivity is closely related to which of the following?:

a) liability
b) costs
c) quality
d) express written warranties
e) defective products
[reveal-answer q=”269636"]Show Answer[/reveal-answer]
[hidden-answer a=”269636"]
Answer c) quality PG 418[/hidden-answer]

11**. What are the three costs that are associated with quality?**

a) Appraisal costs, Prevention costs, Labor costs.
b) Appraisal costs, Prevention costs, Failure costs.
c) Appraisal costs, Prevention costs, Internal Failures costs.
d) Appraisal costs, Prevention costs, Total Costs.
e) Appraisal costs, Prevention costs, Overhead cost.

[reveal-answer q=”966566"]Show Answer[/reveal-answer]
[hidden-answer a=”966566"]
Answer is B found on page 420.[/hidden-answer]

12. Which of the following are two major aspects of the TQM approach?

a) Continuous improvement and process improvement.
b) Six-sigma and continuous improvement.
c) Problem solving and process improvement.
d) Problem solving and continuous improvement.
e) All of the above.

[reveal-answer q=”159215"]Show Answer[/reveal-answer]
[hidden-answer a=”159215"]
Answer is C found on pages 432-434.[/hidden-answer]

13. What is the Japanese term for continuous improvement?

a) kaizen
b) Ishikawa

c) fishbone
d) a. and c. are correct answers,
e) None of the above.

[reveal-answer q="56880"]Show Answer[/reveal-answer]
[hidden-answer a="56880"]
Answer is A found on page 428.[/hidden-answer]

14. What are the four basic steps in the PDSA cycle?

a) Problem, Decision, Solution, Award.
b) Design, Study, Plan, Do, Act.
c) Plan, Design, Check, Act.
d) Plan, Do, Study, Act.
e) None of the above.

[reveal-answer q="185432"]Show Answer[/reveal-answer]
[hidden-answer a="185432"]
Answer is D found on page 433.[/hidden-answer]

15. Which basic quality tool is focused on resolving the most important problem?

a) Scatter diagram
b) Control chart
c) Pareto analysis
d) Cause-and-effect diagram
e) Fishbone diagram

[reveal-answer q="771414"]Show Answer[/reveal-answer]
[hidden-answer a="771414"]
Answer is C found on page 438.[/hidden-answer]

16. Which of the following is a Determinant of Product Quality?

a) Design
b) Product/Service conformity to design
c) Ease of Use
d) Service after delivery
e) All of the Above
[reveal-answer q="908035"]Show Answer[/reveal-answer]
[hidden-answer a="908035"]
Answer: E page 416[/hidden-answer]

17. Which of the following doesn't refer to the term "Ease of Use"?

a) Increases the chances that product will be used for intended design
b) Product conforms to the intended designs
c) Instructions are included in the product
d) Product continues to function safely and properly
e) All of the above refers to "Ease of Use"
[reveal-answer q="240319"]Show Answer[/reveal-answer]
[hidden-answer a="240319"]
Answer: B page 417[/hidden-answer]

18. Which is NOT a Consequence of Poor Quality

a) Productivity

b) Loss of Business
c) Costs
d) Legal Liability
e) None of the Above
[reveal-answer q="419651"]Show Answer[/reveal-answer]
[hidden-answer a="419651"]
Answer: E page 406[/hidden-answer]

19. The consequences of poor quality products or services may result in:

a) Less Liability
b) Baldrige
c) Injuries and defective output
d) Lower costs
e) Faster Productivity
[reveal-answer q="689204"]Show Answer[/reveal-answer]
[hidden-answer a="689204"]
Answer: C page 419[/hidden-answer]

20. One of the things Designers should consider when making a product is...

a) Customer preference
b) Company Costs
c) Production capabilities
d) A and C
e) All of the Above
[reveal-answer q="740578"]Show Answer[/reveal-answer]
[hidden-answer a="740578"]
Answer E page 419[/hidden-answer]

21. Although closely associated with quality, this name is not on the list of quality gurus:

a) W. Edwards Deming
b) Philip Crosby
c) Malcolm Baldrige
d) J. M. Juran
e) Kaoru Ishikawa
[reveal-answer q="922240"]Show Answer[/reveal-answer]
[hidden-answer a="922240"]
Answer: Malcolm Baldrige (pg 409)[/hidden-answer]

22. Which name is associated with management responsibility?

a) Deming
b) Crosby
c) Juran
d) Feigenbaum
e) Ishikawa
[reveal-answer q="397276"]Show Answer[/reveal-answer]
[hidden-answer a="397276"]
Answer: D. Feigenbaum (pg 411)[/hidden-answer]

23. Which quality pioneer compiled a list of 14 points that he believed were imperative to achieve quality in an organization?

a) Deming
b) Crosby

c) Baldrige
d) Juran
e) Ishiikawa
[reveal-answer q=”764070"]Show Answer[/reveal-answer]
[hidden-answer a=”764070"]
Answer: A. Deming (pg 409)[/hidden-answer]

24. Which one of these is a tool for gathering data?

a) Control chart
b) Fishbone diagram
c) Scatter diagram
d) Flowchart
e) Checksheet
[reveal-answer q=”648589"]Show Answer[/reveal-answer]
[hidden-answer a=”648589"]
Answer: E. Checksheet (pg 435)[/hidden-answer]

25. Which one of these is a tool for problem solving?

a) Benchmarking
b) Cause-and-effect diagram
c) Histograms
d) Scatter diagrams
e) Control charts
[reveal-answer q=”152733"]Show Answer[/reveal-answer]
[hidden-answer a=”152733"]
Answer: Cause & Effect Diagram (pg 439)[/hidden-answer]

26. Which of these people are not considered one of the “gurus” who mapped out some of the foundations of modern quality management?

a) Walter Shewhart
b) W. Edwards Deming
c) Joseph M Juran
d) Philip B. Crosby
e) Charles P. Bonini
[reveal-answer q=”681874"]Show Answer[/reveal-answer]
[hidden-answer a=”681874"]
Answer is E (pg 409)[/hidden-answer]

27. What is Six Sigma best defined as:

a) A Japanese term for continuous improvement
b) A business process for improving quality, reducing costs and increasing customer satisfaction
c) Framework for problem solving and improvement activities
d) A diagram of the steps in a process
e) None of the Above

[reveal-answer q=”256416"]Show Answer[/reveal-answer]
[hidden-answer a=”256416"]
Answer is: B, pg.429[/hidden-answer]

28. Which of the following is not a dimension of product quality?

a) Performance
b) Special features

c) Consistency
d) Conformance
e) Reliability

[reveal-answer q="403335"]Show Answer[/reveal-answer]
[hidden-answer a="403335"]
Answer: C, pg. 414- Consistency deals with the dimensions of service quality[/hidden-answer]

29. Philip B. Crosby identified key points in his concept of zero defects, which of the below is one of his key points?

a) Management must be persistent in efforts to achieve good quality
b) Institute modern methods of training on the job
c) Quality products and services begin with design
d) Cost to remedy a problem is a major concern in quality management
e) All the above.

[reveal-answer q="196254"]Show Answer[/reveal-answer]
[hidden-answer a="196254"]
Answer: A, pg.411[/hidden-answer]

30. Reducing one or more steps in a supply chain by cutting out one or more intermediaries is known as:

a) Delayed differentiation
b) Cross-docking
c) Avoidance
d) Disintermediation
e) Reverse logistics

[reveal-answer q="748630"]Show Answer[/reveal-answer]
[hidden-answer a="748630"]
Answer: D, pg. 541[/hidden-answer]

31. What are the key elements of Deming's 14 points?

a) Constancy of purpose
b) Continual improvement
c) Profound knowledge
d) Decreasing labor costs
e) Only a, b, and c
[reveal-answer q="490425"]Show Answer[/reveal-answer]
[hidden-answer a="490425"]
Answer: E (pg 409)[/hidden-answer]

32. By how many times is it more costly to fix a problem at the customer end compared to the design stage?

a) 1x
b) **5x**
c) 3x
d) 2x
e) 4x
[reveal-answer q="846586"]Show Answer[/reveal-answer]
[hidden-answer a="846586"]
Answer: B (pg.407)[/hidden-answer]

33.Costs of activities designed to ensure quality or uncover defects are costs associated with?
a) external failures
b) failure costs
c) appraisal costs
d) prevention costs
e) internal failures
[reveal-answer q=”791932"]Show Answer[/reveal-answer]
[hidden-answer a=”791932"]
Answer: C (pg. 409)[/hidden-answer]

35. What is known as performance, aesthetics, special features, conformance, reliability, durability, perceived quality, and serviceability?
a) quality of design
b) quality of conformance
c) return on quality
d) dimensions of quality
e) Deming prize
[reveal-answer q=”74761"]Show Answer[/reveal-answer]
[hidden-answer a=”74761"]
Answer: D (pg. 403)[/hidden-answer]

36.Which technique uses groups of people to share thoughts and ideas without any criticism?
a) Process Improvement
b) Benchmarking
c) Brainstorming
d) Interviewing
e) 5WH2
[reveal-answer q=”944059"]Show Answer[/reveal-answer]
[hidden-answer a=”944059"]
Answer: C (pg. 444)[/hidden-answer]

37. Benchmarking uses which of the following to improve standards?
a) Larger companies
b) Smaller companies
c) Competitors
d) Suppliers
e) Industry Leaders
[reveal-answer q=”447918"]Show Answer[/reveal-answer]
[hidden-answer a=”447918"]
Answer: E (pg. 445)[/hidden-answer]

38.Which methods asks 7 questions to improve processes?
a) 5W2H
b) Affinity Diagram
c) Quality circles
d) Benchmarking
e) Brainstorming
[reveal-answer q=”489626"]Show Answer[/reveal-answer]
[hidden-answer a=”489626"]
Answer: A (pg. 446)[/hidden-answer]

39. Control charts have which of the following features?

a) Tabulated categories
b) Diagrams
c) Lower control limits
d) Upper control limits
e) Both C and D
[reveal-answer q="923435"]Show Answer[/reveal-answer]
[hidden-answer a="923435"]
Answer: E (pg. 436)[/hidden-answer]

40. A Scatter diagram is useful when there is

a) One variable
b) Correlation between variables
c) Multiple variables
d) NO Correlation between variables
e) Variation
[reveal-answer q="319835"]Show Answer[/reveal-answer]
[hidden-answer a="319835"]
Answer: B (pg. 438)[/hidden-answer]

41.What is NOT the primary determinants of qualiy, which a product or a service successfully satisfies its intended purpose?

a) Ease of use
b) Cost
c) Design
d) Service after delivery
e) Design Conformity
[reveal-answer q="141987"]Show Answer[/reveal-answer]
[hidden-answer a="141987"]
Answer: b) Cost (Pg 416)[/hidden-answer]

42.What is the correct definition of an appraisal cost?

a) cost of preventing defects from occurring
b) cost caused by defective parts or products or by faulty services
c) An approach that evaluates the financial return of investments in quality
d) cost of activities designed to ensure quality or uncover defects
e) all of the above
[reveal-answer q="169148"]Show Answer[/reveal-answer]
[hidden-answer a="169148"]
Answer: d) cost of activities designed to ensure quality or uncover defects. (Pg 420)[/hidden-answer]

43.Which quality tool can be useful in getting a sense of the distribution of observed values?

a) histogram
b) check sheet
c) scatter diagram
d) control chart
e) flow chart
[reveal-answer q="330434"]Show Answer[/reveal-answer]
[hidden-answer a="330434"]
Answer: a) Histogram (Pg 435)[/hidden-answer]

44. What step comes after "develop performance measures and collect data" and before "generate potential solutions" in the TQM problem-solving process?

a) define the problem and establish an improvement goal
b) analyze the problem
c) choose a solution
d) implement the solution
e) monitor the solution to see if it accomplishes the goal
[reveal-answer q="349590"]Show Answer[/reveal-answer]
[hidden-answer a="349590"]
Answer: b) analyze the problem. (Pg433)[/hidden-answer]

46. Who is known as the "father of statistical quality control?"

a) W. Edwards Deming
b) Walter Shewhart
c) Philip B. Crosby
d) Joseph M. Juran
e) Genichi Taguchi
[reveal-answer q="492798"]Show Answer[/reveal-answer]
[hidden-answer a="492798"]
Answer is B. (Pg 409)[/hidden-answer]

47. Which of the following is*NOT*a dimension of quality?

a) Performance
b) Durability
c) Aesthetics
d) Investment
e) Conformance
[reveal-answer q="892693"]Show Answer[/reveal-answer]
[hidden-answer a="892693"]
Answer is D. (Pages:412-413)[/hidden-answer]

49. A statistical chart of time-ordered values of a sample statistic is a:

a) Flowchart
b) Check sheet
c) Scatter Diagram
d) Cause-and-effect diagram
e) Control chart
[reveal-answer q="343927"]Show Answer[/reveal-answer]
[hidden-answer a="343927"]
Answer is E (Page:439)[/hidden-answer]

50. What question is *not* included in the 5W2H approach?

a) Which
b) What
c) Why
d) Where
e) When
[reveal-answer q="428062"]Show Answer[/reveal-answer]
[hidden-answer a="428062"]
Answer is A (Page:446)[/hidden-answer]

51. Which are included in the product quality?

a) Reliability
b) Durability

c) Convenience
d) a and b
e) All of the above

[reveal-answer q="50981"]Show Answer[/reveal-answer]
[hidden-answer a="50981"]
Answer is D, pg.415[/hidden-answer]

52. What are the determinants of quality?

a) Design
b) Ease of use
c)Service after delivery
d) The wellness of product to design
e) All of the above

[reveal-answer q="916486"]Show Answer[/reveal-answer]
[hidden-answer a="916486"]
Answer is E, pg.416[/hidden-answer]

53.Which of the following is not a consequence of poor quality?

a) productivity
b) liability
c) costs
d) speed
e) All of the above

[reveal-answer q="652745"]Show Answer[/reveal-answer]
[hidden-answer a="652745"]
Answer is D, pg.419[/hidden-answer]

54. The appraisal costs means:

a) costs of preventing defects from occurring
b) costs caused by defective parts or products or by faulty services
c) costs of activities designed to ensure quality or uncover defects
d) costs related to defective products
e) neither one is correct.

[reveal-answer q="575780"]Show Answer[/reveal-answer]
[hidden-answer a="575780"]
Answer is C, pg.420[/hidden-answer]

55. A set of international standards for assessing a company's environmental performance is

a) ISO 14000
b) ISO 24700
c) IEC 24700
d) ISO 9000
e) None of the above

[reveal-answer q="116916"]Show Answer[/reveal-answer]
[hidden-answer a="116916"]
Answer is A, pg.424[/hidden-answer]

56. Which tool uses a diagram of the steps as a visual representation of a process?

a) PDSA Cycle
b) Flow Chart
c) Check Sheet
d) Histogram
e) Scatter diagram

[reveal-answer q="481805"]Show Answer[/reveal-answer]
[hidden-answer a="481805"]
Answer is B, pg.435[/hidden-answer]

57. A run chart shows performance over

a) speed
b) quantity
c) productivity
d) time
e) quality

59. All of the following are affected by poor quality EXCEPT — One more choice needed.

a. Loss of Business
b. Increased Liability
c. Decreased Costs
d. Increased Productivity
e. Customer loyalty

[reveal-answer q="489912"]Show Answer[/reveal-answer]
[hidden-answer a="489912"]
Answer C (P418)[/hidden-answer]

60. The Baldrige Award is an award given out for doing what?

a. Stimulate Efforts to improve quality
b. Recognize quality achievements
c. Publicize successful programs
d. All of the above (ABC)
e. None of the above

[reveal-answer q="293240"]Show Answer[/reveal-answer]
[hidden-answer a="293240"]
Answer D (Page 422)[/hidden-answer]

61. Dimensions of quality include: Performance, Special Features, Reliability, Durability, Perceived quality, and ___.

a. Tested Quality, Usefulness
b. Ease of use, Aesthetics,
c. Conformance, Price
d. Aesthetics, Conformance
e. None of the above

[reveal-answer q="406392"]Show Answer[/reveal-answer]
[hidden-answer a="406392"]
Answer D (p412 definition)[/hidden-answer]

62. Which quality tool uses a technique for classifying problem areas according to degree of importance, and focusing on the most important.

a. Pareto Analysis

b. Scatter Diagram
c. Control Chart
d. Histogram
e. None of the above
[reveal-answer q=”605932"]Show Answer[/reveal-answer]
[hidden-answer a=”605932"]
Answer is D, pg.442[/hidden-answer]
63.) Which quality management principle(s) form the basis of the latest version of ISO 9000:
A.) A customer focus
B.) Leadership
C.) A process approach
D.) Continual improvement
E.) All of the above
[reveal-answer q=”125638"]Show Answer[/reveal-answer]
[hidden-answer a=”125638"]
Answer is E (p.425)[/hidden-answer]
64.) Which is the annual award given by the US government to recognize quality achievements of US companies?
A.) European Quality Award
B.) Deming Prize
C.**)** Baldrige Award
D.) Carlton Award
E.) Cadillac Award
[reveal-answer q=”495574"]Show Answer[/reveal-answer]
[hidden-answer a=”495574"]
Answer is C (p.422)[/hidden-answer]
65) Problem solving, material and product losses, scrap, and downtime are examples of:
A) Appraisal costs
B) Prevention costs
C) Internal failure costs
D) External failure costs
E) None of the above
[reveal-answer q=”598391"]Show Answer[/reveal-answer]
[hidden-answer a=”598391"]
Answer is C (p. 421)[/hidden-answer]
66. One of the quality dimentions is this same for product and service. Which one?
a) special features
b) serviceability
c) reliability
d) courtesy
e)convenience
[reveal-answer q=”744585"]Show Answer[/reveal-answer]
[hidden-answer a=”744585"]
answer c (p.403)[/hidden-answer]
67. Six sigma is a process to :
a) improve quality
b) increase customer satisfaction
c) reduce costs

d) all of the above
e) none of the above
[reveal-answer q=”137660"]Show Answer[/reveal-answer]
[hidden-answer a=”137660"]
answer d (p.418)[/hidden-answer]
68.
Who contributed the *continuous improvement* aspect of quality?
a) Juran
b) Crosby
c) Ohno and Shingo
d) Ishikawa
e) Feigenbaum
[reveal-answer q=”972948"]Show Answer[/reveal-answer]
[hidden-answer a=”972948"]
answer c (p. 412)[/hidden-answer]
69.
All of the following are consequences of Poor Quality EXCEPT
a) Liability
b) Loss of business
c) Cost
d) Direct feedback
e) a and d
[reveal-answer q=”944901"]Show Answer[/reveal-answer]
[hidden-answer a=”944901"]
answer d (p. 418)[/hidden-answer]
70.
PDSA stands for
a) Plan Direct Study Act
b) Plan Direct Simplify Act
c) Plan Do Study Act
d) Participate Do Satisfy Act
e) None of the above
[reveal-answer q=”122801"]Show Answer[/reveal-answer]
[hidden-answer a=”122801"]
answer c (p. 433)[/hidden-answer]
71.
Which annual award is given by the U.S. government to recognize quality achievements of U.S. companies?
a) Deming Prize
b) Baldrige Award
c) Juran Award
d) Taguchi Award
e) None of the above
[reveal-answer q=”199592"]Show Answer[/reveal-answer]
[hidden-answer a=”199592"]
answer b (p.422)[/hidden-answer]
72.
Which type of cost relates to attempts to prevent defects from occurring?

a) Prevention Costs
b) Foreseeable Costs
c) Appraisal Costs
d) Failure Costs
e) None of the above
[reveal-answer q=”283684"]Show Answer[/reveal-answer]
[hidden-answer a=”283684"]
answer a (p. 420)[/hidden-answer]

UNIT 4 DISCUSSION

#1
Research the three well-known awards (Baldridge Award, European Quality Award, Deming Prize) given annually to recognize quality. Pick one of the awards and one of the main evaluation criteria. Compare and Contrast this evaluation criterion for Apple and Microsoft. How would these two organizations score on this quality dimension? How would you suggest improving the quality related to this criterion based on the material that is covered in this section?

4.2: Statistical Process Control

TCMC QUALITY MANAGEMENT SERVICES: TERRY MCCANN'S "PROCESS DIAGRAMS"

Pay attention to the key concepts related to the development of a process map and workflow charts. Process development is crucial to an efficient and effective organization. Each process contains the workflow (system design with tools used) and the procedures (work instructions for people). Both of these must align and together become the process.

One or more interactive elements has been excluded from this version of the text. You can view them online here:
https://pressbooks.nscc.ca/operationsmanagement2/?p=191#oembed-1

WIKIPEDIA: "STATISTICAL PROCESS CONTROL "

Read this wiki page to better history and application of the SPC method. This is a standard method used in many organizations to monitor the quality of processes. Familiarizing yourself with the method is the first step in understanding how processes can be monitored for more effective evaluation.

STATISTICAL PROCESS CONTROL

Statistical process control (SPC) is a method of quality control which uses statistical methods. SPC is applied in order to monitor and control a process. Monitoring and controlling the process ensures that it operates at its full potential. At its full potential, the process can make as much conforming product as possible with a minimum (if not an elimination) of waste (rework or scrap). SPC can be applied to any process where the "conforming product" (product meeting specifications) output can be measured. Key tools used in SPC include control charts; a focus on continuous improvement; and the design of experiments. An example of a process where SPC is applied is manufacturing lines.

OVERVIEW

Objective Analysis of Variation

SPC must be practiced in 2 phases: The first phase is the initial establishment of the process, and the second phase is the regular production use of the process. In the second phase, a decision of the period to be examined must be made, depending upon the change in 4 – M conditions (Man, Machine, Material, Method) and wear rate of parts used in the manufacturing process (machine parts, jigs, and fixture)

Emphasis on Early Detection

An advantage of SPC over other methods of quality control, such as "inspection", is that it emphasizes early detection and prevention of problems, rather than the correction of problems after they have occurred.

Increasing Rate of Production

In addition to reducing waste, SPC can lead to a reduction in the time required to produce the product. SPC makes it less likely the finished product will need to be reworked.

Limitations

SPC is applied to reduce or eliminate process waste. This, in turn, eliminates the need for the process step of post-manufacture inspection. The success of SPC relies not only on the skill with which it is applied, but also on how suitable or amenable the process is to SPC. In some cases, it may be difficult to judge when the application of SPC is appropriate.[*citation needed*]

History

SPC was pioneered by Walter A. Shewhart at Bell Laboratories in the early 1920s. Shewhart developed the control chart in 1924 and the concept of a state of statistical control. Statistical control is equivalent to the concept of exchangeability developed by logician William Ernest Johnson also in 1924 in his book *Logic, Part III: The Logical Foundations of Science*. Along with a gifted team at AT&T that included Harold Dodge and Harry Romig he worked to put sampling inspection on a rational statistical basis as well. Shewhart consulted with Colonel Leslie E. Simon in the application of control charts to munitions manufacture at the Army's Picatinny Arsenal in 1934. That successful application helped convince Army Ordnance to engage AT&T's George Edwards to consult on the use of statistical quality control among its divisions and contractors at the outbreak of World War II.

W. Edwards Deming invited Shewhart to speak at the Graduate School of the U.S. Department of Agriculture, and served as the editor of Shewhart's book *Statistical Method from the Viewpoint of Quality Control* (1939) which was the result of that lecture. Deming was an important architect of the quality control short courses that trained American industry in the new techniques during WWII. The graduates of these wartime courses formed a new professional society in 1945, the American Society for Quality Control, which elected Edwards as its first president. Deming traveled to Japan during the Allied Occupation and met with the Union of Japanese Scientists and Engineers (JUSE) in an effort to introduce SPC methods to Japanese industry .

"Common" and "Special" Sources of Variation

Main article: Common cause and special cause (statistics)
Shewhart read the new statistical theories coming out of Britain, especially the work of William Sealy Gosset, Karl Pearson, and Ronald Fisher. However, he understood that data from physical processes seldom produced a "normal distribution curve"; that is, a Gaussian distribution or "bell curve". He discovered that data from measurements of variation in manufacturing did not always behave the way as data from measurements of natural phenomena (for example, Brownian motion of particles). Shewhart concluded that while every process displays variation, some processes display variation that is natural to the process ("common" sources of variation)- these processes were described as in (statistical) control. Other processes additionally display variation that is not present in the causal system of the process at all times ("special" sources of variation), and these were described as 'not in control'.

Application to non-manufacturing processes

In 1988, the Software Engineering Institute suggested that SPC could be applied to non-manufacturing processes, such as software engineering processes, in the Capability Maturity Model (CMM). The Level 4 and Level 5 practices of the Capability Maturity Model Integration (CMMI) use this concept.

The notion that SPC is a useful tool when applied to non-repetitive, knowledge-intensive processes such as research and development or systems engineering has encountered skepticism and remains controversial.

In his seminal article No Silver Bullet, Fred Brooks points out that the complexity, conformance requirements, changeability, and invisibility of software results in inherent and essential variation that cannot be removed. This implies that SPC is less effective in the domain of software development than in, e.g., manufacturing.

In 2014 a method for data validation of measurement data, based on SPC, was tried out. The method enabled the user to validate data containing static wave components (process noise), a requirement when working on hydro power plants where slowly damping surges are abundant during normal operation.

Variation in Manufacturing

In manufacturing, quality is defined as conformance to specification. However, no two products or characteristics are ever exactly the same, because any process contains many sources of variability. In mass-manufacturing, traditionally, the quality of a finished article is ensured by post-manufacturing inspection of the product. Each article (or a sample of articles from a production lot) may be accepted or rejected according to how well it meets its design specifications. In contrast, SPC uses statistical tools to observe the performance of the production process in order to detect significant variations before they result in the production of a sub-standard article. Any source of variation at any point of time in a process will fall into one of two classes.

1) "Common Causes" – sometimes referred to as nonassignable, normal sources of variation. It refers to many sources of variation that consistently acts on process. These types of causes produce a stable and repeatable distribution over time.

2) "Special Causes" – sometimes referred to as assignable sources of variation. It refers to any factor causing variation that affects only some of the process output. They are often intermittent and unpredictable.

Most processes have many sources of variation; most of them are minor and may be ignored. If the dominant sources of variation are identified, however, resources for change can be focused on them. If the dominant assignable sources of variation are detected, potentially they can be identified and removed. Once removed, the process is said to be "stable". When a process is stable, its variation should remain within a known set of limits. That is, at least, until another assignable source of variation occurs. For example, a breakfast cereal packaging line may be designed to fill each cereal box with 500 grams of cereal. Some boxes will have slightly more than

500 grams, and some will have slightly less. When the package weights are measured, the data will demonstrate a distribution of net weights. If the production process, its inputs, or its environment (for example, the machines on the line) change, the distribution of the data will change. For example, as the cams and pulleys of the machinery wear, the cereal filling machine may put more than the specified amount of cereal into each box. Although this might benefit the customer, from the manufacturer's point of view, this is wasteful and increases the cost of production. If the manufacturer finds the change and its source in a timely manner, the change can be corrected (for example, the cams and pulleys replaced).

Application of SPC

The application of SPC involves three main phases of activity:

1. Understanding the process and the specification limits.
2. Eliminating assignable (special) sources of variation, so that the process is stable.
3. Monitoring the ongoing production process, assisted by the use of control charts, to detect significant changes of mean or variation.

Control Charts

The data from measurements of variations at points on the process map is monitored using control charts. Control charts attempt to differentiate "assignable" ("special") sources of variation from "common" sources. "Common" sources, because they are an expected part of the process, are of much less concern to the manufacturer than "assignable" sources. Using control charts is a continuous activity, ongoing over time.

Stable Process

When the process does not trigger any of the control chart "detection rules" for the control chart, it is said to be "stable". A process capability analysis may be performed on a stable process to predict the ability of the process to produce "conforming product" in the future.

Excessive Variation

When the process triggers any of the control chart "detection rules", (or alternatively, the process capability is low), other activities may be performed to identify the source of the excessive variation. The tools used in these extra activities include: Ishikawa diagrams, designed experiments, and Pareto charts. Designed experiments are a means of objectively quantifying the relative importance (strength) of sources of variation. Once the sources of variation have been quantified, actions may be taken to reduce or eliminate them. Methods of eliminating a source of variation might include: development of standards; staff training; error-proofing and changes to the process itself or its inputs.

Mathematics of Control Charts

Digital control charts use logic based rules that determine "derived values" which signal the need for correction. For example,

derived value = last value + average absolute difference between the last N numbers.

TCMC QUALITY MANAGEMENT SERVICES: TERRY MCCANN'S "PROCESS DIAGRAMS"

Pay attention to the key concepts related to the development of a process map and workflow charts. Process development is crucial to an efficient and effective organization. Each process contains the workflow (system design with tools used) and the procedures (work instructions for people). Both of these must align and together become the process.

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https://pressbooks.nscc.ca/operationsmanagement2/?p=191#oembed-2

MYBUSINESSEXCELLENCE: "PROCESS DESIGN AND IMPROVEMENT"

Watch this video for an introduction to process design and improvement. This video provides a foundation for the use of process design as a tool to improve processes to impact quality. Every time we adjust work, we are changing the process. This means that as an operations manager, it is important that you understand how each change impacts the whole process. When an adjustment needs to be made to improve quality a systematic approach to process design is the best method for a successful change.

Video Link https://youtu.be/deyi3BTG5zI

Unit 4 Activity and Grading Rubric

In this activity, you will continue working on your operations management plan by explaining techniques and methodologies for managing your organization's productive resources.

Learning Outcome
Explain techniques and methodologies for managing an organization's productive resources.

Specifications:

- 2-3 page paper
- Created in a Word document
- Follows APA, 6th edition formatting
- Includes a Reference page for cited sources

Instructions: For this activity, you will write a 2-3 page paper discussing ways in which your operations processes can help to generate "value" in the mind of the consumer. You may want to think like a marketer here as you can discuss the quality products you use to create the end item or the high level of dedication your organization's employees display as they provide customer service. The use of technology can also be included in this discussion. For example, you may discuss a filmed tour of the manufacturing process or your service training as part of your advertising campaign. Use at least 4 scholarly sources to research and write about the methodologies that you use to manage your organization's productive resources.

In your paper, make sure that you address the following:

- Identify and assess any specific resources that will help support your operation management plan (i.e. employees, equipment or cash reserves your organization may have, etc.).
- Discuss promotional techniques you can use that will help create value in the consumer's mind (i.e. you can talk about the durability of your product or any specialized customer service you put your employees through).
- Explain how any potential partnerships or other business relationships

gives your product an edge of the competition (i.e. Tide partnered with Febreze to add their product to Tide's laundry detergent to give clothes a fresh, clean scent added to the cleaning power of the detergent).

Please score your paper or have a friend score your paper using the following "rubric," or "scoring guide." The levels will equate to the following letter grades:

4 = A; 3 = B; 2 = C; 1 = D; and 0

Level	Criterion
Research and Documentation (40%)	
4	Use at least 4 scholarly/peer-reviewed publications should be used to support your content. References should come from scholarly sources (i.e. textbooks, scholarly articles, etc.). Any in-text citations MUST be cited in APA format using the APA Manual 6th edition. You should also include a References page, also in APA format, at the end of your paper to cite any sources used.
3	The paper uses at least three scholarly sources to support your content, but it does not meet the minimum requirement for 4 sources.
2	Three or more popular sources (i.e. newspapers, internet sites, magazines, etc.) make up a majority of the references to support your content. The paper lacks credible, scholarly sources and does not meet the minimum number of sources required.
1	The paper includes one or two sources. The paper lacks the use of credible, scholarly sources and may focus on using popular sources. The number of sources used does not meet the minimum requirement (4 sources) and the resources used may not fully support the content of your paper.
0	The paper fails to cite referenced sources, or does not include any research or sources to support ideas. The paper is based off of non-original content.
Analysis and Argument (40%)	
4	Your paper addresses the instructions of the activity prompt with the use of supporting evidence and specific details and explanation. You effectively address all of the following requirements:Identify and assess any specific resources that will help support your operation management plan. Discuss promotional techniques you can use that will help create value in the consumer's mind. Explain how any potential partnerships or other business relationships gives your product an edge of the competition.
3	The content addresses only some of the questions presented in the instructions section and reflects minimal original thought and /or critical analysis relative to the business.
2	The content is vague and is weakly supported by researched evidence. The essay lacks critical analysis relative to the business.
1	The content does not address the required elements; ideas presented are not supported by research or critical analysis.
0	There is a lack of critical analysis for the operation management plan, and/or the essay does not address the business content from the Unit 1 Activity.
Grammar/Style (15%)	
4	The content contains a maximum of two grammatical, citation, and punctuation errors. The ideas are concise and presented in a logical manner that is easy for the reader to follow.
3	The content contains three or four grammatical, citation, punctuation, and/or spelling errors. The sentence structure flows in a concise, logical manner.
2	The paper contains more than four grammatical, citation, punctuation and/or spelling errors that distract the reader from the comprehension of ideas being presented.
1	The paper demonstrates poor writing skills, reflected by lack of syntax and proper grammar, which makes ideas difficult to communicate. Ideas are not presented in a logical manner that is easy to follow.
0	The paper contains numerous grammatical, citation, punctuation, and/or spelling errors.

Format (5%)	
4	The paper should properly formatted (paragraph style, margins, etc.), using the APA Manual, 6th edition. The content is typed in MS Word format, labeled with the student's name and the activity title/unit number, and a reference section to cite any outside sources used.
3	The paper meets most of the requirements for formatting, using the APA Manual, 6th edition, though may contain some errors.
2	The paper lacks proper formatting, based on the APA Manual, 6th edition, and it may use another style of formatting (i.e. MLA, Chicago, etc.).
1	The paper is typed in a format other than MS Word. A style of formatting other than APA may be used, or there are numerous formatting errors that distract the reader's comprehension.
0	The formatting does not comply with the APA Manual, 6th edition and is not created in MS Word.

UNIT 5: SUPPLY CHAIN MANAGEMENT (SCM)

Unit 5: Supply Chain Management (SCM)

Many of the problems associated with supply chain management are closely related to the typical problems of operations management. Instead of the question: "How should we make this?", it becomes: "How should we get this from point A to B?" It may be best to ship the product straight from the factory to the customer, but it may be prohibitively expensive to do so. Many firms find it easier and cheaper to ship products to distribution warehouses first and distribute to customers on a more local level.

Supply chain management refers to the entire process of obtaining the raw goods from a supplier, converting those goods into products, shipping products, and placing them in front of customers. Operations management typically focuses on the production side of supply chain management, but a good manager is concerned with the entire process. In this unit, we will look at the management of firm resources on the supply side as well as the distribution of finished goods to the consumer.

Unit 5 Learning Outcomes

Upon successful completion of this unit, you will be able to:

- apply the principles of supply chain management to a variety of organizational settings;
- explain the “bullwhip effect” and evaluate strategies to limit variation;
    - apply appropriate criteria in choosing suppliers, such as:
    - Can the vendor supply the needed quantity of materials at a reasonable price?
    - Is the quality good?
    - Is the vendor reliable?
    - Does the vendor have a favorable reputation?
    - Is the company easy to work with?
- describe the two main areas of distribution management.

5.1: Fluctuations in the Supply Chain

M. AFFAN BADAR, SHYAMSUNDARREDDY SAMMIDI, AND LESLIE GARDNER'S "REDUCING THE BULLWHIP EFFECT IN THE SUPPLY CHAIN: A STUDY OF DIFFERENT ORDERING STRATEGIES"

Read this article. The costs of the supply chain can have a negative effect on the organization's profitability. This is important because we must make wise choices when choosing the strategy to manage the supply chain. As you read, consider the importance of controlling the ordering strategy of the company.

REDUCING THE BULLWHIP EFFECT IN THE SUPPLY CHAIN: A STUDY OF DIFFERENT ORDERING STRATEGIES

Abstract

Profitability of a company can be affected by the costs associated with backlogs and large inventories due to the bullwhip effect in the supply chain. This work aims to find an ordering strategy that is practical and can minimize the bullwhip effect. Five strategies with different levels of information about inventory and components along the supply line have been compared with the just in time (JIT) pull strategy and the usage of point of sale (POS) data. This work uses the beer game spreadsheet simulation developed by Adams, Flatto, and Gardner (2008). The simulation shows material and information flow in a four-echelon supply chain. Expressions for cost incurred and profit obtained by each player (manufacturer, distributor, wholesaler, and retailer) have been developed. Graphs for cost and profit with time are plotted. The strategy using POS data is found to be the best, and the pull strategy to be the next best. However, both require discipline. This study shows that putting information about the inventory levels and components of the supply line into an ordering strategy can also minimize the bullwhip effect.

Keywords: Supply chain, bullwhip effect, ordering strategy, beer game, inventory

Introduction

A supply chain integrates, coordinates, and controls the movement of goods and materials from a supplier to a customer to the final consumer, which therefore involves activities like buying, making, moving, and selling (Emmett, 2005). Fast-rising supply chain risks are poorly understood and managed by most companies, according to the World Economic Forum (Ladbury, 2008). Profit is the main goal of any commercial organization. To obtain profit one should reduce the costs incurred by manufacturing the product economically and reduce the supply chain costs. Supply chain costs involve inventory costs, which have a considerable share in determining the cost

of the product. As the economy changes, as competition becomes more global, it is no longer company versus company, but it is supply chain versus supply chain (Henkoff, 1994).

Customer order plays a vital role in the supply chain; it actually triggers all the supply chain activities. Supply chain activities begin with a customer order and end when a satisfied customer has paid for the purchase (Chopra & Meindl, 2004). It should be noted that information flows in the supply chain are also as important as material flows. The whole supply chain process is kept moving by information flow from retailer to wholesaler, wholesaler to distributor, and distributor to manufacturer. Effective supply chain management maintains satisfied customers, growth in company market share, constant revenue growth, capability to fund continuous innovation, and capital investment for more value.

According to Simchi-Levi, Kaminsky and Simchi-Levi (2007) effective supply chain management reduces the costs incurred and thus increases the profit. It is very important to analyze demand and order in such a way that it reduces the costs incurred. Lead time is a critical component in making inventory decisions. Information delays are also one of the main components of total lead time, so electronic data interchange may reduce the delays and offer benefits through reduction in both the size and variability of orders placed (Torres & Moran, 2006).

Despite the undoubted benefits of the lean manufacturing and supply chain revolutions, supply chain instability still continues (often described as bullwhip effect), which harms firms, consumers, and the economy through excessive inventories and poor customer service (Torres & Moran, 2006). The bullwhip effect refers to the phenomenon where demand variability amplifies as one moves upstream in a supply chain, from consumption to supply points (from retailer to manufacturer) (Lee, Padmanabhan, & Whang, 1997a). It is an important demand and supply coordination problem that affects numerous organizations, and it is a major phenomenon in the beer game model (Kumar, Chandra, & a,p; Seppanen, 2007). Because of the bullwhip effect, the variability increases at each level of a supply chain as one move from customer sales to production (Chen, Drezner, Ryan, & Simchi-Levi, 2000). Lee et al. (1997a) lists demand signal processing, order batching, price fluctuations, and shortage gaming as the causes for bullwhip effect. Bhattacharya and Bandyopadhyay (2011) presented a good review of the causes of bullwhip effect. According to Chen (1999) a simple forecast formula, such as exponential smoothing or a simple moving average method can lead to bullwhip behavior in certain supply chain settings.

This work is focused toward supply chain costs by minimizing the bullwhip effect. A variety of remedies for the bullwhip effect have been proposed. For the beer game, Sterman (1989) modeled the ordering behavior of players in terms of an anchoring and adjustment heuristic. He used simulation to calculate the parameters that give the minimum total costs for the game. The beer game was developed by Sloan's System Dynamics Group in the early 1960s at MIT. It has been played all over the world by thousands of people ranging from high school students to chief executive officers and government officials (Sterman, 1992). Although this model is useful for simulation studies and development of theory, it probably has limited application for "real world" practitioners looking for effective decision rules. Industry experts and analysts have cited two recent innovations: the Internet and radio frequency identification (RFID), which t can improve supply chain performance by dampening the bull-whip effect (Lee, Padmanabhan, & Whang, 2004).

One of the most popular remedies is complete visibility of POS order data throughout the supply chain. However, Croson and Donohue (2003) conducted an experiment to evaluate whether humans actually use POS data in the beer game when such data was available. Interestingly they found that humans were still inclined to over order, although not as much as when POS data was not available. Thus, disciplined human behavior is required as well as visible information. Another potential remedy is the pull system of JIT manufacturing. Reducing variability in all aspects of a manufacturing system is one of the principles of JIT and lean manufacturing for eliminating waste and cost. JIT utilizes a pull system in which material is produced only when requested and moved to where it is needed. JIT partnerships throughout a supply chain occur when suppliers and purchasers work together to remove waste, drive down costs, and extend JIT to the supply chain (Heizer & Render, 2001). This can involve information sharing of forecasts as in point of sale (POS) strategies or can involve extending the pull system to the supply chain.

This study uses simulations developed in Microsoft Excel by Adams et al. (2008) to assess the impact of using simple adjustment heuristics based on information about inventory levels (inventory less backlog), orders in mail delays, materials in shipping delays, and the immediately upstream supplier's backlog to remedy the demand forecast updating the cause of the bullwhip effect in a four-echelon supply chain as represented by the beer game. The objective is to determine if providing all information about inventory levels and components along the supply line into an ordering strategy is superior to the JIT pull strategy and the use of POS data. Equations for cost and profit obtained by each player in the supply chain (manufacturer, distributor, wholesaler, and retailer) have been determined. The study assumes that the manufacturer satisfies the distributor's order and replenishes from limitless supply of raw material, while the distributor supplies the products to wholesaler, who in turn satisfies the demand of the retailer. The customer orders are placed with the retailer.

Background

Lee et al. (2004) mentioned that Forrester was the first person who documented the phenomenon of bullwhip effect, but the term was not coined by him. As per O'Donnell, Maguire, McIvor and Humphreys (2006), Forrester studied the dynamic behavior of simple linear supply chains and presented a practical demonstration of how various types of business policy create disturbance, and he stated that random meaningless sales fluctuations could be converted by the system into annual or seasonal production cycles.

The term "bullwhip effect" was coined by Procter & Gamble when researchers studied the demand fluctuations for Pampers. If there is no proper channel of information passage between the players in a supply chain (retailers, wholesalers, distributors and manufacturers), this leads to inefficiency like excessive inventories, quality problems, higher raw material costs, overtime expenses, and shipping costs (Lee et al. 1997a, b; Chen et al. 2000). According to Cao and Siau (1999) a change in demand is amplified as it passes between members in the supply chain.

Classic management techniques are widely employed to reduce the bullwhip effect in supply chains. In the JIT system, materials are moved when required, and the suppliers and purchasers work together to eliminate waste reducing the cost of production (Heizer & Render, 2001). Croson and Donohue (2003) examined the impact that POS data sharing had on ordering decisions in a multi-echelon supply chain. In a web-based simulation for supply chain management employing electronic data interchange similar to POS data, Machuca and Barajas (2004) found significant reductions in the bullwhip effect and supply chain inventory costs. Vendor- managed inventory (VMI) is another excellent method for reducing the bullwhip effect, and it has been employed by many international companies, such as Procter & Gamble and Wal-Mart, but the problem associated with this method is the sharing of information between retailer and factory (Lee et al. 1997a, b).

Warburton, Hodgson and Kim (2004) developed equations to compute the order and demand to nullify the bullwhip effect using a generalized order-up-to (OUT) policy. Control theory is another popular approach to reduce the bullwhip effect. Lin, Wong, Jang, Shieh, and Chu (2004) applied z-transforms to reduce the bullwhip effect, whereas Dejonckheere, Disney, Lambrecht, and Towill (2003) examined the bullwhip effect by using transfer function analysis. Many other researchers used computational intelligence techniques such as fuzzy logic, artificial neural networks, and genetic algorithms to reduce the bullwhip effect (O'Donnell et al. 2006). Carlsson and Fuller (2001) employed fuzzy logic. Goldberg (1989),Vonk, Jain, and Johnson (1997) and Moore and DeMaagd (2005) used genetic algorithms. Sarode and Khodke (2009) developed a multi-attribute decision-making technique: analytic hierarchy process (AHP).

A correct measurement is an essential start to investigating problems caused by demand amplification and to assess which measures can be taken to reduce this amplification.Fransoo and Wouters (2000) explained three issues in measuring the bullwhip effect: first, the sequence of aggregation of demand data, second filtering out the various causes of the bullwhip effect, and last the inconsistency in demand. Operational researchers also have worked on finding ways to reduce the bullwhip effect. For instance, Adelson (1966) studied simple supply chain

systems, but the methodology required complex mathematics for solving the problem (Towill, Zhou, & Disney, 2007).

Simulation also has been used in supply chain management to study the bullwhip effect. The beer game is a hands-on simulation that demonstrates material and information flows in a supply chain. As mentioned previously, it was developed by the Systems Dynamic Group of Sloan school of Management at the Massachusetts Institute of Technology. Using the beer game, Sterman (1989) demonstrated that the players systematically misinterpret feedback and nonlinearities, and underestimate the delays between action and response, which leads to bad decision making and causes problems in the behavior of the supply chain (Torres & Moran, 2006). Jacobs' (2000) Internet version of the beer game is brief in description and is limited solely to its characteristics and how that game is played. Machuca and Barajas' (2004) web-based simulation using an electronic data interchange resulted in significant reductions in the bullwhip effect and supply chain inventory costs. Moyaux and McBurney (2006) used some kinds of speculators in agent-based simulations and concluded that these speculators can decrease the price fluctuations caused by the bullwhip effect. However, these speculators are not cost efficient and price bubbles may occur, particularly if too many speculators are used.

In their study, Kaminsky and Simchi-Levi (1998) showed the bullwhip effect, and they explained the effect of passing from a decentralized structure to a centralized structure and also observed the effects of shortening the lead time. Steckel, Gupta, and Banerji (2004) examined how changes in order and delivery cycles, shared POS data, and patterns of consumer demand affected the dynamics in a channel and thereby the severity of the bullwhip effect.

Cangelose and Dill (1965) considered the problem of the bullwhip effect from an organizational learning perspective. Jung, Ahn, Ahn, and Rhee (1999) analyzed the impacts of buyers' order batching had on the supplier demand correlation and capacity utilization in a simple branching supply chain involving two buyers whose demands are correlated; they found that increase in the size of the order lot mitigates the correlation of purchase orders. Cachon & Lariviere (1999) investigated the performance of balanced ordering policies in a supply chain model with multiple retailers and summarized that the bullwhip effect would depend on the order cycle and batch size. They recommended balanced ordering with small batch size and a long order interval to reduce the suppliers' demand variance.

This section has summarized a review of literature on the bullwhip effect. Researchers have employed JIT and POS data, mathematical techniques, algorithms, simulation, and balancing of order and delivery cycles in order to reduce the bullwhip effect.

The Beer Game

The beer game is played as a board game with four players: a retailer, a wholesaler, a distributor, and a factory (Adams et al., 2008). Customer orders are placed with the retailer who fills them to the extent possible. The retailer then orders from the wholesaler to replenish his/her stock. Similarly the wholesaler fills retailer orders and replenishes from the distributor who in turn fills wholesaler orders and replenishes from the factory. The factory fills distributor orders and replenishes from a limitless supply of raw material. All players keep records of backlogs, or unfilled orders, and attempt to fill them as soon as possible. Shipping delays of two weeks (or periods) separate each player, as do information delays of two periods. Initially, all four players have twelve units of inventory, and four units of inventory are on each square representing a shipping delay. Similarly, all of the orders in the information pipeline at the start of the game are for four units. The game board is shown in Figure 1.

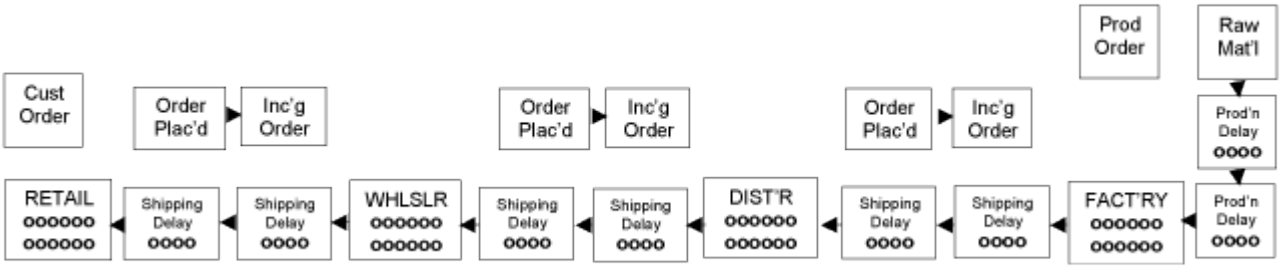


Figure 1: The Initial Setup for the Board Game Version of the Beer Game (taken from Adams et al. 2008) The objective of the game is to fill all customer orders without carrying excessive inventories or having excessive backlogs. The players must fill backlogs eventually. For the first several periods of the game, the customer orders are at four units each period. At some point, the customer orders jump to eight units and remain at that level for the rest of the game. The only stochastic part of the beer game is the human behavior in placing orders but human behavior rarely fails to produce the bullwhip effect. The game runs for 50 periods or until the players become frustrated with excessive backlogs and inventories and the point about the bullwhip effect has been made.

Methodology

The objective of this work is to find whether using information about inventory levels and components of the supply line into an ordering strategy is superior to the JIT pull strategy and the use of POS data at all levels of supply chain. To explore this, cost incurred and profit obtained by each member in a four-echelon supply chain (manufacturer, distributor, wholesaler, and retailer) are computed. For finding the costs incurred and profit obtained, data from spreadsheet beer game simulation developed by Adams et al. (2008) is used. After calculating costs and profit for each player of the supply chain, graphs are plotted between cost versus week (period) and profit versus week for seven different ordering strategies. These graphs have also been plotted for different lead times by Sammidi (2008); however, this paper uses the lead time of two periods.

Sterman (1989) developed an expression for ordering behavior in the beer game in terms of adjustment heuristic that is,

$IO_t = \L_t + AS_t + ASL_t$

Where:

- IO_t – Order rate in time period t,
- $\L_t$ – expected demand in period t,
- AS_t – Difference between the desired stock and actual stock in period t, and
- ASL_t – Difference between the desired and actual supply line in time period t.

The anchoring heuristic $\L_t$ is often determined using exponential smoothing as follows:

$\L_t = \theta L_{t-1} + (1-\theta)\L_{t-1}$

Where L_{t-1} is the demand for the previous period, $\L_{t-1}$ is the forecast value of demand for previous period, θ is a parameter varying between 0 and 1.

The adjustment for stock AS_t is the difference between the desired stock S* and the actual stock S_t multiplied by a parameter α_s ($0 \le \alpha_s \le 1$) specifying the fraction of the difference ordered each period.

$AS_t = \alpha_s(S^* - S_t)$

The adjustment for supply line is the difference between desired supply line SL* and the actual supply line multiplied by a parameter α_{SL} specifying the fraction of the difference ordered each period.

$ASL_t = \alpha_{SL}(SL^*_t - SL_t)$

The supply line consists of orders in mail delays, the immediately upstream supplier's backlog, and the material

in shipping delays (Adams et al., 2008). We can have for orders: 0 ≤α_{SLO} ≤ 1; for material: 0 ≤ α_{SLM} ≤ 1; and for upstream backlog 0 ≤ α_{SLB} ≤ 1.

The cost incurred by each member is calculated by finding the various costs involved. The cost includes the price of the product, ordering cost, holding costs or inventory cost, and the backlog cost. The backlog cost is the cost, which the supplier must pay as a penalty if he/she cannot deliver the product within the time actually agreed upon. The backlog cost per item is computed by assuming it to be double the cost of the inventory per item (Nienhaus, Zeigenbein, & Schoensleben, 2006). Thus,

Total cost = (Cost per item*number of items ordered) + Ordering cost + Inventory cost (2*Inventory cost per item*number of backlog items)

The ordering cost per order and inventory cost per item are assumed to be $100 and $0.5, respectively for each member in the four-echelon supply chain. Hence,

Total cost = Price per item*number of items ordered + 100 + 0.5*number of items in Inventory + 2*0.5* number of backlog items.

The value of price per item increases from manufacturer to retailer. The price per item for the manufacturer is assumed to be $10, and then it is increased by 2.5 times $10 when it comes to the distributor and then 2.5 times the price of the distributor for the wholesaler and then again 2.5 times the price of the wholesaler for the retailer. Thus, the price per item for distributor is $25, for wholesaler it is $62.5 and for the retailer it is $156.25. The number of items ordered, the number of items in inventory, and the backlogs values have been taken from the simulation developed by Adams et al. (2008). After finding the total cost incurred for each member, the revenue of each member of the supply chain is calculated. The revenue for the manufacturer is the price that the distributor pays for the product; the revenue for the distributor is the price that the wholesaler pays for the product; and the revenue for the wholesaler is the price that the retailer pays for the product.

Profit of each member is calculated by deducting their cost incurred from their revenue obtained, and graphs are developed for seven different cases. Sammidi (2008) contains the detailed work. The seven cases are shown in Table 1.

Table 1. Anchoring and Adjustment Cases (Adams et al. 2008)

Case	L_t	AS_t	ASL_t
1	θ = 1, (Pull)	α_s = 1, (12 – (inv – bklg))	None
2	Pull	12 – (inv – bklg)	α_{SLO} = 1, α_{SLM} = 0, α_{SLB} = 0, (Less orders)
3	Pull	12 – (inv – bklg)	α_{SLO} = 0, α_{SLM} = 1, α_{SLB} = 0, (Less material)
4	Pull	12 – (inv – bklg)	α_{SLO} = 1, α_{SLM} = 1, α_{SLB} = 0, (Less material and orders)
5	Pull	12 – (inv – bklg)	α_{SLO} = 1, α_{SLM} = 1, α_{SLB} = 1, (Less material, orders, and upstream supplier's backlog)
6	Pull	α_s = 0, None	None
7	POS	Not applicable	Not applicable

Among the seven cases mentioned, the first five cases demonstrate the reduction in bullwhip effect as more and more information is interpreted into the supply line. The first case uses an anchoring heuristic of ordering what was ordered, which is equivalent to the pull system, but with a stock adjustment of the full difference between the ideal stock of 12 and the inventory level, that is, 12 – (inventory – backlog). This case displays the largest bullwhip effect as shown in Figures 2-3 of all cases studied. Cases 2 – 5 use the same anchoring and stock adjustment heuristics of Case 1, but they have supply line adjustment heuristics that compensate for more and more of the supply line (orders in mail delays, material in shipping delays, and immediate upstream supplier's backlog). As more and more of the supply line is compensated, the bullwhip effect diminishes in Cases 2 – 4 until it is completely eliminated in Case 5, when the entire supply line consisting of the sum of the orders in mail delays, the immediate upstream supplier's backlog, and the material in shipping delays is accounted for.

This paper shows graphs in Figures 2 – 6 for cost and profit versus period (week) for four cases with lead time

of two periods. Because profit is revenue minus cost, the profit graph takes into consideration the effect on cost. Hence, there is no need to display the cost versus week graph for each of the cases. Cost and profit for Case 1 are displayed in Figures 2 and 3. Case 1 illustrates the maximum bullwhip effect when no supply chain line information is provided. Case 5 (Figure 4), Case 6 (Figure 5), and Case 7 (Figure 6) show that the bullwhip effect is eliminated. In Case 5, adjustments for supply chain in terms of order delay, material in shipping delay, and upstream backlog have been taken into account. Case 6 is pull strategy, which does not adjust for either stock or supply line. It does not show any bullwhip but produces a steady-state error. This error is better than the bullwhip effect. Also the steady error of Case 6 is slightly better than that of Case 5. In Case 7 there is complete exchange of data between the members of the supply chain, which eliminates the bullwhip effect. However, Case 6 and Case 7 both require discipline and at times are not easy for companies to follow.

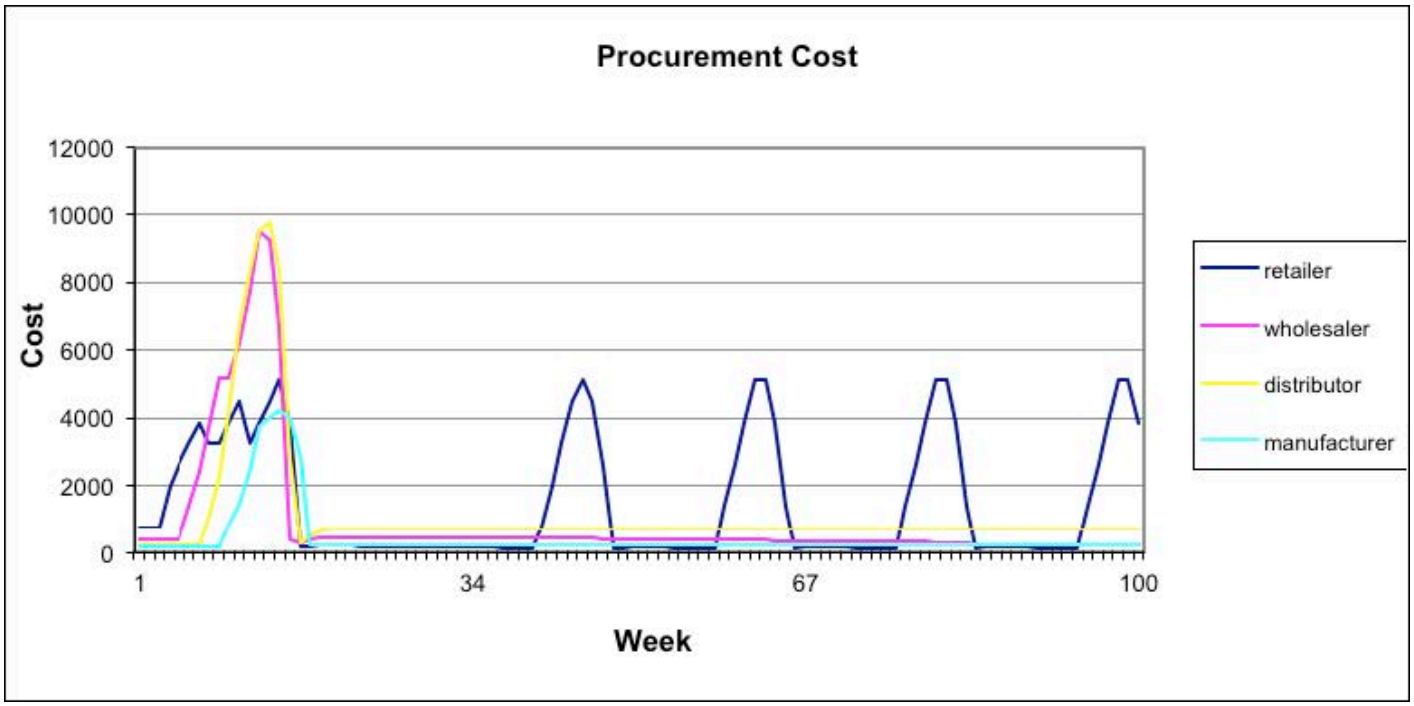


Figure 2. Case 1: Cost for Maximum Bullwhip Effect without Supply Line Informatio

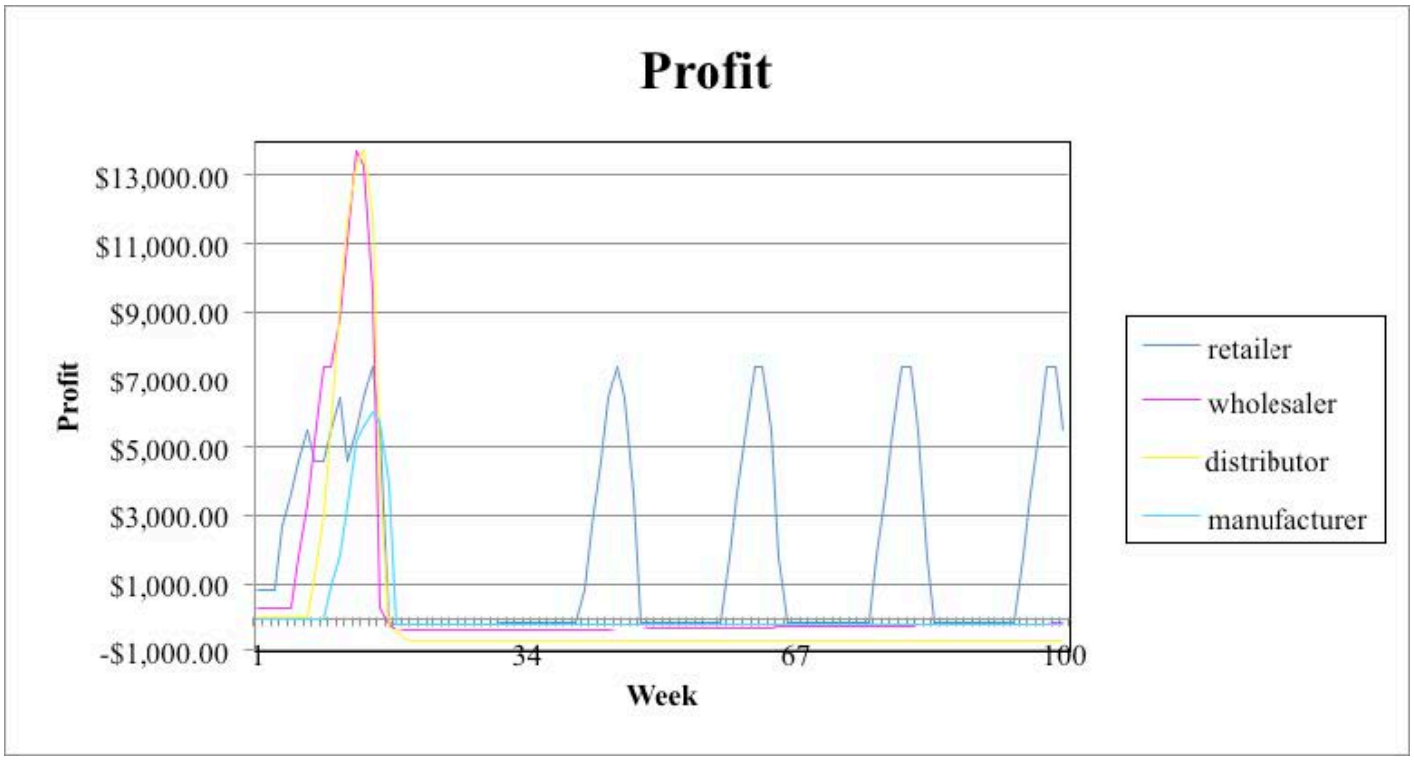


Figure 3. Case 1: Profit for Maximum Bullwhip Effect without Supply Line Information

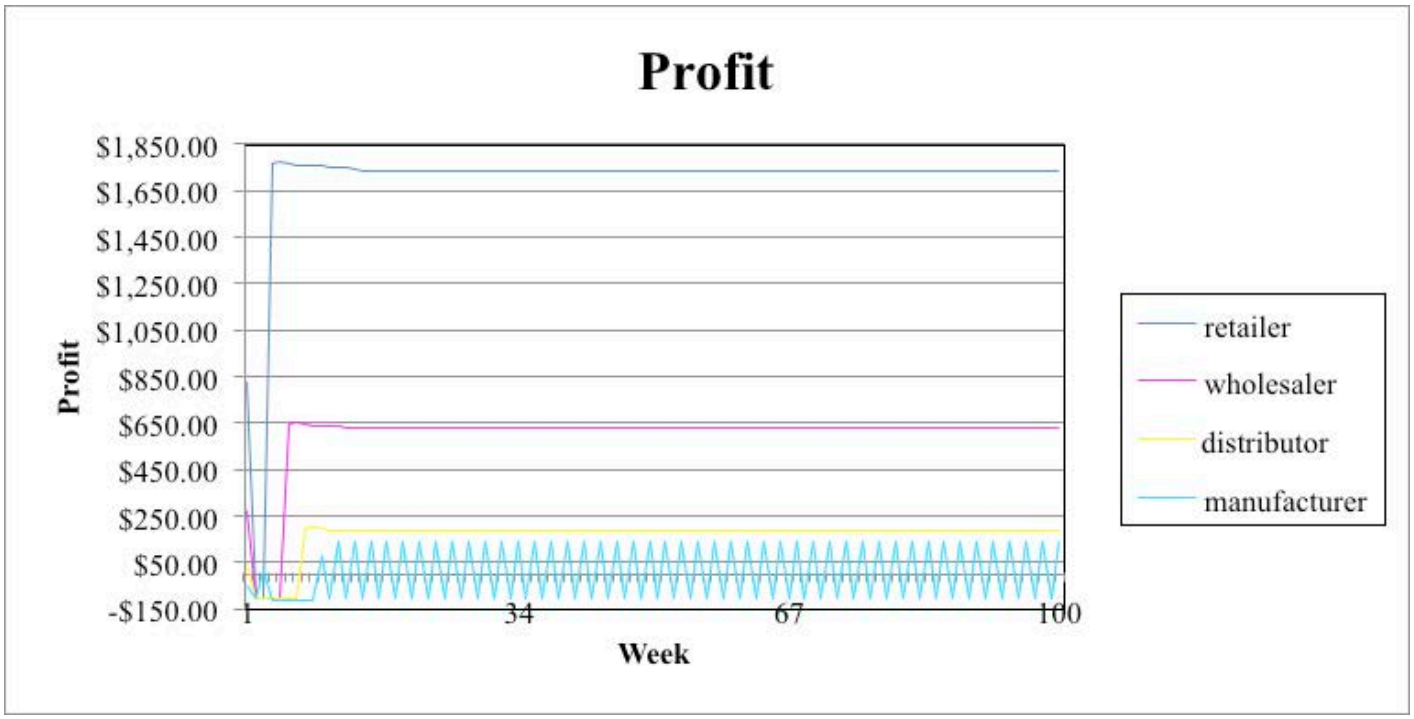


Figure 4. Case 5: Elimination of Bullwhip Effect on Profit by Compensation for Material, Orders, and Upstream Supplier's Backlog in the Supply Line

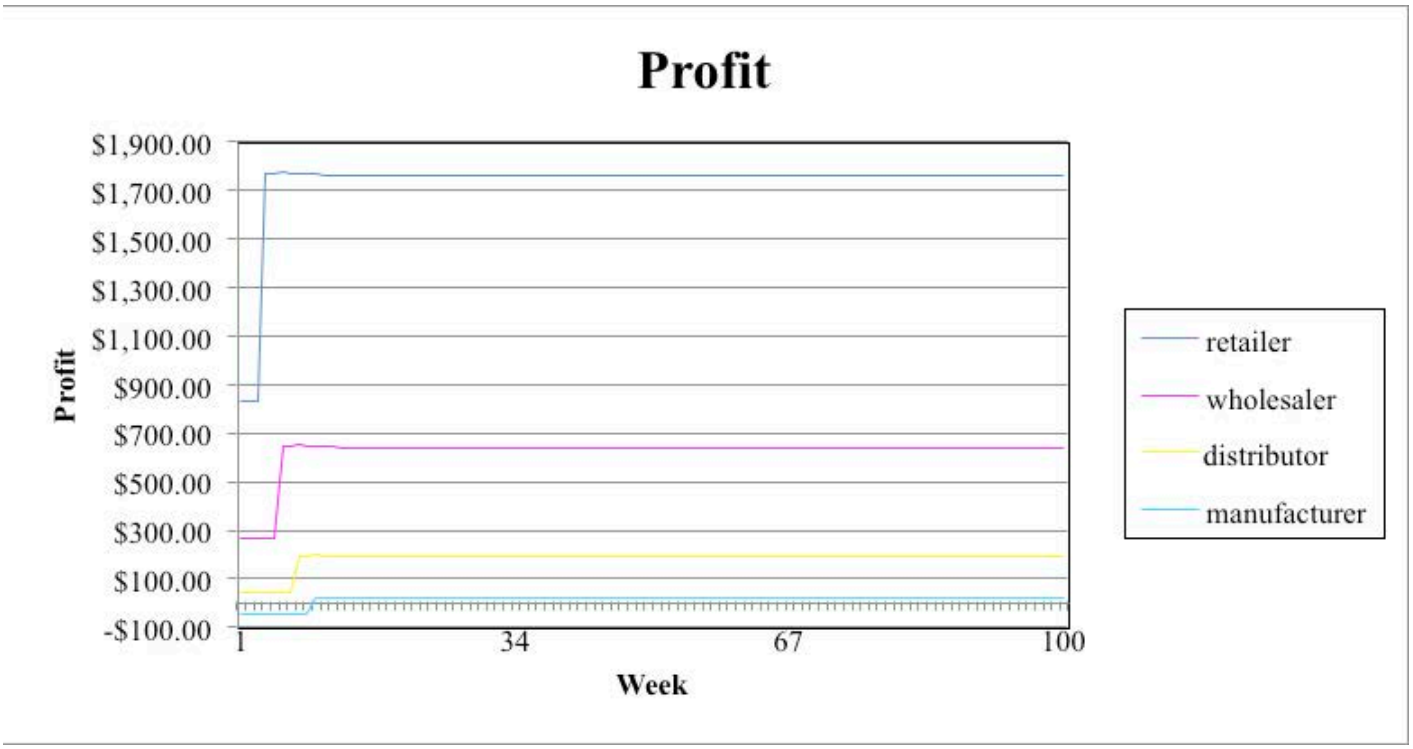


Figure 5. Case 6: Elimination of Bullwhip Effect on Profit by Pull Strategy

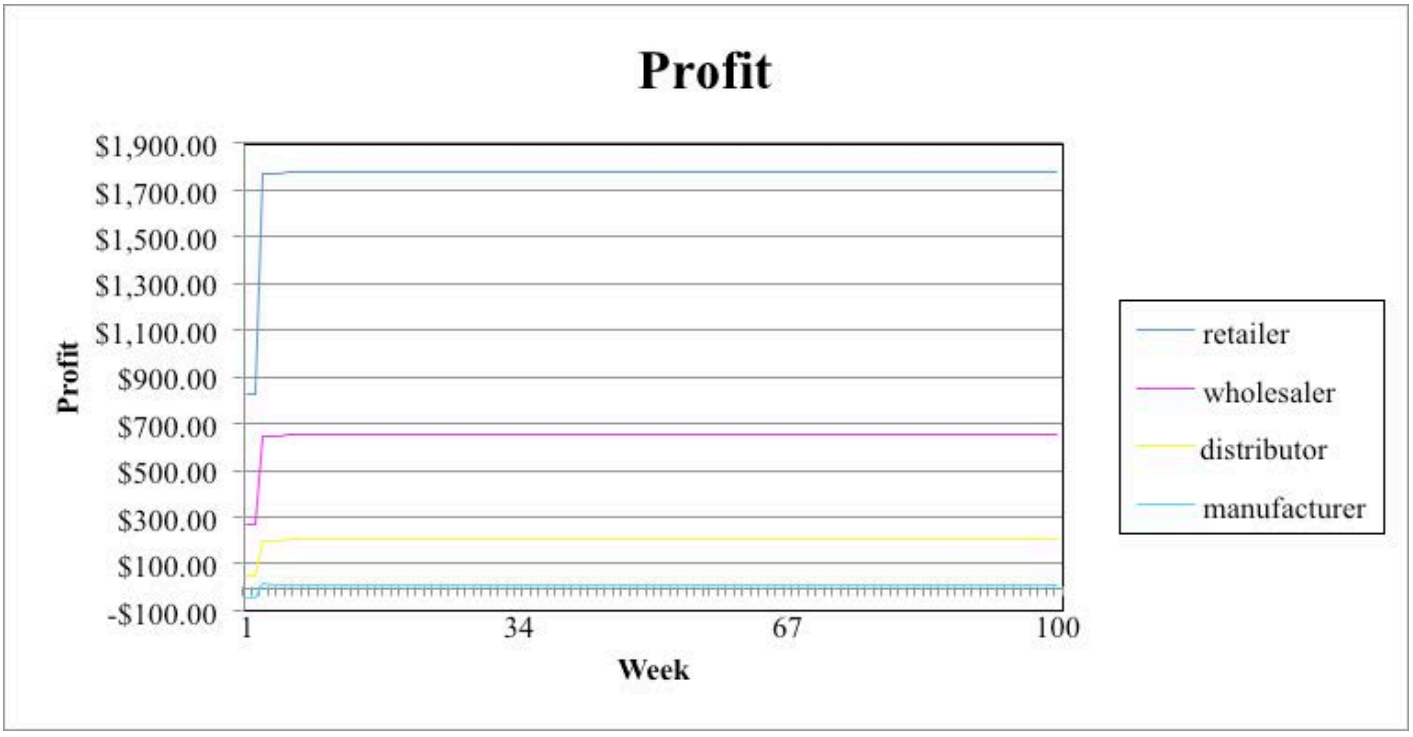


Figure 6. Case 7: POS Eliminates Bullwhip Effect and Backlog

Conclusion

This study is an extension of the work done by Adams et al. (2008), and it uses the beer game spread sheet

simulation developed by them. The beer game (Sterman, 1992), shows information and material flow in a four-echelon supply chain. An attempt has been made in the current work to find an ordering strategy that is easy to employ and can minimize the bullwhip effect. Five strategies (Case 1 through Case 5) with different levels of information about inventory and components along the supply line have been compared with the JIT pull strategy (Case 6) and the usage of POS data (Case 7). The cost incurred and profit obtained by each player (manufacturer, distributor, wholesaler, and retailer) of the supply chain for the seven ordering strategies have been determined. Graphs for cost and profit versus time have been plotted.

From the graphs it is evident that as more and more information is provided for the inventory and components along the supply line from Case 1 through Case 5, the bullwhip effect is reduced. Case 1 uses an anchoring heuristic of ordering what was ordered and a stock adjustment to compensate for the difference between the ideal stock and the inventory level. This case shows the largest bullwhip effect. Cases 2 – 5 use the same anchoring and stock adjustment heuristics of Case 1, but have supply line adjustment heuristics that compensate for more and more of the supply line. As more and more of the supply line is compensated, the bullwhip effect diminishes in Cases 2 – 4 until it is completely eliminated in Case 5, when the entire supply line consisting of the sum of the orders in mail delays, the immediate upstream supplier's backlog, and the material in shipping delays is accounted for.

Case 6 is a pull strategy, which does not adjust for either stock or supply line. It does not show any bullwhip, but it produces a steady-state error. This error is better than the bullwhip effect. Also the steady error of Case 6 is slightly better than that of Case 5. In Case 7 there is complete exchange of data between the members of the supply chain, which eliminates the bullwhip effect. Thus, Case 7 where POS data is used is the best strategy that eliminates the bullwhip effect and Case 6 (pull strategy) is the next best. However, Case 6 and Case 7 both require discipline and at times are not easy for companies to follow. POS has an additional issue because of the reluctance between each member of the supply chain to share information. In such circumstances, Case 5 is a reasonable strategy with better applicability.

5.2 Supply Chain Procurement

11.3 MANAGING THE PRODUCTION PROCESS IN A MANUFACTURING COMPANY

Learning Objective

1. Identify the activities undertaken by the operations manager in overseeing the production process in a manufacturing company.

Once the production process is in place, the attention of the operations manager shifts to the daily activities of materials management, which encompass the following activities: purchasing, inventory control, and work scheduling.

PURCHASING AND SUPPLIER SELECTION

The process of acquiring the materials and services to be used in production is called purchasing (or *procurement*). For many products, the costs of materials make up about 50 percent of total manufacturing costs. Not surprisingly, then, materials acquisition gets a good deal of the operations manager's time and attention.

As a rule, there's no shortage of vendors willing to supply parts and other materials, but the trick is finding the *best* suppliers. In selecting a supplier, operations managers must consider such questions as the following:

- Can the vendor supply the needed quantity of materials at a reasonable price?
- Is the quality good?
- Is the vendor reliable (will materials be delivered on time)?
- Does the vendor have a favorable reputation?
- Is the company easy to work with?

Getting the answers to these questions and making the right choices—a process known as supplier selection—is a key responsibility of operations management.

E-Purchasing

Technology is changing the way businesses buy things. Through *e-purchasing* (or *e-procurement*), companies use the Internet to interact with suppliers. The process is similar to the one you'd use to find a consumer good—say,

a forty-two-inch LCD high-definition TV—over the Internet. You might start by browsing the Web sites of TV manufacturers, such as Sony or Samsung, or electronics retailers, such as Best Buy. To gather comparative prices, you might go to a comparison-shopping Web site, such as Amazon.com, the world's largest online retailer. You might even consider placing a bid on eBay, an online marketplace where sellers and buyers come together to do business through auctions. Once you've decided where to buy your TV, you'd complete your transaction online, even paying for it electronically.

If you were a purchasing manager using the Internet to buy parts and supplies, you'd follow basically the same process. You'd identify potential suppliers by going directly to private Web sites maintained by individual suppliers or to public Web sites that collect information on numerous suppliers. You could do your shopping through online catalogs, or you might participate in an online marketplace by indicating the type and quantity of materials you need and letting suppliers bid on prices. (Some of these e-marketplaces are quite large. Covisint, for example, which was started by automakers to coordinate online transactions in the auto industry, is used by more than two hundred and fifty thousand suppliers in the auto industry, as well as suppliers in the health care field.)[1] Finally, just as you paid for your TV electronically, you could use a system called electronic data interchange (EDI) to process your transactions and transmit all your purchasing documents.

The Internet provides an additional benefit to purchasing managers by helping them communicate with suppliers and potential suppliers. They can use the Internet to give suppliers specifications for parts and supplies, encourage them to bid on future materials needs, alert them to changes in requirements, and give them instructions on doing business with their employers. Using the Internet for business purchasing cuts the costs of purchased products and saves administrative costs related to transactions. And it's faster for procurement and fosters better communications.

INVENTORY CONTROL

If a manufacturer runs out of the materials it needs for production, then production stops. In the past, many companies guarded against this possibility by keeping large inventories of materials on hand. It seemed like the thing to do at the time, but it often introduced a new problem—wasting money. Companies were paying for parts and other materials that they wouldn't use for weeks or even months, and in the meantime, they were running up substantial storage and insurance costs.

Most manufacturers have since learned that to remain competitive, they need to manage inventories more efficiently. This task requires that they strike a balance between two threats to productivity: losing production time because they've run out of materials, and wasting money because they're carrying too much inventory. The process of striking this balance is called inventory , and companies now regularly rely on a variety of inventory-control methods.

Just-in-Time Production

One method is called just-in-time (JIT): the manufacturer arranges for materials to arrive at production facilities *just in time* to enter the manufacturing process. Parts and materials don't sit unused for long periods, and the costs of "holding" inventory are significantly cut. JIT, however, requires considerable communication and cooperation between the manufacturer and the supplier. The manufacturer has to know what it needs, and when. The supplier has to commit to supplying the right materials, of the right quality, at exactly the right time.

Material Requirements Planning

Another method, called material requirements planning (MRP), relies on a computerized program both to

1. Jingzhi, "Covisint.com," http://www.sftw.umac.mo/~jzguo/pages/covisint.html (accessed November 2, 2011).

calculate the quantity of materials needed for production and to determine when they should be ordered or made. Let's say, for example, that you and several classmates are planning a fund-raising dinner for the local animal shelter. First, you estimate how many people will attend—say, fifty. Next, you plan the menu—lasagna, garlic bread, salad, and cookies. Then, you determine what ingredients you'll need to make the food. Next, you have to decide when you'll need your ingredients. You don't want to make everything on the afternoon of the dinner; some things—like the lasagna and cookies—can be made ahead of time. Nor do you want to buy all your ingredients at the same time; in particular, the salad ingredients would go bad if purchased too far in advance. Once you've made all these calculations and decisions, you work out a schedule for the production of your dinner that indicates the order and timing of every activity involved. With your schedule in hand, you can determine when to buy each ingredient. Finally, you do your shopping.

Though the production process at most manufacturing companies is a lot more complex than planning a dinner (even for fifty), an MRP system is designed to handle similar problems. The program generates a production schedule based on estimated output (your food-preparation timetable for fifty guests), prepares a list of needed materials (your shopping list), and orders the materials (goes shopping).

The basic MRP focuses on material planning, but there's a more sophisticated system—called manufacturing resource planning (MRP II)—that goes beyond material planning to help monitor resources in all areas of the company. Such a program can, for instance, coordinate the production schedule with HR managers' forecasts for needed labor.

WORK SCHEDULING

As we've seen, manufacturers make profits by transforming inputs (materials and other resources) into outputs (finished goods). We know, too, that production activities, like all business activities, have to be *controlled*: they have to be monitored to ensure that actual performance satisfies planned performance. In production, the control process starts when operations managers decide not only *which* goods and *how many* will be produced, but *when*. This detailed information goes into a master production schedule (MPS). To draw up an MPS, managers need to know where materials are located and headed at every step in the production process. For this purpose, they determine the *routing* of all materials—that is, the work flow of each item based on the sequence of operations in which it will be used.

Key Takeaways

- Once the production process is under way, the attention of the operations manager shifts to the daily activities of **materials management**, which encompasses materials **purchasing**, **inventory control**, and work scheduling.
- Because material costs often make up about 50 percent of total manufacturing costs, vendor selection and material acquisition gets a good deal of the operations manager's time and attention.
- In recent years, the purchasing function has been simplified through technology advances, including e-purchasing and **electronic data interchange (EDI)**, which process transactions and transmit purchasing documents.
- Commonly used inventory control methods include **just-in-time (JIT) production**, by which materials arrive just in time to enter the manufacturing process, and **material requirements planning (MRP)**, which uses computer programming to determine material needs.
- To schedule jobs, managers create a **master production schedule (MPS)**.

Exercise

What is e-purchasing (or e-procurement)? How does it work? What advantages does it give a purchasing manager? How does it benefit a company? How does it change the relationship between purchasing managers and vendors?

UNIT 5 DISCUSSION

#1
Choosing suppliers for your supply chain is often a challenge. Do you put all your eggs in one basket or look to fulfill your needs through multiple vendors? Using the information provided over choosing a good supplier, apply the criteria to the purchase of a new car. Discuss your answers to the following questions: Is the quality good, is the vendor reliable, does the vendor have a favorable reputation, is the company easy to work with? Based on your answers, which of the vendor would be your choice? Why?

5.3: Supply Chain Distribution

BOUNDLESS: *BUSINESS*, "CHAPTER 10, SECTION 4, PART 8: INVESTMENT IN OPERATIONS"

Read this section to explore supply chain optimization. Supply chains must be fast, cheap and reliable for a good return-on-investment. This section is important because it focuses on how to focus on designing a supply chain that allows for the manufacturing and distribution of products and a low cost and high profit.

INVESTMENT IN OPERATIONS

Investment in information technology has made supply chains faster, cheaper, and more reliable.

LEARNING OBJECTIVE

- Examine the effect of technological advances on supply chain optimization

KEY POINTS

- Supply chain optimization applies processes and tools that ensure the optimal operation of a manufacturing and distribution supply chain.
- Supply chain managers try to maximize the profitable operation of their manufacturing and distribution supply chain.
- Supply chain optimization may include refinements at various stages of the product lifecycle, and new, ongoing, and obsolete items are optimized in different ways.
- Optimization solutions are typically part of, or linked to, the company's replenishment systems distribution requirements planning, so that orders can be automatically generated to maintain the model stock profile. The algorithms used are similar to those used in making financial investment decisions; the analogy is quite precise, as inventory can be considered to be an investment in prospective return on sales.
- Supply chain optimization may include refinements at various stages of the product lifecycle, so that new, ongoing and obsolete items are optimized in different ways: and adaptations for different classes of products, for example seasonal merchandise.

TERM

- **supply chains**: A supply chain is a system of organizations, people, technology, activities, information and resources involved in moving a product or service from supplier to customer.

EXAMPLE

- Because the movement of product (called the stock transfer) needs to be in economic shipping units (i.e., complete unit loads or full truckloads), a series of decisions must be made. Many existing distribution planning systems round quantities up to the nearest full shipping unit. The creation of truckloads, for example, as economic shipping units requires optimization systems that ensure that axle constraints and space constraints are met, and that loading can be achieved in a damage-free way. These goals are generally achieved by adding time-phased requirements until loads meet a specified minimum weight or cube.

FULL TEXT

Supply chains have become faster, cheaper, and more reliable through investment in information technology, cost-analysis, and process-analysis.

Supply chain optimization applies processes and tools that ensure optimal operation of a manufacturing and distribution supply chain. These include the optimal placement of inventory within the supply chain and the minimizing of operating costs associated with manufacturing, transportation, and distribution. Optimization may also incorporate computer-based mathematical modeling techniques.

Ongoing investment in a company's operations is necessary in order for supply chain optimization to be achieved. Supply chain managers may employ optimization such as maximizing gross margin return on inventory invested (GMROII); balancing the cost of inventory at all points in the supply chain with availability to the customer; minimizing total operating expenses (e.g., transportation, inventory, and manufacturing); and maximizing gross profit of products distributed through the supply chain.

Supply chain optimization addresses the general supply chain problem of delivering products to customers at low cost and high profit. This involves balancing the costs of inventory, transportation, distribution, and manufacturing, and supply chain optimization has applications in all industries that manufacture and/or distributegoods (retail, industrial, and/or consumer packaged goods [CPG]).

The classic supply chain approach has been to forecast future inventory demand using statistical trending and "best fit" techniques, which are based on historic demand and predicted future events. The advantage of this approach is that it can be applied to data aggregated at a fairly high level (e.g., category of merchandise; weekly, by customer category), thus requiring modest database sizes and small amounts of manipulation. Unpredictability in demand is subsequently managed by setting safety stock levels; for example, a distributor might hold two weeks of supply for a steadily in-demand article but twice that supply for an article whose demand is more erratic.

Using this forecast demand, a supply chain manufacturing and distribution plan is created to manufacture

and distribute products to meet the demand at low cost and/or high profit. This plan typically addresses several questions:

- How much of each product should be manufactured each day?
- How much of each product should be made at each manufacturing plant?
- Which manufacturing plants should re-stock which warehouses with which products?
- What transportation modes should be used for warehouse replenishment and customer deliveries?

The technical ability to record and quickly manipulate large databases has allowed for the emergence of a new breed of supply chain optimization solutions, which are capable of forecasting at a granular level (for example, per article per customer per day). Some vendors are applying “best fit” models to this data, to which safety stock rules are applied, while other vendors have started to apply stochastic techniques to the optimization problem.

Supply chain optimization may include additional refinements at various stages of the product lifecycle, and new, ongoing, and obsolete items are optimized in different ways. Finally, while most software vendors are offering supply chain optimization as a packaged solution and integrated in ERP software, some vendors are running the software on behalf of clients as application service providers.

Unit 5 Activity and Grading Rubric

In this activity, you will continue working on your operations management plan. As part of your continuing development of your operations management plan, discuss the goal of supply chain management and its application within your business.

Learning Outcome
Discuss the goal of supply chain management and its application in a variety of organizational settings.

Specifications:

- 2-3 page paper
- Created in a Word document
- Follows APA, 6th edition formatting
- Includes a Reference page for cited sources

Instructions: Continue the operations management plan by writing a 2-3 page paper that discusses the role of the supply chain in your operations. It is okay if some of the information overlaps with your purchasing activities. Use at least 4 scholarly sources to write about how supply chain management applies to your organization and answer the following questions:

1. What are the goals of supply chain management in terms of your operations? How will these goals affect your operations?
2. Discuss if you will need to implement a global supply chain management strategy. Why or why not?
3. Identify any suppliers or vendors you plan to utilize and why.
4. Discuss how you will address shortages of supply whether it is equipment or employees as you propose developing this business.
5. Discuss if you will attempt to acquire a supplier or vendor in order to have a greater span of control over the supply chain process.

Please score your paper or have a friend score your paper using the following “rubric,” or “scoring guide.” The levels will equate to the following letter grades:
4 = A; 3 = B; 2 = C; 1 = D; and 0 = F

Level	Criterion
Research and Documentation (40%)	
4	The paper should use at least 4 references from peer-reviewed/scholarly sources to address the activity instructions. Any in-text citations MUST be cited in APA format using the APA Manual 6th edition. You should also include a References page, also in APA format, at the end of your paper to cite any sources used.
3	The paper uses at least three scholarly sources to support your content, but it does not meet the minimum requirement for 4 sources.
2	Three or more popular sources (i.e. newspapers, internet sites, magazines, etc.) make up a majority of the references to support your content. The paper lacks credible, scholarly sources and does not meet the minimum number of sources required.
1	The paper includes one or two sources. The paper lacks the use of credible, scholarly sources and may focus on using popular sources. The number of sources used does not meet the minimum requirement (4 sources) and the resources used may not fully support the content of your paper.
0	The paper fails to cite referenced sources, or does not include any research or sources to support ideas. The paper is based off of non-original content.
Analysis and Argument (40%)	
4	Your paper addresses the three questions in the instructions with the use of supporting evidence and specific details and explanation. You effectively address the following: 1. What are the goals of supply chain management in terms of your operations? How will these goals affect your operations? 2. Discuss if you will need to implement a global supply chain management strategy. Why or why not? 3. Identify any suppliers or vendors you plan to utilize and why. 4. Discuss how you will address shortages of supply whether it is equipment or employees as you propose developing this business. 5. Discuss if you will attempt to acquire a supplier or vendor in order to have a greater span of control over the supply chain process.
3	The content addresses only some of the questions presented in the instructions section and reflects minimal original thought and /or critical analysis relative to the business.
2	The content is vague and is weakly supported by researched evidence. The essay lacks critical analysis relative to the business.
1	The content does not address the required elements; ideas presented are not supported by research or critical analysis.
0	There is a lack of critical analysis for the operation management plan, and/or the essay does not address the business content from the Unit 1 Activity.
Grammar/Style (15%)	
4	The content contains a maximum of two grammatical, citation, and punctuation errors. The ideas are concise and presented in a logical manner that is easy for the reader to follow.
3	The content contains three or four grammatical, citation, punctuation, and/or spelling errors. The sentence structure flows in a concise, logical manner.
2	The paper contains more than four grammatical, citation, punctuation and/or spelling errors that distract the reader from the comprehension of ideas being presented.

1	The paper demonstrates poor writing skills, reflected by lack of syntax and proper grammar, which makes ideas difficult to communicate. Ideas are not presented in a logical manner that is easy to follow.
0	The paper contains numerous grammatical, citation, punctuation, and/or spelling errors.
Format (5%)	
4	The paper should properly formatted (paragraph style, margins, etc.), using the APA Manual, 6th edition. The content is typed in MS Word format, labeled with the student's name and the activity title/unit number, and a reference section to cite any outside sources used.
3	The paper meets most of the requirements for formatting, using the APA Manual, 6th edition, though may contain some errors.
2	The paper lacks proper formatting, based on the APA Manual, 6th edition, and it may use another style of formatting (i.e. MLA, Chicago, etc.).
1	The paper is typed in a format other than MS Word. A style of formatting other than APA may be used, or there are numerous formatting errors that distract the reader's comprehension.
0	The formatting does not comply with the APA Manual, 6th edition and is not created in MS Word.

UNIT 6: JUST-IN-TIME AND LEAN SYSTEMS

Unit 6: Just-In-Time and Lean Systems

Would you order a delivery pizza for dinner from a restaurant advertising delivery in 6 hours? How about a restaurant that can bring you a cold, stale pizza in only 5-minutes? To meet the consumer's needs, the pizza shop must be able to give customers the number of pizzas they want when they want it. Preparing pizzas in advance is too wasteful because most consumers are not likely to buy a stale pizza. Meanwhile, if you take too long to deliver the pizza, you will lose customers to a more responsive competitor. The concept of just-in-time focuses on making what you need to meet customer demand only when you need it. For a pizza delivery shop, that probably means a fresh pizza at the customer's door in around 30 minutes. This philosophy can apply to a range of operations, from simply washing a car to manufacturing a complex aircraft.

Similarly, the concept of lean manufacturing refers to eliminating waste in the manufacturing process. The Toyota Product System is the model for modern manufacturers that want to control waste. In this unit, we will look at seven types of waste and processes for controlling them. In addition, we will explore the origins of the "Just-in-Time" (JIT) philosophy and the use of pull systems to control inventory.

Unit 6 Learning Outcomes

Upon successful completion of this unit, you will be able to:

- discuss the origin of the “just-in-time” (JIT) philosophy;
- apply continuous quality improvement strategies to improve organization processes;
- categorize non value-adding activities into eight types of waste:
    - defects
    - overproduction
    - waiting
    - non-utilized talent
    - transportation
    - inventory
    - motion, and
    - extra-processing;
- explain the use of “kanbans” in JIT pull systems; and
- describe the strategic elements in Lean for the use in manufacturing and service organizations.

6.1: Lean Manufacturing

BOB ALLEN'S "SBDC LEAN MANUFACTURING SUCCESS"

Watch this video to review the use of Lean methods in the manufacturing process to reduce waste and increase continuous quality improvement. Waste can be placed in eight different categories. This video is useful because of the guidance it provides in avoiding pitfalls that have hindered organizations from successfully using Lean methods to increase CQI.

One or more interactive elements has been excluded from this version of the text. You can view them online here:
https://pressbooks.nscc.ca/operationsmanagement2/?p=215#oembed-1

15.6 LEAN CONTROL

Learning Objectives

1. Know what is meant by lean controls, and why the subject can be confusing.
2. Understand the application of lean.
3. Know the five core principals of lean.

Lean control, or simply lean, has become an immensely popular business control and improvement methodology in recent years. Lean control is a highly refined example of nonfinancial controls in action. Lean is a system of nonfinancial controls used to improve product and service quality and decrease waste. Research suggests that up to 70% of manufacturing firms are using some form of lean in their business operations.[1] Lean was initially focused on improving manufacturing operations but is now used to improve product development, order processing, and a variety of other nonmanufacturing processes (sometimes called "lean in the office").

1. PrintPlanet launches lean manufacturing forum. (2008, August 11). Retrieved January 30, 2009, from http://members.whattheythink.com/home/wttnews080811.cfm

WHAT IS MEANT BY LEAN CONTROL?

Lean's popularity has both resulted from, and been driven by, an explosion in the volume of lean-related educational resources. Amazon offers almost 1,800 books and other materials about lean, and Yahoo! hosts over 90 online discussion groups relating to lean. Colleges and universities, industry trade associations, and private consulting firms routinely offer courses, seminars, and conferences to explain what lean is and how to use it.

Lean control is a number of things. According to James Womack, "it is a process for measuring and reducing inventory and streamlining production. It is a means for changing the way a company measures plant performance. It is a knowledge-based system. It takes years of hard work, preparation and support from upper management. Lean is so named because it purports to use much less of certain resources (space, inventory, workers, etc.) than is used by normal mass-production systems to produce comparable output." The term came into widespread use with the 1990 publication of the book *The Machine That Changed the World*, by James P. Womack, Daniel T. Jones, and Daniel Roos.[2]

This abundance of education resources on the topic of lean is actually a mixed blessing for managers who are just now becoming interested in lean. On the one hand, today's managers don't have to search far to find lean materials or programs. But the wealth of lean resources can also be a source of confusion for two main reasons. First, there is no universal definition of lean and little agreement about what the truly core principles of lean are. For instance, quality programs such as Six-Sigma, or even lean Six Sigma, are other titles competing for the "lean" intellectual space. Therefore, lean experts often approach the subject from differing perspectives and describe lean in different ways. To make matters worse, lean is a topic that produces a significant amount of zealotry. So, many experts strongly argue that their particular "brand" of lean is the one right way to implement and use lean. In these circumstances, it's no wonder that managers become confused about where and how to begin.

LEAN APPLICATIONS

Lean will always be associated with Toyota Motor Corporation because most lean tools and techniques were developed by Toyota in Japan beginning in the 1950s. After World War II, Toyota's leaders were determined to make the company a full-range car and truck manufacturing enterprise, but they faced several serious challenges. The Japanese motor vehicle market was small and yet demanded a fairly wide range of vehicle types. This meant that Toyota needed to find a way to earn a profit while manufacturing a variety of vehicles in low volumes. In addition, capital was extremely scarce, which made it impossible for Toyota to make large purchases of the latest production equipment. To succeed, or even survive, Toyota needed a way to build vehicles that would require fewer resources. To achieve this goal, Toyota's leaders, principally Eiji Toyoda and Taiichi Ohno, began to create and implement the production techniques and tools that came to be known as lean.[3]

To gain the most benefits from lean, managers must be able to determine what specific lean tools and techniques will be effective in their particular business. And to make that determination, they must clearly understand what lean is designed to accomplish (its primary objectives) and what core principles lean is based on. With this understanding, managers can decide which lean tools will work well in their business, which lean tools will need to be modified or adapted to work well, and which tools are simply not appropriate.

What, then, are the major objectives and core principles of lean? Despite the arguments and debates that often surround attempts to define and describe lean, it is clear that the ultimate objective of lean is the avoidance of muda, or wasteful activity, in all business operations. As shown in the following figure, muda comprises *seven deadly wastes*. In the lean world, waste means any activity or condition that consumes resources but creates no value for customers. Therefore, waste includes the production of defective products that must be remade or fixed, the production of more products than the market will buy, excessive work-in-process inventories, overprocessing

2. Womack, J. P., Jones, D. T., & Roos, D. (1990). *The machine that changed the world*. New York: Rawson Associates, 1990.
3. Retrieved January 30, 2009, from http://www.toyota.co.jp/en/history/index.html.

(processing steps that aren't really needed or that add no value), unnecessary movement of people or products, and unnecessary waiting by employees.

Elimination of Waste Is the Soul of Lean

Muda is a Japanese term for activity that is wasteful and doesn't add value. It is also a key concept in lean control. Waste reduction is an effective way to increase profitability. Here are the seven deadly wastes, along with their definitions:

1. **Defects** prevent the customer from accepting the product produced. The effort to create these defects is wasted. New waste management processes must be added in an effort to reclaim some value for the otherwise scrap product.
2. **Overproduction** is the production or acquisition of items before they are actually required. It is the most dangerous waste of the company because it hides the production problems. Overproduction must be stored, managed, and protected.
3. **Transportation** is a cost with no added value. In addition, each time a product is moved it stands the risk of being damaged, lost, and delayed. Transportation does not transform the product in any way that the consumer is willing to pay for.
4. **Waiting** refers to both the time spent by the workers waiting for resources to arrive, the queue for their products to empty as well as the capital sunk in goods and services that are not yet delivered to the customer. It is often the case that there are processes to manage this waiting.
5. **Inventory** in the form of raw materials, work-in-progress, or finished goods represents a capital outlay that has not yet produced an income either by the producer or for the consumer. Any of these three items not being actively processed to add value is waste.
6. **Motion** refers to the actions performed by the producer, worker, or equipment. Motion has significance to damage, wear, and safety. It also includes the fixed assets and expenses incurred in the production process.
7. **Overprocessing** is defined as using a more expensive or otherwise valuable resource than is needed for the task or adding features that are designed for but unneeded by the customer. There is a particular problem with this item regarding people. People may need to perform tasks that they are overqualified for to maintain their competency. This training cost can be used to offset the waste associated with overprocessing.

THE FIVE CORE PRINCIPLES OF LEAN

Lean methodologies are lean because they enable a business to do more with less. A lean organization uses less human effort, less equipment, less facilities space, less time, and less capital—while always coming closer to

meeting customers' exact needs. Therefore, lean is not just another cost-cutting program of the kind we often see in business organizations. Lean is much more about the conservation of valuable resources than it is about cost cutting.

In their best-selling book, *Lean Thinking*, James Womack and Daniel Jones identified five core principles of lean.[4] Let's examine them one by one.

Define Value from the Customer's Perspective

The first core principle in the Womack/Jones lean framework is that value must be defined and specified from the customer's perspective. While this seems simple enough, it requires much more than high-sounding, generic statements. To be meaningful, value must be defined in terms of specific products. This means that managers must understand how each specific product meets the needs of specific customers at a specific price and at a specific time.

Describe the Value Stream for Each Product or Service

The second core principle of lean is to describe the value stream for each product or service (or, in some cases, for groups or families of similar products). The value stream is the set of activities that the business is performing to bring a finished product to a customer. It includes both direct manufacturing activities and indirect activities such as order processing, purchasing, and materials management. Developing a detailed description or map of each value stream usually reveals huge amounts of waste. It enables managers to identify which value stream activities add value to the product, which activities add no value but cannot be immediately eliminated for various reasons, and which activities create no value and can be immediately eliminated (or at least reduced substantially).

Create Flow in Each Value Stream

The third essential principle of lean is embodied in the word flow. When a value stream has been completely described as unnecessary, non-value-adding activities have been eliminated, the basic idea of flow is to arrange the remaining activities sequentially, so that products will move smoothly and continuously from one activity to the next. However, flow means more than ease of movement. Flow is the lean principle that directly challenges the traditional "batch-and-queue" model of manufacturing, where people and equipment are organized and located by function, and products (and component parts) are manufactured in large batches. Lean organizations strive to improve flow by reducing the size of production batches, and in the process, they increase flexibility and lower costs.

Produce at the Pace (Pull) of Actual Customer Demand

Producing at the pace or pull of actual customer demand is the fourth key principle of lean. One of the greatest benefits of moving from traditional batch-and-queue manufacturing to continuous flow production is that lead times fall dramatically. Reduced lead times and increased flexibility mean that lean organizations can respond to actual customer demand rather than attempt to predict in advance what that level of demand will be. This allows lean organizations to substantially lower both finished goods and work-in-process inventories.

4. Womack, J. P., & Jones, D. T. (2003). *Lean thinking*. New York: Simon & Schuster.

Strive to Continuously Improve All Business Operations

The fifth core principle of lean is continuous improvement, expressed in Japanese by the word kaizen. Companies that implement lean adopt the mind-set that it is always possible to improve any business activity, and they regularly conduct kaizen events throughout their organizations to improve specific processes or operations. Today, Toyota is recognized as one of the most "lean" business enterprises in the world. Even more daunting, and humbling, is the fact that Toyota is still striving to improve.

Key Takeaway

Lean control, or simply lean, is the system of nonfinancial controls used to improve product and service quality and decrease waste. While popularized through the dramatic successes of Toyota in auto manufacturing, lean processes are used to improve quality and decrease waste in most service and manufacturing industries around the world. In this section, you saw examples of the seven deadly wastes (*muda*) and the five core principles of lean which culminate in continuous improvement, or *kaizen*.

Exercises

1. What is lean control?
2. What types of industries might find lean controls valuable?
3. What does *muda* mean and what are some examples of it?
4. What are the five lean principles?
5. Pick a company you are familiar with—what would it need to do differently to comply with the five lean principles?

6.2: Eliminating Waste

THE PENNSYLVANIA STATE UNIVERSITY, COLLEGE OF EARTH AND MINERAL SCIENCES: ANDY JAMES' "OPERATIONAL EFFICIENCY "

Read this article. Pay particular attention to the examples of the eight wastes. These eight types of waste should be understood and evaluated. Take time to consider your workplace. Identify each type of waste within your organization. Where does it occur? Why does it occur? Is it required waste (regulatory or quality assurance step)? Answers to these questions are a precursor to making sound decisions related to the elimination of waste and changes in process.

OPERATIONAL EFFICIENCY

Lean: Sustainability's blue-collar brother

In understanding operational efficiency for many of the world's corporations, two systems of thought tend to predominate: the Toyota Production System (TPS, more broadly known as "Lean") and Six Sigma.

Although Lean and Six Sigma are systems used to create, hone, and, over time, optimize virtually any process or system, it is important to note that a central concern of each is the elimination of waste. While sustainability may deal with the longer-term ramifications of overuse and waste, as well as other wide-ranging implications, *this* expression of sustainability on the plant floor is as elegant and brutally efficient in intent as it is in execution: waste costs measurable amounts of money. Period. There is no nuanced interpretation, no delicate interpretive dance of language to be had here, which is perhaps why the application of these systems are so popular with CFOs and operations management alike.

Underscoring some of their shared underpinnings, Lean and Six Sigma share essentially the same definitions of waste:

In consideration of what is a shared prescription of two of the dominant efficiency systems in the world, let's consider the sustainable underpinnings of the eight wastes and the types of aspects related to each waste:

Type of Sustainability Aspects Related to Eight Wastes

Lean Waste	Examples of Related Sustainability Aspects
Inventory Waste	• Oversizing of warehouse and production areas, increased energy usage (Planet) • Unnecessary frustration of moving excess inventory to reach needed bays (People) • Inefficient use of capital and resources (Profit)
Talent Waste	• Decreased employee satisfaction and engagement (People) • Inefficient use of one of the organization's most valuable assets (Profit)
Waiting Waste	• Energy waste from idled or below-capacity use of machinery and buildings (Planet) • Energy waste from idled or below-capacity use of machinery and buildings (Planet) • Increased labor cost; Inefficient use of capital and resources (Profit)
Motion Waste	• Excess motion likely means unnecessary energy and fuel consumption for machinery (ie conveyors, forklifts, etc) (Planet) • Potential for increased injuries; Excess "round trips" on site likely unrewarding; Increased physical requirements for the same job; Position may no longer be appropriate for older or less-conditioned employees (People) • Increased labor cost; Increased injuries; Increased cost of energy; Decreased machine life (Profit)
Defects Waste	• Increase in disposed packaging and product; Increase of in-line waste; Additional materials/processes/energy needed to rework (Planet) • Increased frustration and decreased morale in employees (People) • Decreased profitability from writeoffs and increased waste (Profit)
Transportation Waste	• Increased Scope 3 energy use and emissions; Increased use of related chemicals and solvents (Planet) • Need for transport support potentially reducing opportunities in other positions (People) • Decreased profitability (Profit)
Overprocessing Waste	• Unnecessary use of resources, energy, or materials which are not adding value (Planet) • Unnecessary work and potential for injury; Decreased morale in doing "busywork" (People) • Decreased profitability (Profit)
Overproduction Waste	• Excessive energy use and emissions; Wasteful use of materials (Planet) • Unpredictable shift loads; Potential for temporary disruptions or layoffs; Decreased morale (People) • Decreased profitability; Increased overhead (Profit)

Especially in regard to sustainability's efficiency imperatives, we may find that the Lean/Six Sigma waste principles as practiced today are *far* more advanced and prescriptive than any GRI report or sustainability management system when it comes to the overall consideration of *all* types of waste. Where GRI may be far more focused on the defined wastes and setting indicators, Lean/Six Sigma takes a more holistic view in opening the facility to see the less obvious, but equally erosive, wastes.

Furthermore, and of key interest for our efforts in creating sustainability-driven innovation, is that the last 30 years of heavy worldwide adoption of these management systems present us with ample numbers of cognitive "hooks and anchors" from which we may build a platform. For anything from beginning a sustainability initiative internally to creating a B2B offering, the philosophies of sustainability may already be deeply embedded in the organization already: they call them Lean/Six Sigma.

As we will cover in coming Lessons, our goal then is not to unnecessarily create new ideas (which is difficult, and frankly, expensive), but to build on and extend the thoughts, feelings, and frames that already exist in the in the minds of customers.

Caterpillar's use of Six Sigma in supply chain sustainability

Caterpillar is arguably one of the foremost adherents to this efficiency thinking, applying Six Sigma at very high levels throughout not only its organization, but the organizations within its supply chain. In a sense, this push functioned as a very proactive effort on the part of Caterpillar to drive efficiency and waste reduction in its suppliers and to allow its suppliers to work together to find ways to become more efficient. A few highlights from a Gillett, Fink, and Bevington piece in *Strategic Finance* about Caterpillar's use of Six Sigma:

> In addition to its own use of 6 Sigma, the company has taught its suppliers and dealers about the benefits of using the technique to refine the entire sales model. Caterpillar has introduced 850 suppliers worldwide to 6 Sigma, which has created more than 1,000 supplier Black Belts to help run the projects. One supplier that said it was interested in the Caterpillar 6 Sigma methodology allowed Cat to consult and transform the business. When implementing 6 Sigma, Caterpillar used facts and data to show the results the supplier could expect, so it didn't take long for the supplier to totally buy in to the methodology.
>
> Dealers have also taken on the 6 Sigma commitment. More than 165 dealerships have produced more than 1,000 Black Belts to help with projects. Dealers find it amazing that they can share their projects with one another on a Caterpillar website that depicts best practices among the dealers. Even though each dealership is run as a separate business, 6 Sigma has helped give all of them a common feel across the world. Not only are dealerships learning about projects that need to be done in their business, but they're following the steps of the process and learning which projects to do first. Just as Caterpillar embraced the methodology, dealers have also accepted the idea of making 6 Sigma a top-down methodology that pushes the training and concept down to the workers at the lowest level.

While Caterpillar's Six Sigma push started in 2001, a full four years before it would issue even its first sustainability report, the links between the two efforts are readily evident: In both the CAT approach to Six Sigma efficiency and its sustainability efforts, the drive for waste reduction and efficiency is coming from a very directed and structured approach, one which has its roots in operations.

The intermingling between Six Sigma, operations, production, and sustainability at Caterpillar becomes even more evident when examining theCritical Success Factors(link is external) statement of its Sustainability Vision, Mission, Strategy:

> **Critical Success Factors**
>
> **Culture**. Create a culture of sustainability in all our business units and in all our daily work.
>
> **Progress**: We promote our employees' awareness and understanding of sustainability. We continue to foster a corporate culture of transparency, disclosure and engagement.
>
> **Operations**. Champion our sustainability principles and contribute to 2020 aspirational sustainable development goals.
>
> **Progress**: The Caterpillar Production System provides the recipe for efficiency and excellence in our facilities. We actively encourage employees to conserve resources and be more efficient. Operating in a more efficient and sustainable manner will reduce impacts on people and the environment, and help us and our customers save money.
>
> **Business Opportunities**. Identify and pursue business growth opportunities created by sustainable development.
>
> **Progress**: We are actively embedding sustainability throughout our Caterpillar brand portfolio, our new product development process and our technologies. Our business leaders continue to drive growth in sales of products, services and solutions that help customers meet their sustainability challenges. We utilize 6 Sigma methodologies to focus our work and drive measurable benefits.

For one of the world's foremost manufacturers, it would appear a significant portion of Six Sigma enables its sustainability goals, and vice versa. In these types of operations, operating from a place of infused, organization-wide sustainability, it can be very difficult, if not impossible, to determine where "sustainability" ends and "operations" begins.

ELIMINATING OFFICE WASTE

By
Kaye Krueger

Learners review office processes to find ways to save time.

Watch this slide show and explore how waste can be found throughout the work done in the office processes. Often, Lean methods are considered only applicable in a manufacturing context. Sometimes, Lean methods are applied in a service industry when there is direct contact with customers. However, this slide show provides some examples of how waste (as identified by Lean) can be found throughout all parts of an organization.

Activity Link: https://www.wisc-online.com/learn/career-clusters/business-management-and-administration/eng16304/eliminating-office-waste

THE EIGHT WASTES OF LEAN

By
Kaye Krueger

Learners examine ways to eliminate or minimize the wastes found in business processes. A matching exercise completes the activity.

Watch this slide show to explore the eight wastes defined in Lean. Pay close attention to the differences between value-added activities and non-value added activities. Value added activities create value for the customer/client/patient. Non-value added activities are often pure waste within the system.

Activity Link: https://www.wisc-online.com/learn/career-clusters/stem/eng10603/the-eight-wastes-of-lean

6.3: Continuous Improvement

THE GLOSSARY OF EDUCATION REFORM: "CONTINUOUS IMPROVEMENT"

Read this overview of continuous improvement in the context of education. Education is a service. Therefore, operations management concepts apply in the education industry. Keep in mind; some would argue that students are a product manufactured by the education system. This can create a different perspective when reviewing this process in relation to education.

CONTINUOUS IMPROVEMENT

In education, the term **continuous improvement** refers to any school- or instructional-improvement process that unfolds progressively, that does not have a fixed or predetermined end point, and that is sustained over extended periods of time. The concept also encompasses the general belief that improvement is not something that starts and stops, but it's something that requires an organizational or professional commitment to an ongoing process of learning, self-reflection, adaptation, and growth. For example, when a school is continuously improving, a variety of small, incremental changes are occurring daily and in ways that cumulatively, over time, affect multiple dimensions of a school or school system.

Generally speaking, the concept of continuous improvement also reflects a tacit recognition that improving the effectiveness of schools and teaching is not only highly complex, but it entails unforeseen challenges, complications, and reversals, as well as steep or prolonged learning curves—among other unavoidable factors—that require a sustained commitment to incremental, ongoing improvements, rather than the execution of rapidly implemented, breakthrough changes that deliver up the desired results in a predictable fashion.

In the view of many educators, continuous improvement also requires schools to have the on-staff knowledge, skills, and expertise needed to improve educational results and sustain improvement over time. For example, if a school's improvement depends on external organizations, consultants, contracts, and expertise, any realized improvements would probably be neither continuous nor sustainable. In this way, the concept of continuous improvement is related to capacity—the abilities, skills, and expertise of school leaders, teachers, faculties, and staffs—and to action research—informal, in-process research that helps educators develop, in real time, adaptive solutions and improvement strategies. In some cases, a continuous-improvement plan or process will be graphically represented as a circle or ring of arrows—often called a*cycle of action* or *cycle of inquiry*—since the process may follow a defined series of steps that are repeated over time.

It should be noted that *continuous improvement* has become something of a buzzword in education, and the appearance or use of the term does not necessarily mean that a school or school system is actually executing, in any practical or authentic sense, an improvement process that could be accurately labeled "continuous" in the senses described above.

KIRA GREER'S "WHAT IS A KAIZEN EVENT?"

Watch this video about the use of Kaizen events to increase the quality of your process. Kaizen is one tool that is used when practicing Lean methods. This provides you with background information on the development of this tool.

One or more interactive elements has been excluded from this version of the text. You can view them online here:
https://pressbooks.nscc.ca/operationsmanagement2/?p=219#oembed-1

MARKETS FOR GOOD: BETH KANTER'S "CREATING A CULTURE OF CONTINUOUS IMPROVEMENT BASED ON DATA"

Read this article. Consider the importance of creating a culture focused on continuous improvement within both service and manufacturing organizations. This is important because the culture either supports or hinders any initiative started within an organization. If the culture does not support continuous quality improvement, then either the CQI process will fail or the culture must be shifted.

CREATING A CULTURE OF CONTINUOUS IMPROVEMENT BASED ON DATA

Beth Kanter returns in her latest column, describing how nonprofits can develop a culture of improvement through the application of data.

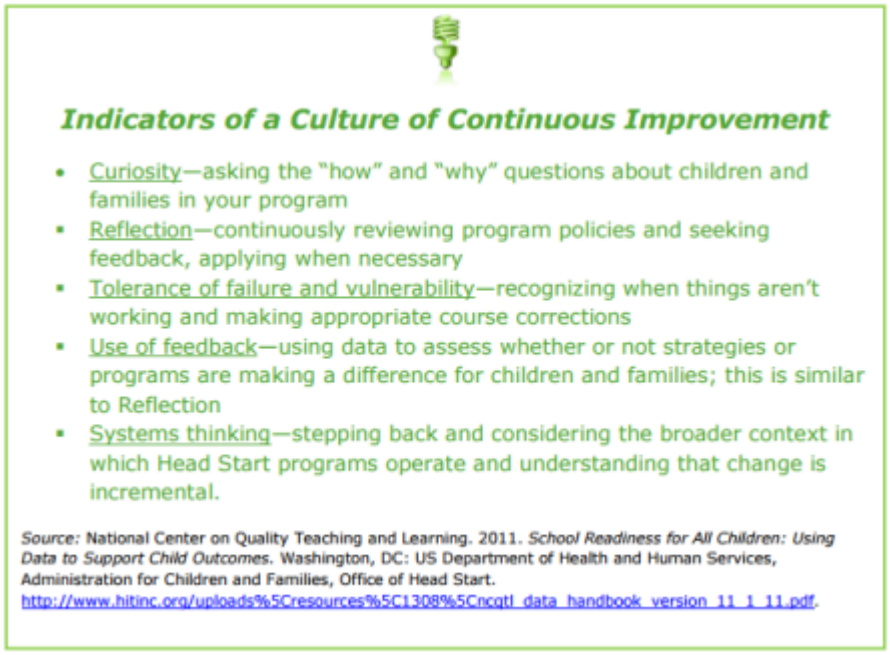
I'm always on the look out for useful and thought provoking resources on how nonprofits can use data to make better decisions that lead to greater impact. So, when Mary K Winkler, one of the nonprofit data nerds I follow on Twitter and Senior Research Associate at Urban Institute's Center on Nonprofits & Philanthropy specializing in performance management told me via Twitter she had just published a new guide on this topic, I had to check it out.Moving Beyond a Culture of Compliance to a Culture of Continuous Improvement is a resource guide to help leadership, management, supervisory, and data-focused staff in Head Start and Early Head Start programs (1) understand how data, including data they already collect, can help them achieve their program goals; (2) learn techniques for fostering a culture of learning in their organization; and (3) increase their ability to identify and address gaps and continuously improve their programs. It was designed to complement existing technical assistance resources through tip sheets, examples, and links to multiple resources.I was most interested in Part 2 (pages 17-21) because I think the advice is applicable to organizations beyond those managing head start programs. This section of the report covers new ways of thinking about organizational culture based in continuous improvement based on feedback. It speaks to establishing culture norms among staff of curiosity, reflection, and trust. It outlines the practices and skills needed to create a learning culture. Here's what I learned:**Definition: A culture of continuous improvement**

The term means learning culture. The term "continuous" that the organization has create a virtuous cycle of feedback that repeatedly inspires staff to reflect on what is working and what can be done differently to get better results. This process of reflection is embedded in the organization's working style, not a random moment of inspiration after a program evaluation is completed. Everyone on staff understands that the questions are the best teachers and in an effort to sustain learning articulate questions and seek answers to those questions.

Organizations that have this type of culture do not play the blame game if something needs to be improved. They have a created a safe space for staff and program participants and other stakeholders to give feedback, reflect, ask questions, and think creatively about solutions. Senior leaders model the skill that Edgar H. Schein calls "Humble Inquiry" – the art of asking questions based on curiosity and building trust.

Cultural Indicators

The report describes the indicators below as hallmarks of a culture of continuous improvement.



The report points out that Head Start Programs often have to balance compliance with creating a culture of continuous improvement, not an easy task. Not only do organizations need data collection systems, but also systems for observation, learning, reflection, and action or as the report describes "systems that help us identify and solve problems proactively instead of always reacting." The report offers up the metaphor of "how shift from fighting fires to innovation."

The report also talks about an organization's cultural readiness to switch to a culture of continuous improvement, using a blog post I wrote about being data-informed for inspiration. It maps out stages of change, but also recognizes that organizations may be in different stages at the same time:

- **Dormant:** At this stage, the organization does not know where to start. Data collection may occur from time to time, but there is no formal reporting. There are no data systems in place, such as dashboards or simple collection methods. Staff are often overwhelmed by the thought of measurement and it falls to the bottom of the to-do list. Alternatively, there may bean emphasis on collecting more data than is necessary, but no one relates it to decision making. There is not a reflection process for analyzing success or failure for future use.
- **Testing and Coordinating:** At this stage, the organization is regularly collecting data, but it is stored across different spreadsheets and collected by different people or departments. Data are not linked to organizational results or mission-driven goals across programs. Discussions on how to improve results are rarely part of staff meetings. Scaling and Institutionalization: At this stage, there is an organization-wide system and dashboard for collecting data that are shared with different departments. There are different views or levels of detail for senior leaders, line staff, or other stakeholders. There are periodic (e.g., weekly, biweekly, monthly, or quarterly) check-ins to evaluate what is working and what is not. The organization provides training and professional development for staff to learn how to use measurement

tools.

- **Empowering:** At this stage, performance indicators are used across programs throughout the organization. There is a staff position responsible for setting the overall agenda for data collection and reporting, helping staff understand data, and assuring that systems and timelines are successful. All staff, however, are empowered and expected to check, apply, and interpret their own data. In addition to periodic check-ins, the organizational dashboard includes goal-oriented performance metrics. The organizational dashboard I hared across departments and there is a process for analyzing, discussing, and applying results. Data visualization techniques are used not only to report the data analysis but also to reflect on best practices culled from the data.

The report also includes a reference to this excellent tool for evaluating an organization's capacity to do evaluation activities. The report identifies these criteria:

Core Competencies of Organizations: With a Culture of Continuous Improvement

- Our organization measures outcomes (changes in participant condition, behavior or knowledge), not just efforts (quantifiable activities or services delivered).
- Our organization can identify which indicators are appropriate for measuring how we work.
- Our organization has clarity about what we want to accomplish in the short term (e.g., one to five years) and what success will look like.
- Our organization ensures that staff have the information and skills they need to successfully engage with data for program improvement (e.g., access to resources and training)
- Our organization has staff who are experienced in data collection, data use, and different stakeholders' information needs.
- Our organization has staff who know how to analyze data and interpret what the data mean.
- Our organization values learning. This is demonstrated by staff actively asking questions, gathering information, and thinking critically about how to improve their work.
- Leaders in our organization support data use to identify areas of improvement. Our organization is capable of effectively communicating about data and results (both positive and negative) within and outside the organization.
- Our organization promotes and facilitates internal staff members' learning and reflection in meaningful ways regarding data use, planning, implementation and discussion of findings ("learning by doing").
- Our organization modifies its course of action based on findings from program data.
- Mangers look at program data as an important input to help them improve staff performance and manage for results.
- Findings from program data are integrated into decision-making when deciding which policy options and strategies to pursue.

For people who are in the data for good space, technical work and "janitorial" work are only a part of their jobs. Understanding organizational data culture or creating a culture of continuous improvement based on data is a hot topic. It's on the agenda at Do Good Data Conference later this month (I'm co-facilitating the ending plenary). It's also on the Data on Purpose Conference at Stanford in June. For some organizations, it is more zen – it's about beginning it and continuing it as Laura Quinn from Idealware points out in her latest Markets For Good blog.

Does your nonprofit have a culture of continuous improvement based on data? What does it look it? How did it get started?

UNIT 6 DISCUSSION

#1

Most of us are familiar with the education system. This might be through our personal experience with K-12 or post K-12 education or our children's experience. Using information in this unit, evaluate the operations of an education system. You may choose a K-12 system, a Higher Education (community college, college, or university) program, or a technical institute that you are familiar with to complete this evaluation. Discuss how and where continuous quality improvement processes could be embedded within the system to increase the quality of the outcomes.

6.4: JIT Pull Systems

OPENSTAX CNX: "OPERATIONS MANAGEMENT: SPECIAL TOPIC – JUST-IN-TIME AND LEAN SYSTEMS"

Read this page and explore the just-in-time manufacturing systems. Just-in-time inventory principle is designed to reduce waste associated to maintaining inventory or inputs. Consider the impact of a just-in-time approach to the reduction of waste in your inventory system.

OPERATIONS MANAGEMENT: SPECIAL TOPIC: JUST-IN-TIME AND LEAN SYSTEMS

Summary

Just-in-time (JIT) is a management philosophy that originated in the 1970s. Taiichi Ohno is credited with developing JIT and perfected it for Toyota's manufacturing plants in Japan. The main goal of JIT is to eliminate anything that does not add value from the customer's perspective. Non-value-added activities are referred to as "waste" in JIT. Examples of waste include:

- overproduction beyond what is needed to satisfy immediate demand
- waiting time (work-in-process, customer waiting)
- unnecessary transportation (material handling, customer travel through a facility, etc.)
- processing waste (yield rates, start-up costs)
- inventory storage waste (space, deterioration, obsolescence, etc.)
- unnecessary motion and activity (waste in work techniques, etc.)
- waste from product and service defects (rework, scrap, warranty, etc.)

There are three essential elements that contribute to the successful practice of JIT:

- JIT manufacturing principles
- Total Quality Management (TQM)
- employee empowerment

JIT MANUFACTURING PRINCIPLES

In a manufacturing setting, there are six major ways to pursue JIT goals: inventory reduction to expose waste, use of a "demand-pull" production system, quick setups to reduce lot sizes, uniform plant loading, flexible resources, and cellular flow layouts.

Inventory reduction to expose waste

Inventory covers up a lot of wasteful practices (poor equipment, weak vendors, bad quality, long setup times, etc.). By gradually lowering inventory, the weaknesses of the production system can be revealed and addressed one by one. Machines can be replaced or better maintained, vendors quality and delivery can be improved, machine setup procedures can be streamlined, quality practices can be implemented, and labor and equipment can be laid out more efficiently. These improvements permit the organization to operate with less inventory, less costs, and faster response times in meeting customer needs.

Demand-pull production system

The traditional approach to manufacturing management promotes a strong focus on machine and labor utilization. The view was that if managers make sure that workers and machines are always busy, then surely the factory will be productive and efficient. This approach is called the "push" system of manufacturing, where raw material and work-in-process is continuously pushed through the factory in the pursuit of high utilization. The problem with this approach is that it usually produces high levels of inventories, long lead times, overtime costs, high levels of potential rework, and workers who are competing with one another rather than working cooperatively.

In contrast to the push system, JIT espouses a "demand-pull" system that operates on the rule that work should flow to a work center only if that work center needs more work. If a work center is already occupied with work activity, the upstream work center should stop production until the downstream work center communicates a need for more material. The emphasis on maintaining high utilization is removed in a JIT environment. The focus of a JIT environment is on addressing the challenges that affect the overall effectiveness of the factory (setup time reduction, quality improvement, enhanced production techniques, waste elimination, etc.) in meeting its strategic goals, rather than allowing excess inventory to cover up inefficiencies that reduce the factory's competitiveness.

Quick setups to reduce lot sizes

The longer it takes, and the more expensive it is to setup equipment and labor to produce an item, the greater the quantity of items that have to be produced in a given production run. Traditional production management philosophy promoted the notion that long production runs of the same item were the key to driving down unit costs. The problem was that large production runs created large quantities of WIP and finished goods inventory that far exceeded the demand. These items would consequently cause high levels of inventory costs, long lead times, high potential rework, low flexibility in responding to customer needs, etc.

Driving down setup costs and setup times are key to dramatically improving factory competitiveness in a JIT environment. In the 1980s, the 3M company converted a factory that made a few adhesive products in long production runs into a factory that made over 500 adhesive products in small production runs. To keep unit production costs under control, 3M studied the setups on its coating machines. Since the cost of chemical waste disposal was a major part of the cost of changing over a coating machine to make another product, 3M shortened the length of hoses that needed purging and redesigned the shape of the adhesive solution holding pan on the

coating machine to be shallower. 3M also used quick-connect devices, disposable filters, and work teams to speed up setups. The result was that 3M could maintain low unit costs on its coating machines while producing small lots of hundreds of products to meet market demand quickly.

Uniform plant loading

The successful practice of JIT means having the right quantities of the right products in the right place at the right time. Driving down setup times enables the company to produce the product mix and quantities that are demanded in the present time period.

Flexible resources

The enemy of JIT is uncertainty. A JIT environment thrives on predictability in customer demand, production processes, suppliers, and workers. Of course, uncertainty cannot be completely eliminated in most organizational environments.

The defense against uncertainty that cannot be driven out is to implement flexible resources that can adapt easily to changing circumstances. General-purpose, moveable equipment that can fulfill a wide variety of production requirements is one way to improve flexibility. For example, drilling machines with quick-change bits which can be wheeled into position to form new work cells allows the factory to maximize efficiency while producing exactly what is needed to satisfy immediate demand. Another example is Toyota's use of paint canisters that attach to paint sprayers. Any car can be painted any color without having to purge hoses in switching from one color to another.

Multifunctional workers are another way to bring flexibility to the work environment. At Honeywell's heating and cooling controls plant, workers are trained to operate all the machines on their work line. The flexibility that comes from multifunctional workers changes the nature of how work gets done. Instead of workers being trained on one machine and working independently of one another, multifunctional workers have a "big picture" view of the production line, where every worker understands all aspects of the line and how to work together to meet quality and schedule goals regardless of the circumstances.

Line/cellular flow layouts

Earlier in this chapter, we described the efficiencies that repetitive process layouts provide. Repetitive process layouts are perfectly suited for driving out non-value-added activities and transitioning to a JIT environment. Intermittent layouts feature dozens or even hundreds of different paths through the facility. They are filled with complexity, uncertainty, and low visibility. Workers tend to have specialized skills, work independently of other departments, and have little sense of "ownership" of the products they work on.

In contrast, cell layouts promote JIT goals by featuring unidirectional product flows, high visibility, and fast throughput times. Workers with multifunctional skills are assigned to individual cells and have responsibility and control of the products they produce. Workers in a cell environment tend to have a greater sense of ownership and pride in their work because they have a "big picture" view of the product as it is converted from raw material to a finished good. This deeper understanding of the production process increases the opportunities for workers to contribute ideas for process improvements.

TOTAL QUALITY MANAGEMENT

TQM was discussed in detail earlier. TQM goes hand in hand with the JIT philosophy because quality is a

major source of uncertainty and non-value-added activities in an organization with poor quality practices. TQM promotes continuous improvement, doing it right the first time, designing quality into products and processes, and establishing an overall focus on prevention as the primary quality activity.

EMPLOYEE EMPOWERMENT

Front-line employees play a critical role in successful JIT practice. They work in partnership with management and each other in the continuous pursuit of excellence. There are several ways in which front-line employees contribute to JIT success:

- Employees work together in problem-solving teams to gather data and build consensus on how to improve work processes.
- Employees are responsible for understanding the quality measures of their work and what they need to do to meet the needs of internal and external customers.
- Each employee is empowered to take action to correct problems.
- Employees have cross-functional skill sets that allow them to be assigned to areas which need help, and to help them adopt a broader ("big picture") view of the production process.
- Unlike a traditional "push" environment where line workers are relatively independent of one another in their work activities, JIT employees are connected by the "demand pull" discipline, where work is not produced unless the downstream work center needs it. Demand-pull promotes the inter-connectedness of workers.
- Front-line employees are responsible for the basic maintenance of their machines. This helps employees have a better understanding of the condition of their equipment and its ability to meet quality and production requirements.

Management works with employees by being coaches and facilitators rather than authoritative supervisors. Managers are charged with hiring employees who can work in a proactive team environment, and provide the training and incentives to build a work culture that is focused on continuous improvement.

CONCLUSION: THE EVOLUTION OF JIT INTO "LEAN OPERATIONS"

The JIT philosophy has evolved from a manufacturing-focused management approach to a set of management principles that can be applied to any organization. "Lean operations" is a term that is replacing JIT, especially in service environments. "Lean operations" captures the true essence and power of how a culture built around continuous improvement and the pursuit of value-added activities leads directly to competitive advantage in the marketplace. Lean operations is a management philosophy for any organization to achieve higher quality, increased productivity, improved delivery speed, greater responsiveness to changing markets, and increased customer satisfaction.

- Downloads
- History
- Attribution
- More Information

AGILELION INSTITUTE: JOSEPH HURTADO'S "OPEN KANBAN INTRODUCTION VIDEO"

Watch this video and explore how Kanban is used in organizations to increase effectiveness in IT projects. Kanban is a less complex method to apply Lean within the organization. This is also is designed to be agile and easily adapted to the needs of the organization. Pay attention to how you might adapt this method to work in your organization in improving quality and reducing waste in a way that does not relate to an IT project.

One or more interactive elements has been excluded from this version of the text. You can view them online here:
https://pressbooks.nscc.ca/operationsmanagement2/?p=221#oembed-1

Unit 6 Activity and Grading Rubric

In this activity, you will continue working on your operations management plan. As part of your continuing development of your operations management plan, you will discuss the goal of supply chain management and its application within your business.

Learning Outcome

Explain quality management, and apply quality management principles to continuous improvement in operations management.

Specifications:

- 2-3 page paper
- Created in a Word document
- Follows APA, 6th edition formatting
- Includes a Reference page for cited sources

Instructions: Continuing with your operations management plan, use at least 4 scholarly sources to write a 2–3 page paper that addresses the Malcolm Baldrige Quality Award–Criteria for Performance Excellence. A link to the "Ishikawa Fishbone Diagram" is provided as an additional resource tool to help you design/develop your organization's quality improvement plan.

The National Institute of Standards and Technology: "Criteria for Performance Excellence"

Instructions: The link to the Criteria for Performance Excellence is found under "Popular Links" on the National Institute of Standards and Technology's homepage. Please review the criteria.

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You may use the following information based off of the Baldrige Quality Award Criteria as a guide for developing your responses for the paper's questions.

1. **Leadership:** Who will serve in management/leadership positions, and why? What qualities do these leaders and managers exhibit in order to enhance the business?

2. **Strategic Planning:** Give a brief overview of how you intend to use strategic planning as part of your operations management process.
3. **Customer Focus**: What demographic(s) are you intending to sell your product or service to, and why?
4. **Measurement, Analysis, and Knowledge Management:** What training or systems (i.e. performance appraisals, drug testing, etc.) will you implement in your business to help ensure that work is being performed at the level of quality you expect?
5. **Workforce Focus:** Where do you expect to recruit a workforce from? How will you go about you recruiting process?
6. **Operations Focus:** Here, you want to offer a detailed description as to how the operations process will flow within your organization's structure (i.e. how will you use your people, equipment, or other assets you have as your core competencies in terms of helping to ensure quality will be established and/or maintained within your organization)?
7. **Results:** This criterion will require you to make a forecast, or estimation, as you will not know how well the organization performs until it has been put into operation. This section is optional to complete.

For this paper, you are required to cover items 1-6, listed above. Focus on how your operations plan will help to create and/or generate process improvement as you manufacture your product or provide your service (i.e. what things can you do along the way to help make your operations create a better product or service?). You do not need to complete item 7 (optional, you may attempt to if you desire) of the criteria items as your plan will not provide you with measurable results at this point.

Make sure to also address the following in your paper:

1. Identify and assess whether or not your business will utilize continuous improvement processes or procedures. Why or why not?
2. Discuss any continuous process improvement techniques other organizations are using that you would use with your operations plan, and explain why.
3. Using the "Fishbone Diagram" as a reference, choose three elements to address in your paper. See the instructions in the reading section below for more detail.

Reading: Hubpages: "Ishikawa Fishbone Diagram; Continuous Process Improvement; Cause and Effect"

Link: Hubpages: "Ishikawa Fishbone Diagram; Continuous Process Improvement; Cause and Effect"

Instructions: Please review the website linked above for additional insight into creating continuous quality improvement. Using the “Fishbone Diagram” as a reference, select three of the following and discuss how you will use each to aid you in providing quality improvement as you manufacture your product or provide your service:
PDCA, the 5 Whys,
Tally
Sheets, Brainstorming
and Mind Mapping, Histograms
and Bar Charts, Pareto
Analysis, Process
Mapping, Value Stream
Mapping, or
Statistical Process Control (SPC) Charts.

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Please score your paper or have a friend score your paper using the following “rubric,” or “scoring guide.” The levels will equate to the following letter grades:

4 = A; 3 = B; 2 = C; 1 = D; and 0 = F

Level	Criterion
	Research and Documentation (40%)
4	Any research sources used should come from scholarly sources (i.e. textbooks, scholarly articles, etc.). This Link: The Saylor Foundation's "Unit 6 Activity and Grading Rubric" (PDF) Instructions: Please download the instructions for the activity in which you continue working on your operations management plan. As part of your continuing development of your operations management plan, discuss the goal of supply chain management and its application within your business. requires that at least 4 sources are used. Any in-text citations MUST be cited in APA format using the APA Manual 6th edition. You should also include a References page, also in APA format, at the end of your paper to cite any sources used.
3	The paper uses at least three scholarly sources to support your content, but it does not meet the minimum requirement for 4 sources.
2	Three or more popular sources (i.e. newspapers, internet sites, magazines, etc.) make up a majority of the references to support your content. The paper lacks credible, scholarly sources and does not meet the minimum number of sources required.
1	The paper includes one or two sources. The paper lacks the use of credible, scholarly sources and may focus on using popular sources. The number of sources used does not meet the minimum requirement (4 sources) and the resources used may not fully support the content of your paper.
0	The paper fails to cite referenced sources, or does not include any research or sources to support ideas. The paper is based off of non-original content.
	Analysis and Argument (40%)
4	Your paper addresses the three questions in the instructions with the use of supporting evidence and specific details and explanation. You effectively address the following:Identify and assess whether or not your business will utilize continuous improvement processes or procedures. Why or why not? Discuss any continuous process improvement techniques other organizations are using that you would use with your operations plan, and explain why.
3	The content addresses only some of the questions presented in the instructions section and reflects minimal original thought and /or critical analysis relative to the business.
2	The content is vague and is weakly supported by researched evidence. The essay lacks critical analysis relative to the business.
1	The content does not address the required elements; ideas presented are not supported by research or critical analysis.
0	There is a lack of critical analysis for the operation management plan, and/or the essay does not address the business content from the Unit 1 Activity.
	Grammar/Style (15%)
4	The content contains a maximum of two grammatical, citation, and punctuation errors. The ideas are concise and presented in a logical manner that is easy for the reader to follow.
3	The content contains three or four grammatical, citation, punctuation, and/or spelling errors. The sentence structure flows in a concise, logical manner.
2	The paper contains more than four grammatical, citation, punctuation and/or spelling errors that distract the reader from the comprehension of ideas being presented.
1	The paper demonstrates poor writing skills, reflected by lack of syntax and proper grammar, which makes ideas difficult to communicate. Ideas are not presented in a logical manner that is easy to follow.

0	The paper contains numerous grammatical, citation, punctuation, and/or spelling errors.
	Format (5%)
4	The paper should properly formatted (paragraph style, margins, etc.), using the APA Manual, 6th edition. The content is typed in MS Word format, labeled with the student's name and the activity title/unit number, and a reference section to cite any outside sources used.
3	The paper meets most of the requirements for formatting, using the APA Manual, 6th edition, though may contain some errors.
2	The paper lacks proper formatting, based on the APA Manual, 6th edition, and it may use another style of formatting (i.e. MLA, Chicago, etc.).
1	The paper is typed in a format other than MS Word. A style of formatting other than APA may be used, or there are numerous formatting errors that distract the reader's comprehension.
0	The formatting does not comply with the APA Manual, 6th edition and is not created in MS Word.

UNIT 7: CAPACITY PLANNING AND FACILITY LAYOUT

Unit 7: Capacity Planning and Facility Layout

In the last unit, we looked at manufacturing and service processes that help companies deliver what a customer wants when they want it. Before the firm can successfully institute these processes, it must understand the requirements that determine its production capacity. In the introduction to Unit 6, we considered how a pizza shop delivers its product. Is it likely that their 30-minute delivery would cover an order for 100 pizzas? Probably not, because they have planned their production capacity based on the demand of individual or family-sized consumers. When planning production capacity, the firm has to consider not only demand, but also the physical aspects of their facility. How close does the operation need to be to consumers? Is the facility within easy reach of the resources needed for production?

In this unit, you will learn how to use forecasting models to understand capacity requirements. We will also evaluate factors that help managers identify the optimal location for a new facility. Finally, we will conclude with a review of basic facility layout designs that maximize production efficiency.

Unit 7 Learning Outcomes

Upon successful completion of this unit, you will be able to:

- describe the determinants of effective capacity;
    - facilities
    - product and service factors
    - process factors
    - human factors
    - policy factors
    - operational factors
    - supply chain factors, and
    - external factors;
- describe what factors an organization must consider in selecting a facility location;
- identify the benefits of four basic layout designs in the physical placement of resources:
    - process
    - product
    - cellular, and
    - fixed position; and
- apply the Line Balancing steps to the design of an appropriate product layout.

7.1: Capacity Planning

INDIAN INSTITUTE OF TECHNOLOGY: PROFESSOR ARUN KANDA'S "FORECASTING"

Watch this lecture for a detailed look at the importance of forecasting in identifying capacity requirements. Professor Kanda also reviews a variety of forecasting models along with the process of forecast control.

One or more interactive elements has been excluded from this version of the text. You can view them online here:
https://pressbooks.nscc.ca/operationsmanagement2/?p=231#oembed-1

10.5 FORECASTING DEMAND

Learning Objective
1. Forecast demand for a product.

It goes without saying, but we'll say it anyway: without enough customers, your business will go nowhere. So, before you delve into the complex, expensive world of developing and marketing a new product, ask yourself questions like those in Figure 10.5 "When to Develop and Market a New Product". When Bob Montgomery asked himself these questions, he concluded that he had two groups of customers for the PowerSki Jetboard: (1) the dealerships that would sell the product and (2) the water-sports enthusiasts who would buy and use it. His job, therefore, was to design a product that dealers would want to sell and enthusiasts would buy. When he was confident that he could satisfy these criteria, he moved forward with his plans to develop the PowerSki Jetboard.

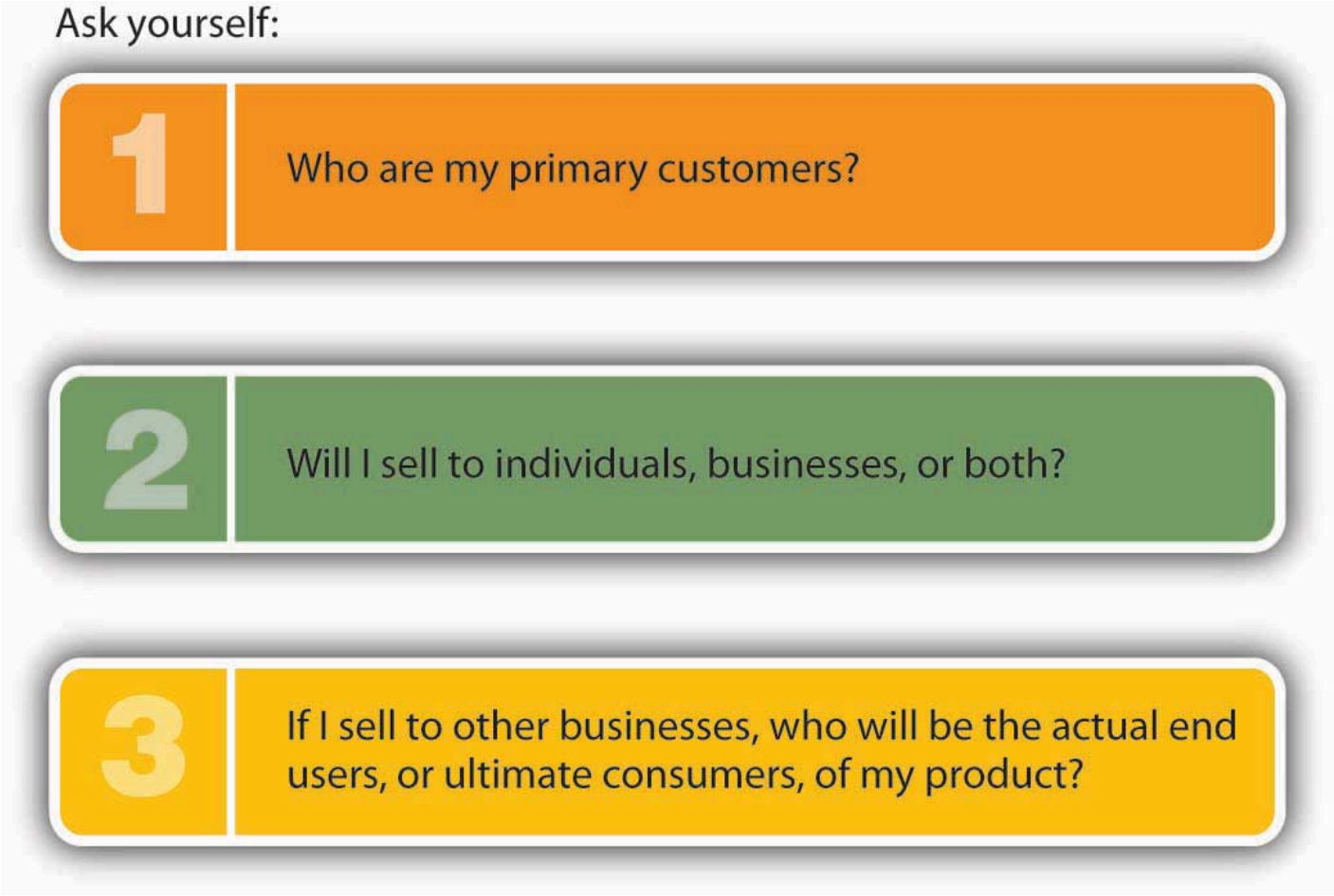

Figure 10.5 When to Develop and Market a New Product

After you've identified a group of potential customers, your next step is finding out as much as you can about what they think of your product idea. Remember: because your ultimate goal is to roll out a product that satisfies customer needs, you need to know ahead of time what your potential customers want. Precisely what are their unmet needs? Ask them questions such as these:[1]

- What do you like about this product idea? What don't you like?
- What improvements would you make?
- What benefits would you get from it?
- Would you buy it? Why, or why not?
- What would it take for you to buy it?

Before making a substantial investment in the development of a product, you need to ask yourself yet another question: are there enough customers willing to buy my product at a price that will allow me to make a profit? Answering this question means performing one of the hardest tasks in business: forecasting demand for your proposed product. There are several possible approaches to this task that can be used alone or in combination.

1. Karl Ulrich and Steven Eppinger, *Product Design and Development*, 2nd ed. (New York: Irwin McGraw-Hill, 2000), 66; and Kathleen Allen, *Entrepreneurship for Dummies* (Foster, CA: IDG Books, 2001), 79.

PEOPLE IN SIMILAR BUSINESSES

Though some businesspeople are reluctant to share proprietary information, such as sales volume, others are willing to help out individuals starting new businesses or launching new products. Talking to people in your prospective industry (or one that's similar) can be especially helpful if your proposed product is a service. Say, for example, that you plan to open a pizza parlor with a soap opera theme: customers will be able to eat pizza while watching reruns of their favorite soap operas on personal TV/DVD sets. If you visited a few local restaurants and asked owners how many customers they served every day, you'd probably learn enough to estimate the number of pizzas that you'd serve during your first year. If the owners weren't cooperative, you could just hang out and make an informal count of the customers.

POTENTIAL CUSTOMERS

You can also learn a lot by talking with potential customers. Ask them how often they buy products similar to the one you want to launch. Where do they buy them and in what quantity? What factors affect demand for them? If you were contemplating a frozen yogurt store in Michigan, it wouldn't hurt to ask customers coming out of a bakery whether they'd buy frozen yogurt in the winter.

PUBLISHED INDUSTRY DATA

To get some idea of the total market for products like the one you want to launch, you might begin by examining pertinent industry research. For example, to estimate demand for jogging shoes among consumers sixty-five and older, you could look at data published on the industry association's Web site, National Sporting Goods Association, http://www.nsga.org/i4a/pages/index.cfm?pageid=1.[2] Here you'd find that forty million jogging/running shoes were sold in the United States in 2008 at an average price of $58 per pair. The Web site also reports that the number of athletes who are at least forty and who participate in road events increased by more than 50 percent over a ten year period.[3] To find more specific information—say, the number of joggers older than sixty-five—you could call or e-mail USA Track and Field. You might find this information in an eighty-seven-page statistical study of retail sporting-goods sales published by the National Sporting Goods Association.[4] If you still don't get a useful answer, try contacting organizations that sell industry data. American Sports Data, for instance, provides demographic information on no fewer than twenty-eight fitness activities, including jogging.[5] You'd want to ask them for data on the number of joggers older than sixty-five living in Florida. There's a lot of valuable and available industry-related information that you can use to estimate demand for your product.

Now, let's say that your research turns up the fact that there are three million joggers older than sixty-five and that six hundred thousand of them live in Florida, which attracts 20 percent of all people who move when they retire.[6] How do you use this information to estimate the number of jogging shoes that you'll be able to sell during your first year of business? First, you have to estimate your market share: your portion of total sales in the

2. "Running USA: Running Defies The Great Recession, Running USA's State of the Sport 2010—Part II," *LetsRun.com*, http://www.letsrun.com/2010/recessionproofrunning0617.php (accessed October 28, 2011); "Sporting Goods Market in 2010," National Sporting Goods Association, http://www.nsga.org/i4a/pages/index.cfm?pageid=1 (accessed October 28, 2011).
3. "Long Distance Running: State of the Sport," *USA Track & Field*, http://www.usatf.org/news/specialReports/2003LDRStateOfTheSport.asp (accessed October 29, 2011).
4. National Sporting Goods Association, http://nsga.org (accessed October 28, 2011).
5. "Trends in U.S. Physical Fitness Behavior (1987–Present)," http://www.americansportsdata.com/phys_fitness_trends1.asp (accessed October 28, 2011).
6. Alan Scher Zagier, "Eyeing Competition, Florida Increases Efforts to Lure Retirees," *Boston Globe*, December 26, 2003, http://www.boston.com/news/nation/articles/2003/12/26/eyeing_competition_florida_increases_efforts_to_lure_retirees (accessed October 28, 2011).

older-than-sixty-five jogging shoe market in Florida. Being realistic (but having faith in an excellent product), you estimate that you'll capture 2 percent of the market during your first year. So you do the math: 600,000 pairs of jogging shoes sold in Florida × 0.02 (a 2 percent share of the market) = 12,000, the estimated first-year demand for your proposed product.

Granted, this is just an estimate. But at least it's an educated guess rather than a wild one. You'll still want to talk with people in the industry, as well as potential customers, to hear their views on the demand for your product. Only then would you use your sales estimate to make financial projections and decide whether your proposed business is financially feasible. We'll discuss this process in a later chapter.

Key Takeaways

- After you've identified a group of potential customers, your next step is finding out as much as you can about what they think of your product idea.
- Before making a substantial investment in the development of a product, you need to ask yourself: are there enough customers willing to buy my product at a price that will allow me to make a profit?
- Answering this question means performing one of the hardest tasks in business: forecasting demand for your proposed product.
- There are several possible approaches to this task that can be used alone or in combination.
- You can obtain helpful information about product demand by talking with people in similar businesses and potential customers.
- You can also examine published industry data to estimate the total market for products like yours and estimate your **market share**, or portion of the targeted market.

Exercise

(AACSB) Analysis

Your friends say you make the best pizzas they've ever eaten, and they're constantly encouraging you to set up a pizza business in your city. You have located a small storefront in a busy section of town. It doesn't have space for an eat-in restaurant, but it will allow customers to pick up their pizzas. You will also deliver pizzas. Before you sign a lease and start the business, you need to estimate the number of pizzas you will sell in your first year. At this point you plan to offer pizza in only one size.

Before arriving at an estimate, answer these questions:

1. What factors would you consider in estimating pizza sales?
2. What assumptions will you use in estimating sales (for example, the hours your pizza shop will be open)?
3. Where would you obtain needed information to calculate an estimate?

Then, estimate the number of pizzas you will sell in your first year of operations.

IDS355: OPERATIONS MANAGEMENT WIKISPACE: "CHAPTER 5: STRATEGIC CAPACITY

PLANNING FOR PRODUCTS AND SERVICES"

Read the chapter five summary. Pay attention to the inputs to capacity planning and the determinants and steps in the capacity planning process. This is important to understanding how to use this information to increase the quality of your forecasts. In addition, this helps you understand your organization's capability to meet the forecast needs. Answer the questions at the end of the summary. Compare your results with the authors.

CH. 5 STRATEGIC CAPACITY PLANNING FOR PRODUCTS AND SERVICES

Chapter 5

This chapter examines how important strategic capacity planning is for products and services. The overall objective of strategic capacity planning is to reach an optimal level where production capabilities meet demand. Capacity needs include equipment, space, and employee skills. If production capabilities are not meeting demand, high costs, strains on resources, and customer loss may result. It is important to note that capacity planning has many long term concerns given the long term commitment of resources.

Managers should recognize the broader effects capacity decisions have on the entire organization. Common strategies include **leading capacity**, where capacity is increased to meet expected demand, and **following capacity**, where companies wait for demand increases before expanding capabilities. A third approach is **tracking capacity** which adds incremental capacity over time to meet demand.

Finally, The two most useful functions of capacity planning are design capacity and effective capacity. **Design capacity** refers to the maximum designed service capacity or output rate and the **effective capacity** is the design capacity minus personal and other allowances. These two functions of capacity can be used to find the efficiency and utilization. These are calculated by the formulas below:

Efficiency = Actual Output/ Effective Capacity x 100%

Utilization = Actual Output/ Design Capacity x 100%

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Chapter 5 Strategic Capacity Planning for Products and Services

Capacity refers to a system's potential for producing goods or delivering services over a specified time interval. Capacity planning involves long-term and short term considerations. Long-term considerations relate to the overall level of capacity; short-term considerations relate to variations in capacity requirements due to seasonal, random, and irregular fluctuations in demand.

Excess capacity arises when actual production is less than what is achievable or optimal for a firm. This often means that the demand in the market for the product is below what the firm could potentially supply to the market. Excess capacity is inefficient and will cause manufacturers to incur extra costs or lose market share. Capacity can be broken down in two categories: Design Capacity and Effective Capacity: refers to the maximum designed service capacity or output rate. Effective capacity is design capacity minus personal and other allowances. Product and service factors effect capacity tremendously.

Chapter 5 focuses on capacity planning for products and services. Capacity is the ability of a systems potential for producing goods or delivering services over a specific time interval. The capacity decisions within a company are very important because they help determine the limit of output and provide a major insight to determining operating costs. Basic decisions about capacity often have long term consequences and this chapter explains the ramifications of those choices. When considering capacity planning within a company, three key inputs should be considered. The three inputs are the kind of capacity to be determined, how much of the products will be needed, and when will the product be needed.

The most important concept of capacity planning is to find a medium between long term supply and capabilities of an organization and the predicted level of long term demand. Organizations also have to plan for actual changes in capacity, changes in consumer wants and demand, technology and even the environment. When

evaluating alternatives in capacity planning, managers have to consider qualitative and quantitative aspects of the business. These aspects involve economic factors, public opinions, personal preferences of managers.

This chapter describes capacity planning as a key factor in designing systems. The capacity decision is strategic and long-term in nature. Capacity planning is described as matching the capabilities of an organization with the predicted level of future demand. Many organizations become involved with capacity planning due to changes in demand, technology, the environment, etc. Organizations have capacities or limits that their system can handle.

Three key inputs to capacity planning:

1. The kind of capacity that will be needed
2. How much capacity will be needed
3. When will it be needed

*Accurate forecasts are critical to the planning process

Defining And Measuring Capacity

When selecting a measure of capacity, it is best to choose one that doesn't need updating. When dealing with more than one product, it is best to measure capacity in terms of each product. For example, the capacity of a firm is to either produce 100 microwaves *or* 75 refrigerators. This is less confusing than just saying the capacity is 100 or 75. Another method of

measuring capacity is by referring to the availability of inputs. Note that one specific measure of capacity can't be used in all situations; it needs to tailored to the specific situation at hand.

Determinants of Effective Capacity

- **Facilities:** The size and provision for expansion are key in the design of facilities. Other facility factors include locational factors (transportation costs, distance to market, labor supply, energy sources). The layout of the work area can determine how smoothly work can be performed.
- **Product and Service Factors:** The more uniform the output, the more opportunities there are for standardization of methods and materials. This leads to greater capacity.
- **Process Factors:** Quantity capability is an important determinant of capacity, but so is output quality. If the quality does not meet standards, then output rate decreases because of need of inspection and rework activities. Process improvements that increase quality and productivity can result in increased capacity. Another process factor to consider is the time it takes to change over equipment settings for different products or services.
- **Human Factors:** the tasks that are needed in certain jobs, the array of activities involved and the training, skill, and experience required to perform a job all affect the potential and actual output. Employee motivation, absenteeism, and labor turnover all affect the output rate as well.
- **Policy Factors:** Management policy can affect capacity by allowing or not allowing capacity options such as overtime or second or third shifts
- **Operational Factors:** Scheduling problems may occur when an organization has differences in equipment capabilities among different pieces of equipment or differences in job requirements. Other areas of impact on effective capacity include inventory stocking decisions, late deliveries, purchasing requirements, acceptability of purchased materials and parts, and quality inspection and control procedures.
- **Supply Chain Factors:** Questions include: What impact will the changes have on suppliers, warehousing, transportation, and distributors? If capacity will be increased, will these elements of the supply chain be able to handle the increase? If capacity is to be decreased, what impact will the loss of business have on these elements of the supply chain?
- **External Factors:** Minimum quality and performance standards can restrict management's options for

increasing and using capacity.

- Inadequate planning can be a major limiting determining of effective capacity.

The most important parts of effective capacity are process and human factors. Process factors must be efficient and must operate smoothly, if not the rate of output will dramatically decrease. Human factors must be trained well and have experience, they must be motivated and have a low absenteeism and labor turnover. In resolving constraint issues, all possible alternative solutions must be evaluated. This is possible by using CVP analysis and the Break-Even Point formula.

Steps in the Capacity Planning Process

1. Estimate future capacity requirements
2. Evaluate existing capacity and facilities and identify gaps
3. Identify alternatives for meeting requirements
4. Conduct financial analyses of each alternative
5. Assess key qualitative issues for each alternative
6. Select the alternative to pursue that will be best in the long term
7. Implement the selected alternative
8. Monitor results

Questions:

1. All of the following factors are part of determining effective capacity ***except***:

a. Human
b. External
c. Facility
d. Design
e. all of the above are factors

[reveal-answer q="724278"]Show Answer[/reveal-answer]
[hidden-answer a="724278"]
answer:d design factors...page 181[/hidden-answer]

2. The capacity planning process **DOES NOT** include which of the following?

a. Estimate future requirements
b. Implement selected alternative
c. Access key quantitative issues
d. Identify alternatives
e. Both a & d

[reveal-answer q="87079"]Show Answer[/reveal-answer]
[hidden-answer a="87079"]
answer:c page 183[/hidden-answer]

3. All of the following are true of Capacity decisions ***except***:

a. impact the ability of the organization to meet future demands
b. affect operating costs
c. are a major determinant of initial cost
d. are a major determinant of variable cost
e. often involve long term commitment of resources.

[reveal-answer q="325866"]Show Answer[/reveal-answer]
[hidden-answer a="325866"]
answer: d
[/hidden-answer]

4. Which of the following industries measure capacity?

a. Farming
b. Theater
c. Retail Sales
d. Hospital
e. All of the above
[reveal-answer q=”371459"]Show Answer[/reveal-answer]
[hidden-answer a=”371459"]
answer e. page 180[/hidden-answer]
5. Which of the following describes the initial cost of an investment?
a. Internal rate of return
b. proceeds
c. Present value
d. cash flow
e. Both a & d
[reveal-answer q=”276593"]Show Answer[/reveal-answer]
[hidden-answer a=”276593"]
answer: c. page 196[/hidden-answer]
6) Which statement best describes a constraint of capacity planning?
a. Facilitates the performance of a process or system in achieving its goal
b. Limits the performance of a process or system in achieving its goal
c. Enhances the performance of a process or system in achieving its goal
d. Excels the performance of a process or a system in achieving its goal.
e. Maximizes the performance of a process or a system in achieving its goal
[reveal-answer q=”480240"]Show Answer[/reveal-answer]
[hidden-answer a=”480240"]
Answer: B answer on page 201 in the margin
[/hidden-answer]
7) What are the three primary strategies in capacity planning?
a. growing,leading, tracking
b. leading, moving, tracking
c. leading, following, tracking
d. tracking, analyzing, leading
e. synthesizing, leading, tracking
[reveal-answer q=”143043"]Show Answer[/reveal-answer]
[hidden-answer a=”143043"]
Answer: C found on page 191[/hidden-answer]
8) Which of the following is **NOT** a determinant of effective capacity planning?
a. supply chain
b. external forces
c. human considerations
d. operational factors
e. all the above are determinants of effective capacity planning
[reveal-answer q=”155670"]Show Answer[/reveal-answer]
[hidden-answer a=”155670"]
Answer: E all the above, answer found on page 189[/hidden-answer]
9) What are the major difference between design capacity and effective capacity?
a. the size of the facility vs the effectiveness of the facility

b. the design and aesthetics of the facility vs. the size of the facility
c. the design and aesthetics of the facility vs. the effectiveness of the facility
d. the actual amount of output vs. the potential maximum amount of output
e. there is no difference

[reveal-answer q=”134739"]Show Answer[/reveal-answer]
[hidden-answer a=”134739"]
Answer: D actual output vs. potential maximum output[/hidden-answer]
10) Which answer(s) defines why capacity decisions are important?
a. capacity decisions have a real impact on whether or not a company will meet future demands
b. capacity decisions affect operating costs
c. capacity decisions are generally a major determinant of initial cost
d. capacity decisions affect competitiveness and management
e. all of the above are components of capacity decision importance
[reveal-answer q=”11480"]Show Answer[/reveal-answer]
[hidden-answer a=”11480"]
Answer: E all of the above
[/hidden-answer]
11) When would a company incorporate a capacity cushion?
a. when demand is certain
b. when demand is uncertain
c. when the company has very standard products
d. when the company sales are declining
e. when the company sales are increasing
[reveal-answer q=”734710"]Show Answer[/reveal-answer]
[hidden-answer a=”734710"]
Answer: B demand is uncertain (192)[/hidden-answer]
12) Which of the following is a reason a company would want to outsource?
a. The organization does not have the necessary skills
b. The organization has unique quality requirements
c. Demand is high and steady
e. none of the above
[reveal-answer q=”426387"]Show Answer[/reveal-answer]
[hidden-answer a=”426387"]
answer: E none of the above (195)[/hidden-answer]
13) What is the evidence of an unbalanced system?
a. system is flexible
b. stage of life cycle is taken into account
c. capacity requirements are smoothed out
d. a bottleneck operation exists
e. the company is in the growth phase
[reveal-answer q=”915050"]Show Answer[/reveal-answer]
[hidden-answer a=”915050"]
Answer: E bottleneck operation exists (197)[/hidden-answer]
14) At the break even point…
a.TC=TR
b. The firm is obtaining a profit

c. TFC=TVC
d. Volume of output is TC > TR
e. none of the above
[reveal-answer q=”884118"]Show Answer[/reveal-answer]
[hidden-answer a=”884118"]
answer: (A) total cost and total revenue are equal (203)[/hidden-answer]
15) Dis-economies of scale happen when...
a. the output rate is less than the optimal level
b. the firm should increase the output rate in order to decrease average unit costs
c. the output rate is more than the optimal level
d. none of the above
e. both a and b
[reveal-answer q=”97987"]Show Answer[/reveal-answer]
[hidden-answer a=”97987"]
answer: C the output rate is more than the optimal level (200)
[/hidden-answer]
16) Reasons for strategic capacity planning include all of the following ***except*** :
a) Changes in the environment
b) Changes in technology
c) Changes in demand
d) Strengths and weaknesses
e) Opportunities and threats
[reveal-answer q=”103661"]Show Answer[/reveal-answer]
[hidden-answer a=”103661"]
D. Strengths and weaknesses (pg 185)[/hidden-answer]
17) Strategic capacity planning for services differs from that for goods due to:
a) The inability to store services in advance
b) Demand volatility
c) Degree of customization
d) The need for customer convenience
e) All of the above
[reveal-answer q=”65766"]Show Answer[/reveal-answer]
[hidden-answer a=”65766"]
E. All of the above (pg 194)[/hidden-answer]
18) Relevant criteria in determining whether to outsource production include:
a) Location
b) Quality
c) Current in-house capacity
d) Costs
e) All of the above
[reveal-answer q=”397993"]Show Answer[/reveal-answer]
[hidden-answer a=”397993"]
E. All of the above (pg 195)[/hidden-answer]
19) In dis-economies of scale, average unit costs after the optimal level are:
a) Larger
b) Smaller
c) Lowest

d) Constant
e) None of the above
[reveal-answer q=”46858"]Show Answer[/reveal-answer]
[hidden-answer a=”46858"]
A. Larger (pg 200)[/hidden-answer]
20) Which of the following assumptions must be satisfied in order to use Cost Volume Analysis?
a) Variable cost per unit is greater than revenue per unit
b) Variable cost per unit is constant
c) More than one product in involved
d) Fixed costs change with volume
e) Revenue per unit changes with volume
[reveal-answer q=”448585"]Show Answer[/reveal-answer]
[hidden-answer a=”448585"]
B. Variable cost per unit is constant (pg 205)[/hidden-answer]
21) Which of the following is **NOT** a primary capacity strategy?
a) continuous
b) leading
c) following
d) tracking
e) both b and d
[reveal-answer q=”547680"]Show Answer[/reveal-answer]
[hidden-answer a=”547680"]
Answer: a, page 191[/hidden-answer]
22) Which is an important factor in planning service capacity?
a) availability of capacity
b) the need to be near customers
c) the degree of volatility of demand
d) both b and c
e) none of the above
[reveal-answer q=”290284"]Show Answer[/reveal-answer]
[hidden-answer a=”290284"]
Answer: d, page 194[/hidden-answer]
23)The maximum designed service capacity or output rate is known as?
a) capacity cushion
b) bottleneck operation
c) effective capacity
d) design capacity
e) both c and d
[reveal-answer q=”19014"]Show Answer[/reveal-answer]
[hidden-answer a=”19014"]
Answer: d, page 188[/hidden-answer]
24) Given the following information, compute the efficiency: Effective capacity = 40 trucks per day, Actual output = 36 trucks per day
a) 82%
b) 99%
c) 90%

d) 89.7%
e) 54%
[reveal-answer q=”311620"]Show Answer[/reveal-answer]
[hidden-answer a=”311620"]
Answer: c, page 189[/hidden-answer]
25) Which of the following are steps in the capacity planning process?
a) estimate future capacity requirements
b) conduct financial analysis
c) monitor results
d) implement the selective alternative
e) all of the above
[reveal-answer q=”810968"]Show Answer[/reveal-answer]
[hidden-answer a=”810968"]
Answer: e, page 192[/hidden-answer]
26) Which of these are NOT determinants of effective capacity?
a) Facilities
b) Process Factors
c) Human Factors
d) Policy Factors
e) All of above are determinants of effective capacity
[reveal-answer q=”604261"]Show Answer[/reveal-answer]
[hidden-answer a=”604261"]
Answer E (page 190)[/hidden-answer]
27) What is a constraint?
a) Something that allows a system to perform more effectively and efficiently.
b) Something that hinders performance of a system in achieving its goals.
c) Something that attempts to smooth out capacity requirements.
d) Something that monitors results
e) Something that can never be overcome.
[reveal-answer q=”551606"]Show Answer[/reveal-answer]
[hidden-answer a=”551606"]
Answer B (page 201)[/hidden-answer]
28) Which assumptions must be satisfied in order for cost-volume analysis to be a valuable tool?
a) Variable cost/unit exceeds revenue/unit
b) Everything produced may not be sold
c) Only one product involved
d) Revenue per unit may change depending on volume
e) Variable cost per unit may differ depending on volume
[reveal-answer q=”834176"]Show Answer[/reveal-answer]
[hidden-answer a=”834176"]
Answer C (page 205)[/hidden-answer]
29) What is the correct formula for the break even point in units?
a) FC / (Revenue per unit – VC per unit)
b) VC/(FC-Revenue)
c) Revenue/(VC – FC)
d) FC/(VC-Revenue)
e) None of the above

[reveal-answer q="188712"]Show Answer[/reveal-answer]
[hidden-answer a="188712"]
Answer A (page 204)[/hidden-answer]
30) What is the best way to measure capacity for a steel mill?
a) In dollars
b) In number of workers
c) In the size of the mill
d) In tons of steel produced per day
e) In number of resources used
[reveal-answer q="479056"]Show Answer[/reveal-answer]
[hidden-answer a="479056"]
Answer D (page 188)[/hidden-answer]
31) What is the first step in the capacity planning process?
A. Evaluate existing capacity
B. Estimate future capacity
C. Determine future capacity price
D. Select alternative capacity
E. Find key quality issues
[reveal-answer q="625917"]Show Answer[/reveal-answer]
[hidden-answer a="625917"]
Answer = B. Page 192[/hidden-answer]
32) Which of these is a determinant of effective capacity?
A. Facilities
B. Product factors
C. Human factors
D. Operational factors
E. All of these
[reveal-answer q="922882"]Show Answer[/reveal-answer]
[hidden-answer a="922882"]
Answer = E. Page 190[/hidden-answer]
33) What is the first step in strategy formulation?
A. Determine Product/Service
B. Formulate policy
C. Locate facilities
D. Formulate process
Order operations
[reveal-answer q="939674"]Show Answer[/reveal-answer]
[hidden-answer a="939674"]
Answer = C. Page 191[/hidden-answer]
34) When is it best to use simulation?
A. For short tem goals
B. For long term goals
C. For current goals
D. For customer wants
E. For "what if" analysis
[reveal-answer q="605353"]Show Answer[/reveal-answer]
[hidden-answer a="605353"]

Answer = E. Page 207[/hidden-answer]

35) Decision theory is best used in which of the following?

A. Finance
B. Inventory
C. Long term analysis
D. Consumer demand
E. Short term analysis

[reveal-answer q="979803"]Show Answer[/reveal-answer]
[hidden-answer a="979803"]

Answer = A. Page 207[/hidden-answer]

36) What is capacity?

I. The upper limit or ceiling on the load that an operating unit can handle.
II. The lower limit or bottom on the load that an operating unit can handle.
III. A system's potential for producing goods or delivering services over a specified time interval.
IV. A ceiling on output and a major determinant of operating costs.

a.) I and II
b.) II and III
c.) I, II, and IV
d.) I, III, and IV
e.) I and IV

[reveal-answer q="1252"]Show Answer[/reveal-answer]
[hidden-answer a="1252"]Answer: D. Found on pages 185, 207[/hidden-answer]

37) What is the difference between efficiency and utilization?

a.) Efficiency is the ratio of actual output to effective capacity, while capacity utilization is the ratio of actual output to design capacity.
b.) Efficiency is expressed as a percentage, while capacity utilization is not.
c.) Efficiency is a measure of system effectiveness, while capacity utilization measures capacity tailored to a situation.
d.) Utilization is the ratio of actual output to effective capacity, while efficiency is the ratio of actual output to design capacity.
e.) Utilization is expressed as a percentage, while efficiency is not.

[reveal-answer q="572545"]Show Answer[/reveal-answer]
[hidden-answer a="572545"]

Answer: A. Found on page 188[/hidden-answer]

38) Find the design capacity when utilization = 72 and actual output = 36 trucks per day.

a.) 35 trucks per day
b.) 40 trucks per day
c.) 45 trucks per day
d.) 50 trucks per day
e.) 55 trucks per day

[reveal-answer q="826829"]Show Answer[/reveal-answer]
[hidden-answer a="826829"]

Answer: D. Found on page 189 (Utilization = [Actual Output/ Design Capacity] x 100)[/hidden-answer]

39) An operation in a sequence of operations whose capacity is lower than that of the other operations is known as:

a.) Effective Capacity
b.) Design Capacity
c.) Bottleneck Operation
d.) Capacity Cushion
e.) Effective Operation

[reveal-answer q="337427"]Show Answer[/reveal-answer]
[hidden-answer a="337427"]
Answer: C. Found on page 197[/hidden-answer]
40) Which of the following is NOT one of the five steps used to resolve constraint issues:
a.) Identify the most pressing constraint.
b.) Change the operation to achieve the maximum benefit, given the constraint.
c.) Make sure other portions of the process are supportive of the constraint.
d.) Explore and evaluate ways to overcome the constraint.
e.) Allow the constraint to limit performance when a strategy is expanding.

[reveal-answer q="531515"]Show Answer[/reveal-answer]
[hidden-answer a="531515"]
Answer: E. Found on page 201 and 202[/hidden-answer]

Possible Future Demand			
Alternatives	**Low**	**Moderate**	**High**
Small Facility	$10	$11	$11
Medium Facility	7	12	12
Large Facility	(3)	2	16

41. Use the information above to answer this question. If the company uses Maxi-min Criterion to choose the best alternative, what would be the best choice for this company?
a) Small Facility
b) Medium Facility
c) Large Facility
d) Do Nothing
e) They are all incorrect answers.
[reveal-answer q="572158"]Show Answer[/reveal-answer]
[hidden-answer a="572158"]
Answer is A found on page 217 (Supplement to Chapter 5)[/hidden-answer]
42. What is Capacity cushion? If utilization is 38%.
a) 72%
b) 74%
c) 12%
d) 22%
e) 62%

[reveal-answer q="106561"]Show Answer[/reveal-answer]
[hidden-answer a="106561"]
Answer is E found on page The formula is Capacity cushion = 100% – Utilization[/hidden-answer]

Product	Annual Demand	Standard Processing Time per Unit (Hr)	Processing Time Needed (Hr)
1	300	5.00	1,500
2	400	8.00	3,200
3	700	2.00	1,400
Total	6,100		

43. Use the information in the table to answer this question. *Note*: department is working one 8-hour shift 250 days a year. How many machines would be needed to handle the required volume? (Round your answer to the whole number)
a) 3 machines
b) 1 machines
c) 5 machines
d) 2 machines
e) 4 machines
[reveal-answer q=”266604"]Show Answer[/reveal-answer]
[hidden-answer a=”266604"]
Answer is A found on page 194.[/hidden-answer]

Based on the information below answer the following Questions 44-47.

The owner of Cookies Inc., Zoya, is contemplating adding a new line of cookies, which require leasing for a monthly payment of $4,000. Variable costs would be $2 per cookie, and cookies retail price for $6 each.

44. How many cookies must be sold in order to break-even?
a) 1000 cookies/month
b) 1200 cookies/moth
c) 2100 cookies/moth
d) 1100 cookies/moth
e) None of the above.
[reveal-answer q=”909983"]Show Answer[/reveal-answer]
[hidden-answer a=”909983"]
Answer is A found on page 204. FC=$4,000; VC=$2 per cookie: Rev.=$6 per cookie; Q=FC/(Rev-VC); Q=$4,000/($6-$2)=1000 cookies/month.[/hidden-answer]

45. What would be the profit (loss) if 900 cookies are made and sold in a month?
a) 400 profit
b) 400 loss
c) 4000 profit
d) 4000 loss
e) None of the above.
[reveal-answer q=”782303"]Show Answer[/reveal-answer]
[hidden-answer a=”782303"]
Answer is **B** found on page 204. $P = Q(R – v) – FC$
[/hidden-answer]

46. How many cookies must be sold to realize a profit of $10,000?
a) 3500 cookies
b) 5300 cookies
c) 3000 cookies
d) 3200 cookies
e) 2300 cookies

[reveal-answer q="184969"]Show Answer[/reveal-answer]
[hidden-answer a="184969"]
Answer is A found on page 204. Q=($10,000+$4,000)/($6-$2)=3,500 cookies[/hidden-answer]

47. If 2,500 cookies can be sold, and a profit is $8,000, what price should be charged per cookie?

a) $7.00
b) $7.50
c) $6.80
d) $6.50
e) $7.80

[reveal-answer q="368491"]Show Answer[/reveal-answer]
[hidden-answer a="368491"]
Answer is C found on page 204.Profit = Q(R – v) – FC
$8,000=2,500(R-$2)-$4,000
$8,000+$4,000=2,500R-$5,000
$17,000=2,500R
R=$6.8 [/hidden-answer]

Number of Machines	Total Annual Fixed Costs	Corresponding Range of Output
1	$12,00	0 to 300
2	15,000	301 to 600
3	24,000	601 to 900

Variable Cots is $12 per unit, and revenue is $42 per unit.

Use the table above to answer the following Questions 8-10.

48. Determine the break-even point for range (0 to 300).

a) 400 units
b) 320 units
c) 420 units
d) 380 units
e) 520 units

[reveal-answer q="114352"]Show Answer[/reveal-answer]
[hidden-answer a="114352"]
Answer is A found on page 205. Q=FC/(R-v); 12,000/($42-$12)=400 units.[/hidden-answer]

49. Determine the break even point for range (301 to 600).

a) 500 units
b) 400 units
c) 320 units
d) 420 units
e) 520 units

[reveal-answer q="464300"]Show Answer[/reveal-answer]
[hidden-answer a="464300"]
Answer is A found on page 205.[/hidden-answer]

50. If projected annual demand is between 580 and 650 units, how many machines should the manager purchase. If break-even point for

One machine: 400 units **Range** (0 to 300)
Two machines: 500 units **Range** (301 to 600)
Three machines: 800 units **Range** (601 to 900)

a) 2 machines
b) 3 machines
c) 1 machine
d) a&b both are correct
e) None of the above; the manager should do nothing.
[reveal-answer q="804364"]Show Answer[/reveal-answer]
[hidden-answer a="804364"]Answer is **A** found on page 205.
Comparing the projected range of demand to the two ranges for which a break -even point, you can see that the break-even point is 500 units, which is in the range 301 to 600. This means that even if demand is at the low end of the range, it would be above the break even point and thus yield a profit. That is not true of range 601 to 900. At the top end of projected demand, the volume would still be less than the break-even point for that range, so there would be no profit. Thus, the manager should choose two machines.[/hidden-answer]

51) If the output rate is less than the optimal level, increasing the output rate results in decreasing average unit costs according to:
a) diseconomies of scale
b) economies of scale
c) capacity cushion
d) efficiency
e) utilization
[reveal-answer q="91709"]Show Answer[/reveal-answer]
[hidden-answer a="91709"]
Answer B (Page 200)[/hidden-answer]

52) If: Design capacity= 60 trucks per day, effective capacity = 40 trucks per day, actual output = 36 trucks per day, compute the efficiency:
a) 20%
b) 30%
c) 40%
d) 50%
e) 90%
[reveal-answer q="729977"]Show Answer[/reveal-answer]
[hidden-answer a="729977"]
Answer E (Efficiency=Actual output/effective capacity=36trucks per day/40 trucks per day=90%) (Page 188)[/hidden-answer]

54) What is capacity cushion?
a) Extra amount of capacity intended to offset uncertainty in demand
b) Estimate in future capacity requirement
c) Common demand pattern
d) External service or good
e) All of the above
[reveal-answer q="767423"]Show Answer[/reveal-answer]
[hidden-answer a="767423"]
Answer A (Page 192)[/hidden-answer]

55) What do long term considerations relate to?
a) demand
b) capacity cushion
c) supply

d) overall level of capacity requirements
e) short term events
[reveal-answer q=”779150"]Show Answer[/reveal-answer]
[hidden-answer a=”779150"]
Answer D (Page 192)[/hidden-answer]
56) What are the three primary strategies of a strategy formulation?
a. leading, following, and concluding
b. start up, following, and tracking
c. leading, following, and tracking
d. start up, leading, and follow up
e. leading, processing, concluding
[reveal-answer q=”173575"]Show Answer[/reveal-answer]
[hidden-answer a=”173575"]
answer is c. (found on page 191)[/hidden-answer]

7.2: Facility Location and Layout

IDS355: OPERATIONS MANAGEMENT WIKISPACE: "CHAPTER 8: LOCATION PLANNING AND ANALYSIS"

Review #1 Location Cost-Volume-Profit Analysis, which should help you to understand the financial aspects of choosing a location. In addition consider the factors that influences the location of a new facility. This is important because a poor choice can make it very difficult to meet demand and manage costs effectively.

CH. 8 LOCATION PLANNING AND ANALYSIS

Location Planning

Every firm must use location planning techniques. There are many options for location planning. Corporations choose from expanding an existing location, shutting down one location and moving to another, adding new locations while retaining existing facilities, or doing nothing. There are a variety of methods used to decide the best location or alternatives for the corporation. Methods such as identifying the country, general region, small number of community alternatives, and site alternatives.

Several factors that influence location positioning include the location of raw materials, proximity to the market, climate, and culture. Models for evaluating whether a location is best for an organization consist of cost-profit analysis for locations, the center of gravity model, the transportation model, and factor rating.

This chapter discusses the decision to relocate a facility by considering costs and benefits. If you are planning on moving or acquiring a new facility, there are many factors to consider: the size, the geographic area, culture, transportation costs and others. After a location or locations have been chosen a cost-profit-volume analysis is done.

The main factors that affect location decisions include regional factors, community considerations, and site-related factors. Community factors consist of quality of life, services, attitudes, taxes, environmental regulations, utilities, and development support.

EVALUATING LOCATION ALTERNATIVES *(Page 385)*

– There are three specific analytical techniques available to aid in evaluating location alternatives:

1. **Location Cost-Volume-Profit Analysis:**
    1. The Cost-Volume-Profit (CVP) Analysis can be represented either mathematically or graphically. It involves three steps: 1) For each location alternative, determine the fixed and variable costs, 2)For all locations, plot the total-cost lines on the same graph, and 3) Use the lines to determine which alternatives will have the highest and lowest total costs for expected levels of output. Additionally, there are four assumptions one must keep in mind when using this method:

1. Fixed costs are constant.
2. Variable costs are linear.
3. Required level of output can be closely estimated.
4. There is only one product involved.
5.

2. **Total cost = FC = v(Q)**

where FC=Fixed Cost, v=Variable Cost per Unit, Q=Number of Units (Also shown below but not in the same format)

1. **Factor Rating**
    1. This method involves qualitative and quantitative inputs, and evaluates alternatives based on comparison after establishing a composite value for each alternative. Factor Rating consists of six steps:
        1. Determine relevant and important factors.
        2. Assign a weight to each factor, with all weights totaling 1.00.
        3. Determine common scale for all factors, usually 0 to 100.
        4. Score each alternative.
        5. Adjust score using weights (multiply factor weight by score factor); add up scores for each alternative.
        6. The alternative with the highest score is considered the best option.
    2. Minimum scores may be established to set a particular standard, though this is not necessary.
2. **Center of Gravity Method:**
    - This technique is used in determining the location of a facility which will either reduce travel time or lower shipping costs. Distribution cost is seen as a linear function of the distance and quantity shipped. The Center of Gravity Method involves the use of a visual map and a coordinate system; the coordinate points being treated as the set of numerical values when calculating averages. If the quantities shipped to each location are *equal* , the center of gravity is found by taking the averages of the *x* and *y* coordinates; if the quantities shipped to each location are *different* , a weighted average must be applied (the weights being the quantities shipped).

Company Relocating

There are many factors that contribute to a company relocating. Some of the reasons include expanding the market and diminishing resources. For an existing company to relocate, they must weigh their options when planning to relocate elsewhere. They can expand their existing facility, add new ones and keep their existing facilities open, move to another location and shut down one location, or keep things the way they are and not do anything. Globalization has led many companies to set up operations in other countries. Two factors that make relocation appealing are advances in technology and trade agreements. By going global, companies will expand their markets and be able to cut costs in labor, transportation, and taxes. They also have gained ideas for new products and services.

IDENTIFYING A COUNTRY, REGION, COMMUNITY, AND SITE *(Page 376)*

· factors that influence location decisions are:

Manufacturing :
o Availability of energy and water
o Proximity to raw materials
o Transportation cost
Service:
o Traffic patterns
o Proximity to markets
o Location of competitors
·Once important factors have been determined, an organization will narrow down alternatives to a specific geographic region. These factors that influence location selection are often different depending on whether the firm is a manufacturing or service firm. When deciding on a location, mangers must take into account the culture shock employees might face after a location move. Culture shock can have a big impact on employees which might affect workers productivity, so it is important that mangers look at this.

v **IDENTIFYING A COUNTRY**

o A decision maker must understand the benefits and risks as well as the probabilities of them occurring

v **IDENTIFYING A REGION-** 4 major considerations

o Location to Raw Materials: The three most important reasons for a firm to locate in a particular region includes *raw materials, perishability, and transportation cost.* This often depends on what business the firm is in.
o Location to Markets: Profit maximizing firms locate near markets that they want to serve as part of their competitive strategy. A *Geographic information system(GIS)* is a computer based tools for collecting, storing, retrieving, and displaying demographic data on maps.
o Labor Factors : Primary considerations include labor availability, wage rates, productivity, attitudes towards work, and the impact unions may have.
o Other : Climate is sometimes a consideration because bad weather can disrupt operations. Taxes are also an important factor due to the fact that taxes affect the bottom line in some financial statements.

v **IDENTIFYING A COMMUNITY**

o There are many important factors for deciding upon the community in which move a business. They include facilities for education, shopping, recreation and transportation among many others. From a business standpoint these factors include utilities, taxes, and environmental regulation.

v **IDENTIFYING A SITE**

o The main considerations in choosing a site are land, transportation, zoning and many others. When identifying a site I]it is important to consider to see if the company plans on growing at this location. If so, the firm must consider whether or not location is suitable for expansion. There are many decisions that go into choosing exactly where a firm will establish its operations. First, a company must determine the driving factors that will influence which areas are suitable locations. After these factors have been determined, the company will identify potential countries and examine the pros and cons of establishing operations in these countries. After looking at pro and cons of the different countries and deciding on a country, then decision makers will identify a region within the country. When identifying a region, decision makers must take the four major factors explained above into consideration. The last two stages of the search include choosing a community and a site.

Note: The above part is way too lengthy for this assignment.

Summary below..

Summary : There are several ways that are very helpful in evaluating location alternatives, such as locational cost-profit-volume analysis, factor rating, and the center of gravity method. First, let's take a look at Location Cost-Profit-Volume Analysis.

This analysis can be done numerically or graphically. The procedure for locational cost-profit-volume analysis involves these steps:

1. Determine the fixed and variable costs associated with each location alternative.

2. Plot the total-cost lines for all location alternatives on the same graph.
3. Determine which location will have the lowest total cost for the expected level of output. Alternatively, determine which location will have the highest profit.

This method assumes the following:

1. Fixed costs are constant for the range of probable output.
2. Variable costs are linear for the range of probable output.
3. The required level of output can be closely estimated.
4. Only one product is involved.

Here're a couple of important formulas to remember:

Total cost = Fixed cost + Variable cost per unit * Quantity or volume of output

Total profit = Quantity(Revenue per unit – Variable cost per unit) – Fixed cost

In most situations, other factors besides cost must also be considered. We will now consider another kind of cost often considered in location decisions: transportation costs.

Transportation costs sometimes play an important role in location decisions. The company can include the transportation costs in a locational cost-volume analysis by incorporating the transportation cost per unit being shipped into the variable cost per unit if a facility will be the sole source or destination of shipments. When there is a problem with shipment of goods from multiple sending points to multiple receiving points, and a new location is to be added to the system, the company should undertake a separate analysis of transportation. In this case, transportation model of linear programming is very helpful. The model is used to analyze each of the configurations considered, and it reveals the minumum costs each would provide. Then the information can be included in the evaluation of location alternatives.

Multiple Plant Manufacturing Strategies *(page 381-382)*

-*When comapnies have several manufacturing facilities t* here are several different ways for a company to organize their operations. These ways include: assigning different product lines to different plants, assigning different market areas to different plants, or assigning different processes to different plants. These strategies carry their own cost and managerial implications, but they also carry a certain competitive advantage. There are four different types of plant strategies:

1. **Product Plant Strategy**

- Products or product lines are produced in separate plants, and each plant is usually responsible for supplying the entire domestic market.
- It is a decentralized approach as each plant focuses on a narrow set of requirements that includes specialization of labor, materials, and equipment along product lines.
- Specialization involved in this strategy usually results in economies of scale and, compared to multipurpose plants, lower operating costs.
- The plant locations may either be widely scattered or placed relatively close to one another.

2. **Market Area Plant Strategy**

- Here, plants are designed to serve a particular geographic segment of a market.
- The individual plants can produce either most, or all of the company's products and supply a limited geographical area.

- The operating costs of this strategy are often times higher than those of product plants, but savings on shipping costs for comparable products can be made.
- This strategy is useful when shipping costs are high due to volume, weight, or other factors.
- It can also bring the added benefits of faster delivery and response times to local needs.
- It requires a centralized coordination of decisions to add or delete plants, or to expand or downsize current plants because of changing market conditions.

3. **Process Plant Strategy**

- Here, different plants concentrate on different aspects of a process.
- This strategy is most useful when products have numerous components; separating the production of components results in less confusion than if all the production were done in the same location.
- A major issue with this strategy is the coordination of production throughout the system, and it requires a highly informed, centralized administration in order to be an effective operation.
- It can bring about additional shipping costs, but a key benefit is that individual plants are highly specialized and generate volumes that brings economies of scale.

4. **General-Purpose Plant Strategy**
Plants are flexible and have the ability to handle a range of products

- It allows for a quick response to products and market changes, but can be less productive than a more focused approach.
- A benefit to this approach is the increase in learning opportunities that happens when similar operations are being done in different plants. Solutions to problems as well as improvements made at one plant can be shared with the other plants

Question 1:
From a company standpoint, which factors determine the desirability of a community as a place for its workers and managers to live?
A) The amount of parking spaces
B) Retail stores
C) Schools
D) Locals attitudes towards the company.
E) Both C and D.
[reveal-answer q=”139132"]Show Answer[/reveal-answer]
[hidden-answer a=”139132"]
answer is c. (found on page 191)[/hidden-answer].
Question 2:
What is NOT a risk a corporation must consider when planning a location?
A) Political
B) Exporting
C) Economic
D) Cultural
E) Economic

[reveal-answer q="44299"]Show Answer[/reveal-answer]
[hidden-answer a="44299"]
Answer: B. Pages 373-374.[/hidden-answer]
Question 3:
What do banks, fast-food chains, supermarkets, and retail stores view locations as?
A) One in many intricate decisions for their organizations
B) A crucial part of the marketing strategy.
C) An easier way to distribute their product or service.
D) New ideas for future investments.
E) A second home.
[reveal-answer q="832271"]Show Answer[/reveal-answer]
[hidden-answer a="832271"]
Answer: B. Page 369[/hidden-answer]
Question 4:
What is the third step when making location decisions?
A) Evaluate the alternatives and make a selection.
B) Identify important factors.
C) Decide on criteria for evaluating alternatives.
D) Develop location alternatives.
E) None of the above.
[reveal-answer q="544113"]Show Answer[/reveal-answer]
[hidden-answer a="544113"]
Answer: D. Page 376.[/hidden-answer]
Question 5:
What is the center of gravity method?
A) A method that determines the location of a facility that will minimize shipping cost and travel time to various destinations.
B) A method that determines the location of a facility closest to the most number of consumers.
C) A method that determines the location of a facility closest to the main supplier
D) A method that determines the location of a facility in the middle-point of all suppliers.
E) none of the above
[reveal-answer q="7801"]Show Answer[/reveal-answer]
[hidden-answer a="7801"]
Answer: A. Page 388
[/hidden-answer]
1.) Location analysis assumes that both qualitative and quantitative factors are important in determining an ideal location when using:
a. The Transportation Model
b. The Center of Gravity Method
c. Factor Rating
d. Cost-Profit Analysis
e. None of the above
[reveal-answer q="631057"]Show Answer[/reveal-answer]
[hidden-answer a="631057"]
Page 379 9th Ed.[/hidden-answer]
2.) The transportation model can be applied to solve factors including:
I. Cost

II. Profit
III. Capacity
IV. Management
a. I only
b. I and II only
c. I, II, and III only
d. II, III, and IV only
e. II and IV only
[reveal-answer q=”349330"]Show Answer[/reveal-answer]
[hidden-answer a=”349330"]
Page 391 9th Edition[/hidden-answer]
3.) The Transportation Model uses the following information to determine costs:
a. A list of shipping origins
b. Demand of destinations
c. Unit costs
d. None of the above
e. All of the above
[reveal-answer q=”920131"]Show Answer[/reveal-answer]
[hidden-answer a=”920131"]
e. All of the above[/hidden-answer]
4.) Which is a **TRUE** assumption needed to perform Cost-Profit Volume Analysis?
a. Fixed costs are exponential
b. Variable costs are logarithmic
c. All costs are linear
d. At least 2 products are being compared
e. Revenue is NOT included in the analysis
[reveal-answer q=”792503"]Show Answer[/reveal-answer]
[hidden-answer a=”792503"]c. All costs are linear
9th Edition says that variable costs are linear, and fixed costs are constant.
[/hidden-answer]
5.) In the Factor Rating Method of location analysis, which of the following is **NOT** a managerial choice?
a. Assigning weight to the importance of aspects being compared
b. Adding the applied (weight x value) of various categories to get a composite for a location
c. Determining the ultimate choice for the location
d. Assigning information gathering on a location
e. All of the above are managerial choices
Question 5 needs an answer, also needs page numbers where answers are found
1) What does GIS stand for?
A. General Information Systems
B. Great Information Systems
C. Geographic Information Systems
D. General Institutions
E. None of the above
[reveal-answer q=”669674"]Show Answer[/reveal-answer]
[hidden-answer a=”669674"]
Answer: C[/hidden-answer]
2)The primary consideration for identifying a site is?

A. Location
B. Zoning
C. Transportation
D. None of the Above
E. All of the above
[reveal-answer q=”877886"]Show Answer[/reveal-answer]
[hidden-answer a=”877886"]
Answer: E[/hidden-answer]
3) What are the common techniques used to evaluate location alternatives?
A. Locational cost-profit-volume analysis
B. Factor ratings
C. Center of gravity method
D. Transportation model
E. All of the above
[reveal-answer q=”921061"]Show Answer[/reveal-answer]
[hidden-answer a=”921061"]
Answer: E[/hidden-answer]
4) What is a general-purpose plant strategy?
A. A general approach to evaluating locations that include qualitative and quantitative inputs.
B. A way to evaluate rating of geographic area
C. A general approach to evaluating locations that include regional inputs.
D. A way of being capable of handling a wide range of different products.
E. None of the above
[reveal-answer q=”847806"]Show Answer[/reveal-answer]
[hidden-answer a=”847806"]
Answer: D[/hidden-answer]
5) Method for locating a distribution center that minimizes the distribution costs.
A.Location cost-pofit-volume analysis
B. Method for finding balance between company culture and geographic culture.
C. Method that compares costs to benefits
D. All of the above.
E. None of the above
[reveal-answer q=”739633"]Show Answer[/reveal-answer]
[hidden-answer a=”739633"]
Answer: A[/hidden-answer]
1) What is a primary factor in the regional level of location decisions?
A. Location of raw materials or supplies
B. Quality of life
C. Location of markets
D. A and C
E. None of the above
[reveal-answer q=”650549"]Show Answer[/reveal-answer]
[hidden-answer a=”650549"]
Answer: D page 365 (9th edition)[/hidden-answer]
2) In a geographic information system (GIS), which is **NOT** involved in the data?
A. Age
B. Incomes

C. Quality of life
D. Type of employment
E. Type of housing
[reveal-answer q="397044"]Show Answer[/reveal-answer]
[hidden-answer a="397044"]
Answer: C page 366 (9th edition)[/hidden-answer]
3) What is a disadvantage of globalization?
A. Transportation costs
B. Security costs
C. Unskilled labor
D. Import restrictions
E. All of the above
[reveal-answer q="235689"]Show Answer[/reveal-answer]
[hidden-answer a="235689"]
Answer: E page 373 (9th edition)[/hidden-answer]
4) Mining operations, farming, forestry, and fishing are all examples of which primary reason for firms locating near or at the source of raw materials?
A. Necessity
B. Perishability
C. Transportation costs
D. Processing
E. None of the above
[reveal-answer q="434730"]Show Answer[/reveal-answer]
[hidden-answer a="434730"]
Answer: A page 365 (9th edition)[/hidden-answer]
5) Which of the following would you establish a composite value for?
A. The transportation model
B. Factor rating
C. The center of gravity method
D. Locational Cost-Profit-Volume Analysis
E. Geographic information system
[reveal-answer q="877949"]Show Answer[/reveal-answer]
[hidden-answer a="877949"]
Answer: B page 379 (9th edition)[/hidden-answer]
1. Which of these is a computer-based tool for collecting, storing, retrieving, and displaying demographic data on maps?
A. Geographic Data System
B. Geographic Information System
C. Demographic Data System
D. CAM
E. none of the above
[reveal-answer q="151402"]Show Answer[/reveal-answer]
[hidden-answer a="151402"]
Answer: B page 379[/hidden-answer]
2. Which is a major consideration when choosing to operate in a region?
A. the minimum wage rate
B. identifying a community

C. location to raw materials
D. possible sites available
E. none of the above
[reveal-answer q="596713"]Show Answer[/reveal-answer]
[hidden-answer a="596713"]
Answer: C page 378[/hidden-answer]
3. Considering global expansion, decision makers need to be absolutely clear on the benefits and risks and the likelihood of their occurrences when deciding upon identifying:
A. a continent
B. a site
C. a community
D. a country
E. none of the above
[reveal-answer q="852496"]Show Answer[/reveal-answer]
[hidden-answer a="852496"]
Answer: D page 378[/hidden-answer]
4. A dominant factor that influences the location decision of a manufacturing firm is:
A. Climate changes
B. Location to competitors
C. Proximity to markets
D. Transportation cost
E. none of the above
[reveal-answer q="879782"]Show Answer[/reveal-answer]
[hidden-answer a="879782"]
Answer: D page 376[/hidden-answer]
5. Which of the following is **Not** a primary consideration when identifying a site for operations?
A. Land
B. Transportation
C. Zoning
D. Future expansion
E. All of the Above
[reveal-answer q="790281"]Show Answer[/reveal-answer]
[hidden-answer a="790281"]
Answer: E page 381[/hidden-answer]
1 . When using the Center of Gravity Method, what are the two differing variables for equal and unequal quantities shipped, respectively?
a. n 1 ; n 2
b. n;Q
c. n; n i
d. e; u e
e. n; Q i
[reveal-answer q="788607"]Show Answer[/reveal-answer]
[hidden-answer a="788607"]
Answer: e (pages 388-89)[/hidden-answer]
2. Which location alternative technique involves viewing the problem in economic terms?
a. Factor Rating
b. CVP

c. GIS
d. Center of Gravity
e. Transportation Model
[reveal-answer q="380818"]Show Answer[/reveal-answer]
[hidden-answer a="380818"]
Answer: b (page 385)[/hidden-answer]
3. When considering foreign locations, crime, and the threat of terrorism fall under which category?
a. Safety
b. Cultural Differences
c. Market
d. Financial
e. Customer Preferences
[reveal-answer q="860072"]Show Answer[/reveal-answer]
[hidden-answer a="860072"]
Answer: a (page 378)[/hidden-answer]
4. When using the factor rating method of location alternative evaluation, which of the following could be considered relevant factors?
a. Location of market
b. Water supply
c. Parking facilities
d. Revenue potential
e. All of the above
[reveal-answer q="840699"]Show Answer[/reveal-answer]
[hidden-answer a="840699"]
Answer: e (page 387)[/hidden-answer]
5. Which of the following is **not** a step in the general procedure for making location decisions?
a. Develop location alternatives
b. Evaluate the alternatives and make a selection
c. Gain government approval of location alternatives
d. Decide on criteria for evaluating alternatives
e. Identify important factors (e.g., location of markets)
[reveal-answer q="427062"]Show Answer[/reveal-answer]
[hidden-answer a="427062"]
Answer: c (page 376)[/hidden-answer]

Chapter 8

Summary:

The location of a business is crucial to it's growth. There are many factors that come into play when choosing a suitable location. Usually it is one or a few factors that dominate the decision making process. For example, a change in market supply and/or demand, perhaps even if inputs used by the business have run out. A business can suffer greatly if the right location is not chosen. Therefore a business should evaluate all their options very carefully before making a final conclusion.

There are generally four options a manager has with regard to location planning. The first option would be to take the current facility and make it bigger. The second would be to keep the current facility and just create a (or many) new one(s). The third would be to close down the current facility entirely and build a new one. The last option would be to keep things the way they are.

Questions: Questions need to be multiple choice format.

1. What is the name of the computer-based tool used for collecting, storing, retrieving, and displaying demographic data on maps?
[reveal-answer q="885635"]Show Answer[/reveal-answer]
[hidden-answer a="885635"]
A: Geographic Information System (GIS)[/hidden-answer]
2. True or False: Most organizations try to find the one best location.
[reveal-answer q="75168"]Show Answer[/reveal-answer]
[hidden-answer a="75168"]
A: False[/hidden-answer]
3. What are the three primary regional factors involved in location decision making?
[reveal-answer q="544675"]Show Answer[/reveal-answer]
[hidden-answer a="544675"]
A: raw materials, markets, and labor considerations[/hidden-answer]
4. Name three trade agreements mentioned in this chapter.
[reveal-answer q="180880"]Show Answer[/reveal-answer]
[hidden-answer a="180880"]
A: North American Free Trade Agreement (NAFTA), the General Agreement on Tariffs and Trade (GATT), and the U.S. – China Trade Relations Act
[/hidden-answer]
5. What are five disadvantages to having global operations?
[reveal-answer q="934620"]Show Answer[/reveal-answer]
[hidden-answer a="934620"]
A: Transportation costs, security costs, unskilled labor, import restrictions, and criticisms.[/hidden-answer]
6. Suppose that the operating costs of a company has a weight of .20. There are three possible location choices. The first location has a score of 60/100. The second location has a score of 50/100. The third location has a score of 80/100. What are the weighted scores of each location possibility?
[reveal-answer q="414468"]Show Answer[/reveal-answer]
[hidden-answer a="414468"]A:
Location 1: .20(60) = 12
Location 2: .20(50) = 10
Location 3: .20(80) = 16[/hidden-answer]
7. What are some benefits associated with a company moving it's operation's globally?
[reveal-answer q="789107"]Show Answer[/reveal-answer]
[hidden-answer a="789107"]
A: Market expansion, financial savings, legal, etc.[/hidden-answer]
8. What is the center of gravity method used for?
[reveal-answer q="414231"]Show Answer[/reveal-answer]
[hidden-answer a="414231"]
A: Locating a distribution center that minimizes distribution costs.[/hidden-answer]
9. Find the center of gravity with the information provided below.

Destination	x	y
L1	8	5
L2	6	2
L3	4	3
L4	3	5

[reveal-answer q="520534"]Show Answer[/reveal-answer]
[hidden-answer a="520534"]
A:
x = 21/4 = 5.25
y = 15/4 = 3.75
The center of gravity is located at (5.25, 3.75)[/hidden-answer]

10. Determine the center of gravity based on the following information:

Destination	x	y	Weekly Quantity
L1	7	6	700
L2	5	3	500
L3	8	6	800
L4	6	4	600
L5	2	2	200
Total	28	21	2,800

[reveal-answer q="526711"]Show Answer[/reveal-answer]
[hidden-answer a="526711"]
A:
x = [7(700) + 5(500) + 8(800) + 6(600) + 2(200)] / 2,800 = 6.36
y = [6(700) + 3(500) + 6(800) + 4(600) + 2(200)] / 2,800 = 4.75[/hidden-answer]

11. Use the table below and the cost-profit-volume analysis to determine the B Superior range approximation.

Location	Fixed Costs per Year	Variable Costs per Unit
1	$250,000	$20
2	$150,000	$50
3	$350,000	$25
4	$225,000	$40

[reveal-answer q="709861"]Show Answer[/reveal-answer]
[hidden-answer a="709861"]
A:
Total Cost of C = Total Cost of B
350,000 + 25Q = 150,000 + 50Q
200,000 = 25Q
Q = 8,000[/hidden-answer]

12. Use the table from Question 12 and the cost-profit-volume analysis to find the C Superior range approximation.

[reveal-answer q="540668"]Show Answer[/reveal-answer]
[hidden-answer a="540668"]
A:
Total Cost of A = Total Cost of C
250,000 + 20Q = 350,000 + 25Q
5Q = 100,000
Q = 20,000[/hidden-answer]

Use the following information to answer question 1-3.

A firm paid $2000 for rent, $300 for maintenance fee in January. They sold 2000 units in the month and the cost per unit was $5. The price for the product is $10 per unit.

1. What is their total costs for the month?

a. $2300
b. $10000
c. $12300
d. $2000
e. none of the above

[reveal-answer q="161111"]Show Answer[/reveal-answer]
[hidden-answer a="161111"]
Answer: c. page 376[/hidden-answer]

2. What is the firm's total revenue for the month?

a. $20000
b. $10000
c. $2300
d. $2000
e. none of the above

[reveal-answer q="394072"]Show Answer[/reveal-answer]
[hidden-answer a="394072"]
Answer: a. page 378
[/hidden-answer]

3. What is the firm's profit for the month ?

a. $20000
b. $10000
c. $12300
d. $7700
e. none of the above

[reveal-answer q="797333"]Show Answer[/reveal-answer]
[hidden-answer a="797333"]
Answer: d. page 378[/hidden-answer]

4. If two alternatives yield comparable annual costs, management would be indifferent in choosing between the two in terms of _.

a. total revenue
b. total costs
c. total profit
d. total variable costs
e. total fixed costs

[reveal-answer q="386604"]Show Answer[/reveal-answer]
[hidden-answer a="386604"]
Answer b. page 378[/hidden-answer]

5. The transportation cost must be converted into cost per unit of in order to correspond to other variable costs if raw materials are involved.

a. input
b. output
c. initial input
d. both a& b
e. none of the above

[reveal-answer q=”257456"]Show Answer[/reveal-answer]
[hidden-answer a=”257456"]
Answer: b. page 378[/hidden-answer]
6. Which of the following is NOT a governmental factor when locating in a foreign region?
a) Import restrictions
b) Currency restrictions
c) Liability laws
d) Local product standards
e) all of the above
[reveal-answer q=”419645"]Show Answer[/reveal-answer]
[hidden-answer a=”419645"]
Answer: E, pg. 378[/hidden-answer]

UNIT 7 DISCUSSION

#1
Choose a business that you would be interested in opening in your community. How would you decide where to locate that business? What would you be most concerned about in making this choice?

Unit 7 Activity and Grading Rubric

In this activity, you will continue working on your operations management plan. In this section of your business plan, you will discuss facility design and layout.

Learning outcome
Apply basic design principles to determine appropriate facility location and layout.

Specifications:

- 2-3 page paper
- Created in a Word document
- Follows APA, 6th edition formatting
- Includes a Reference page for cited sources

Instructions: Continuing with the operations management plan, write a 2-3 page paper that describes your organization's facility layout. For a physical space, you can estimate the footage of space you will need. You may refer to the following Cisco-Eagle website* to help you determine how and/or where you willconfigure your business. Use the "parts" section as a guide,incorporating what you will actually need for your business. Or, if you are going to offer a website instead, write about the strategies you will use to drive consumers to your online location (i.e. using e-mail blasting, social media, or advertising on popular search engine site among other strategies). Use at least 4 scholarly sources to write a summary of your facility or website design. Make sure you address all of the following:

Identify where you will operate your business venture (i.e. in a particular part of town, a certain city, or geographical region of the country), and explain your choice.

Discuss any specific layout plans you have for your facility (i.e. where you place your equipment, storage, etc. within the facility and why). If you are doing a service, you will discuss warehouse and storage facilities. Assess how the product or service you intend to provide impacts your facility design or location on the basis of: volume, weight of items to be produced, or amount of quantity you need to sell to be profitable.

Address the estimated cost of the building to house the operation or rental fees.

* Terms of Use: Please respect the copyright and terms of use on the webpage linked above.

Please score your paper or have a friend score your paper using the following “rubric,” or “scoring guide.” The levels will equate to the following letter grades:

4 = A; 3 = B; 2 = C; 1 = D; and 0 = F

Level	Criterion
	Research and Documentation (40%)
4	Any research sources utilized should come from scholarly sources (i.e. textbooks, scholarly articles, etc.). This paper uses at least 4 scholarly sources to respond to the activity instructions. Any in-text citations MUST be cited in APA format using the APA Manual 6th edition. You should also include a References page, also in APA format, at the end of your paper to cite any sources used.
3	The paper uses at least three scholarly sources to support your content, but it does not meet the minimum requirement for 4 sources.
2	Three or more popular sources (i.e. newspapers, internet sites, magazines, etc.) make up a majority of the references to support your content. The paper lacks credible, scholarly sources and does not meet the minimum number of sources required.
1	The paper includes one or two sources. The paper lacks the use of credible, scholarly sources and may focus on using popular sources. The number of sources used does not meet the minimum requirement (4 sources) and the resources used may not fully support the content of your paper.
0	The paper fails to cite referenced sources, or does not include any research or sources to support ideas. The paper is based off of non-original content.
	Analysis and Argument (40%)
4	Your paper addresses the three questions in the instructions with the use of supporting evidence and specific details and explanation. You effectively address the following:Identify where you will operate your business venture (i.e. in a particular part of town, a certain city, or geographical region of the country), and explain your choice. Discuss any specific layout plans you have for your facility (i.e. where you place your equipment, storage, etc. within the facility and why). If you are doing a service, you will discuss warehouse and storage facilities. Assess how the product or service you intend to provide impacts your facility design or location on the basis of: volume, weight of items to be produced, or amount of quantity you need to sell to be profitable. Address the estimated cost of the building to house the operation or rental fees.
3	The content addresses only some of the questions presented in the instructions section and reflects minimal original thought and /or critical analysis relative to the business.
2	The content is vague and is weakly supported by researched evidence. The essay lacks critical analysis relative to the business.
1	The content does not address the required elements; ideas presented are not supported by research or critical analysis.
0	There is a lack of critical analysis for the operation management plan, and/or the essay does not address the business content from the Unit 1 Activity.
	Grammar/Style (15%)
4	The content contains a maximum of two grammatical, citation, and punctuation errors. The ideas are concise and presented in a logical manner that is easy for the reader to follow.
3	The content contains three or four grammatical, citation, punctuation, and/or spelling errors. The sentence structure flows in a concise, logical manner.
2	The paper contains more than four grammatical, citation, punctuation and/or spelling errors that distract the reader from the comprehension of ideas being presented.
1	The paper demonstrates poor writing skills, reflected by lack of syntax and proper grammar, which makes ideas difficult to communicate. Ideas are not presented in a logical manner that is easy to follow.

0	The paper contains numerous grammatical, citation, punctuation, and/or spelling errors.
	Format (5%)
4	The paper should properly formatted (paragraph style, margins, etc.), using the APA Manual, 6th edition. The content is typed in MS Word format, labeled with the student's name and the activity title/unit number, and a reference section to cite any outside sources used.
3	The paper meets most of the requirements for formatting, using the APA Manual, 6th edition, though may contain some errors.
2	The paper lacks proper formatting, based on the APA Manual, 6th edition, and it may use another style of formatting (i.e. MLA, Chicago, etc.).
1	The paper is typed in a format other than MS Word. A style of formatting other than APA may be used, or there are numerous formatting errors that distract the reader's comprehension.
0	The formatting does not comply with the APA Manual, 6th edition and is not created in MS Word.

UNIT 8: WORK SYSTEMS DESIGN

Unit 8: Work Systems Design

It seems reasonable that a worker's level of job satisfaction would influence his or her job performance. At some point in your life, you have probably performed a job task that you did not enjoy. Perhaps the work was too physically demanding or there was a problem with the location of the work area. Or perhaps the work was so monotonous that you were starved for mental stimulation. One of the ways that operations managers can impact job satisfaction is through work systems design. In this unit, we will explore how operations managers use strategies like skill variety, task significance, or work organization to enhance job performance. We will also consider models for analyzing work to eliminate unnecessary tasks and regulate the duration of each stage in a production line.

Unit 8 Learning Outcomes

Upon successful completion of this unit, you will be able to:

- evaluate the appropriateness of a work systems design for a given operational context with respect to optimizing performance;
- explain the principles behind using a motion study to improve process performance in service industries; and
- analyze worker output in non-repetitive job tasks using work sampling

8.1: Job Design

BOUNDLESS: *MANAGEMENT* "CHAPTER 5, SECTION 9, PART 1: DEFINING JOB DESIGN"

Read this section. Pay close attention to the approaches to job design and the importance of the key elements to good design. This is important because efficiency and effectiveness is directly related to the way in which a job is designed. Good job design takes attention to detail and alignment with process.

DEFINING JOB DESIGN

Job design is the systematic and purposeful allocation of tasks to individuals and groups within an organization.

LEARNING OBJECTIVES

- Identify the key elements of job design from a general perspective, within the context of organizational behavior
- Compare and contrast the multitude of job-design approaches and perspectives available in the organizational field

KEY POINTS

- The key inputs for a strong job design are a task, motivation, resource allocation and a compensation system.
- Taylorism, or scientific management, is the original job-design theory. It stresses standardization of tasks and proper training of workers to administer the tasks for which they are responsible.
- The Socio-Technical Systems Approach is a theory that maps the evolution from individual work to work groups. The organization itself is structured to encourage group autonomy and productivity.
- The Core Characteristics Model connects job characteristics to the psychological states that the worker brings to the job. It emphasizes designing jobs so that they lead to desired outcomes.
- Taking into account these various theoretical models, job design is best described as specifying a task with enough context to communicate clearly and concisely what is expected of a given employee.

TERM

- empowerTo give people more confidence or strength to do something, often by enabling them to increase their control over their own life or situation.

FULL TEXT

Job Design Overview

Job design is the allocation of specific work tasks to individuals and groups. Allocating jobs and tasks means specifying the contents, method, and relationships of jobs to satisfy technological and organizational requirements, as well as the personal needs of jobholders.

Key Elements of Job Design

To understand job design, it is helpful to identify some key elements and their relationship with job design processes.

- A *task* can be best defined as a piece of assigned work expected to be performed within a certain time. Job designers must strictly and thoroughly identify tasks that need completion.
- *Motivation* describes forces within the individual that account for the level, direction, and persistence of effort expended at work. Individuals need to be compelled, excited, and passionate to do their work. Managers should design jobs that motivate employees.
- *Resource allocation* occurs when an organization decides to appropriate or allocatecertain resources to specific jobs, tasks, or dilemmas facing the organization. In job design, it is necessary to identify and structure jobs in a way that uses the company's resources efficiently. Appropriate resource allocation allows large organizations to foster and develop innovation in their workforce and underscoresstrategy through distribution.
- *Reward systems* also play a role in job design. Reward systems include compensation, bonuses, raises, job security, benefits, and various other reward methods for employees. An outline or description of reward packages should be established when constructing jobs.

Theoretical Models of Job Design

Organizations may employ various theoretical approaches for job design. These include Taylorism, Socio-Technical Systems Approach, Core Characteristics Model, and Psychological Empowerment Theory. Each approach emphasizes different aspects to be considered in effective job design.

Taylorism

Taylorism, also known as scientific management, is a foundation for systematic job design. Frederick Taylor developed this theory in an effort to develop a "science" for every job within an organization according to the following principles:

- Create a standard method for each job.
- Successfully select and hire proper workers.
- Effectively train these workers.
- Support these workers.

The Socio-Technical Systems Approach

The Socio-Technical Systems Approach is based on the evolution from individual work to work groups. This approach has the following guiding principles:

- The design of the organization must fit its goals.
- Employees must be actively involved in designing the structure of the organization.
- Control of variances in production or service must be undertaken as close to their source as possible.
- Subsystems must be designed around relatively self-contained and recognizable units of work.
- Support systems must fit in with the design of the organization.
- The design should allow for a high-quality working life.
- Changes should continue to be made as necessary to meet changing environmental pressures.

Core Characteristics Model

Another modern job design theory is the Core Characteristics Model, which maintains five important job elements that motivate workers and performance:

- Skill variety
- Task identity
- Task significance
- Autonomy
- Job feedback

The individual elements are then proposed to lead to positive outcomes through three psychological states:

- Experienced meaningfulness
- Experienced responsibility
- Knowledge of results

Psychological Empowerment Theory

Psychological Empowerment Theory posits that there is a distinction between empowering practices and cognitive motivational states. When individuals are aware of the impact they have, they benefit more than if they cannot attribute positive impact to any of their actions.

Overall Trend

Many more iterations of job design theory have evolved, but general trends can be identified among them: job design is moving towards autonomous work teams and placing added emphasis on the importance of meaning derived from the individual.

WIKIPEDIA: "JOB DESIGN"

Read this wiki page. Pay close attention to core dimensions and techniques of job design. This is important because different combinations of these core dimensions motivate different types of employees. Each of the core dimensions can be viewed as if on a continuum. You may need a high skill variety and a low task identity for a specific job.

JOB DESIGN

Job design (also referred to as **work design** or **task design**) is the specification of contents, methods and relationship of jobs in order to satisfy technological and organizational requirements as well as the social and personal requirements of the job holder. Its principles are geared towards how the nature of a person's job affects their attitudes and behavior at work, particularly relating to characteristics such as skill variety and autonomy.The aim of a job design is to improve job satisfaction, to improve through-put, to improve quality and to reduce employee problems (e.g., grievances, absenteeism).

JOB CHARACTERISTIC THEORY

The job characteristic theory proposed by Hackman & Oldham (1976) stated that work should be designed to have five core job characteristics, which engender three critical psychological states in individuals—experiencing meaning, feeling responsible for outcomes, and understanding the results of their efforts. In turn, these psychological states were proposed to enhance employees' intrinsic motivation, job satisfaction, quality of work and performance, while reducing turnover.

Core Job Dimensions

1. *Skill variety* — This refers to the range of skills and activities necessary to complete the job. The more a person is required to use a wide variety of skills, the more satisfying the job is likely to be.
2. *Task identity* — This dimension measures the degree to which the job requires completion of a whole and identifiable piece of work. Employees who are involved in an activity from start to finish are usually more satisfied.

3. *Task significance* — This looks at the impact and influence of a job. Jobs are more satisfying if people believe that they make a difference, and are adding real value to colleagues, the organization, or the larger community.
4. *Autonomy* — This describes the amount of individual choice and discretion involved in a job. More autonomy leads to more satisfaction. For instance, a job is likely to be more satisfying if people are involved in making decisions, instead of simply being told what to do.
5. *Feedback* — This dimension measures the amount of information an employee receives about his or her performance, and the extent to which he or she can see the impact of the work. The more people are told about their performance, the more interested they will be in doing a good job. So, sharing production figures, customer satisfaction scores etc. can increase the feedback levels.

Critical Psychological States

The five core job dimensions listed above result in three different psychological states.

- *Experienced meaningfulness of the work*: The extent to which people believe that their job is meaningful, and that their work is valued and appreciated (comes from core dimensions 1-3).
- *Experienced responsibility for the outcomes of work*: The extent to which people feel accountable for the results of their work, and for the outcomes they have produced (comes from core dimension 4).
- *Knowledge of the actual results of the work activity*: The extent to which people know how well they are doing (comes from core dimension 5).

TECHNIQUES OF JOB DESIGN

Job Rotation

Job rotation is a job design method which is able to enhance motivation, develop workers' outlook, increase productivity, improve the organization's performance on various levels by its multi-skilled workers, and provides new opportunities to improve the attitude, thought, capabilities and skills of workers. Job rotation is also process by which employees laterally mobilize and serve their tasks in different organizational levels; when an individual experiences different posts and responsibilities in an organization, ability increases to evaluate his capabilities in the organization.

Job Enlargement

Hulin and Blood (1968) define *Job enlargement* as the process of allowing individual workers to determine their own pace (within limits), to serve as their own inspectors by giving them responsibility for quality control, to repair their own mistakes, to be responsible for their own machine set-up and repair, and to attain choice of method. Frederick Herzberg referred to the addition of interrelated tasks as 'horizontal job loading'.

Job Enrichment

Job enrichment increases the employees' autonomy over the planning and execution of their own work. Job enrichment has the same motivational advantages of job enlargement, however it has the added benefit of

granting workers autonomy. Frederick Herzberg viewed job enrichment as 'vertical job loading' because it also includes tasks formerly performed by someone at a higher level where planning and control are involved.

Scientific Management

Under *scientific management* people would be directed by reason and the problems of industrial unrest would be appropriately (i.e., scientifically) addressed. This philosophy is oriented toward the maximum gains possible to employees. Managers would guarantee that their subordinates would have access to the maximum of economic gains by means of rationalized processes. Organizations were portrayed as rationalized sites, designed and managed according to a rule of rationality imported from the world of technique.[10]

Human Relations School

The *Human Relations School* takes the view that businesses are social systems in which psychological and emotional factors have a significant influence on productivity. The common elements in human relations theory are the beliefs that

- Performance can be improved by good human relations
- Managers should consult employees in matters that affect staff
- Leaders should be democratic rather than authoritarian
- Employees are motivated by social and psychological rewards and are not just "economic animals"
- The work group plays an important part in influencing performance

Socio-technical Systems

Socio-technical systems aims on jointly optimizing the operation of the social and technical system; the good or service would then be efficiently produced and psychological needs of the workers fulfilled. Embedded in Socio-technical Systems are motivational assumptions, such as intrinsic and extrinsic rewards.

Work Reform

Work reform states about the workplace relation and the changes made which are more suitable to management and employee to encourage increased workforce participation.

Motivational Work Design

The psychological literature on employee motivation contains considerable evidence that job design can influence satisfaction, motivation and job performance. It influences them primarily because it affects the relationship between the employee's expectancy that increased performance will lead to rewards and the preference of different rewards for the individual.

Hackman and Oldman developed the theory that a workplace can be redesigned to greater improve their core job characteristics. Their overall concept consists of:

- Making larger work units by combining smaller, more specialized tasks.
- Mandating worker(s) to be responsible via having direct contact with clients.

- Having employee evaluations done frequently in order to provide feedback for learning.
- Allowing workers to be responsible for their job by giving them authority and control.

A similar theory was also mention earlier by Frederick Herzberg. Herzberg theory consist of a *Two Factor Theory*:

1. Hygiene Factors
2. Motivational Factors

16.6 DESIGNING A HIGH-PERFORMANCE WORK SYSTEM

Learning Objectives

1. Define a high-performance work system.
2. Describe the role of technology in HR.
3. Describe the use of HR systems to improve organizational performance.
4. Describe succession planning and its value.

Now it is your turn to design a high-performance work system (HPWS). HPWS is a set of management practices that attempt to create an environment within an organization where the employee has greater involvement and responsibility. Designing a HPWS involves putting all the HR pieces together. A HPWS is all about determining what jobs a company needs done, designing the jobs, identifying and attracting the type of employee needed to fill the job, and then evaluating employee performance and compensating them appropriately so that they stay with the company.

E-HRM

At the same time, technology is changing the way HR is done. The electronic human resource management (e-HRM) business solution is based on the idea that information technologies, including the Web, can be designed for human resources professionals and executive managers who need support to manage the workforce, monitor changes, and gather the information needed in decision making. At the same time, e-HRM can enable all employees to participate in the process and keep track of relevant information. For instance, your place of work provides you with a Web site where you can login; get past and current pay information, including tax forms (i.e., 1099, W-2, and so on); manage investments related to your 401(k); or opt for certain medical record-keeping services.

More generally, for example, many administrative tasks are being done online, including:

- providing and describing insurance and other benefit options
- enrolling employees for those benefits
- enrolling employees in training programs
- administering employee surveys to gauge their satisfaction

Many of these tasks are being done by employees themselves, which is referred to as *employee self-service*. With all the information available online, employees can access it themselves when they need it.

Part of an effective HR strategy is using technology to reduce the manual work performance by HR employees. Simple or repetitive tasks can be performed self-service through e-HRM systems that provide employees with information and let them perform their own updates. Typical HR services that can be formed in an e-HRM system include:

- Answer basic compensation questions.
- Look up employee benefits information.
- Process candidate recruitment expenses.
- Receive and scan resumes into recruiting software.
- Enroll employees in training programs.
- Maintain training catalog.
- Administer tuition reimbursement.
- Update personnel files.

Organizations that have invested in e-HRM systems have found that they free up HR professionals to spend more time on the strategic aspects of their job. These strategic roles include employee development, training, and succession planning.

THE VALUE OF HIGH-PERFORMANCE WORK SYSTEMS

Employees who are highly involved in conceiving, designing, and implementing workplace processes are more engaged and perform better. For example, a study analyzing 132 U.S. manufacturing firms found that companies using HPWSs had significantly higher labor productivity than their competitors. The key finding was that when employees have the power to make decisions related to their performance, can access information about company costs and revenues, and have the necessary knowledge, training, and development to do their jobs—and are rewarded for their efforts—they are more productive.[1]

For example, Mark Youndt and his colleagues[2] demonstrated that productivity rates were significantly higher in manufacturing plants where the HRM strategy focused on enhancing human capital. Delery and Doty found a positive relationship between firm financial performance and a system of HRM practices. [3] Huselid, Jackson, and Schuler found that increased HRM effectiveness corresponded to an increase in sales per employee, cash flow, and company market value. [4]

HPWS can be used globally to good result. For example, Fey and colleagues studied 101 foreign-based firms operating in Russia and found significant linkages between HRM practices, such as incentive-based compensation,

1. Konrad, A. M. (2006, March/April). Engaging employees through high-involvement work practices. *Ivey Business Journal Online*, 1–6. Retrieved January 30, 2009, from http://www.iveybusinessjournal.com.
2. Youndt, M., Snell, S., Dean, J., & Lepak, K. (1996). Human resource management, manufacturing strategy, and firm performance. *Academy of Management Journal, 39*, 836–866.
3. Delery, J., & Doty, H. (1996). Modes of theorizing in strategic human resource management: Tests of universalistic, contingency, and configurational performance predictions. *Academy of Management Journal 39*, 802–835.
4. Huselid, M., Jackson, S., and Schuler, R. (1997). Technical and strategic human resource management effectiveness as determinants of firm performance. *Academy of Management Journal 40*, 171–188.

job security, employee training, and decentralized decision making, and subjective measures of firm performance.[5]

IMPROVING ORGANIZATIONAL PERFORMANCE

Organizations that want to improve their performance can use a combination of HR systems to get these improvements. For example, performance measurement systems help underperforming companies improve performance. The utility company Arizona Public Service used a performance measurement system to rebound from dismal financial results. The company developed 17 "critical success indicators," which it measures regularly and benchmarks against the best companies in each category. Of the 17, nine were identified as "major critical success indicators." They are:

- cost to produce kilowatt hour
- customer satisfaction
- fossil plants availability
- operations and maintenance expenditures
- construction expenditures
- ranking as corporate citizen in Arizona
- safety all-injury incident rate
- nuclear performance
- shareholder value return on assets

Each department sets measurable goals in line with these indicators, and a gainsharing plan rewards employees for meeting the indicators.

In addition, companies can use reward schemes to improve performance. Better-performing firms tend to invest in more sophisticated HRM practices, which further enhances organizational performance.[6] Currently, about 20% of firms link employee compensation to the firm's earnings. They use reward schemes such as employee stock ownership plans, gainsharing, and profit sharing. This trend is increasing.

Researcher Michel Magnan wanted to find out: Is the performance of an organization with a profit-sharing plan better than other firms? And, does adoption of a profit-sharing plan lead to improvement in an organization's performance?

The reasons profit-sharing plans would improve organizational performance go back to employee motivation theory. A profit-sharing plan will likely encourage employees to monitor one another's behavior because "loafers" would erode the rewards for everyone. Moreover, profit sharing should lead to greater information sharing, which increases the productivity and flexibility of the firm.

Magnan studied 294 Canadian credit unions in the same region (controlling for regional and sector-specific economic effects). Of the firms studied, 83 had profit sharing plans that paid the bonus in full at the end of the year. This meant that employees felt the effect of the organizational performance reward immediately, so it had a stronger motivational effect than a plan that put profits into a retirement account, where the benefit would be delayed (and essentially hidden) until retirement.

Magnan's results showed that firms with profit-sharing plans had better performance on most facets of

5. Fey, C., Bjorkman, I., & Pavlovskaya, A. (2000). The effect of human resource management practices on firm performance in Russia. *International Journal of Human Resource Management, 11*, 1–18.
6. Shih, H.-A., Chiang, Y.-H., & Hsu, C.-C. (2006, August). Can high performance work systems really lead to better performance? *International Journal of Manpower*, *27*(8), 741–763.

organizational performance. They had better performance on asset growth, market capitalization, operating costs, losses on loans, and return on assets than firms without profit-sharing plans. The improved performance was especially driven by activities where employee involvement had a quick, predictable effect on firm performance, such as giving loans or controlling costs.

Another interesting finding was that when firms adopted a profit-sharing plan, their organizational performance went up. Profit-sharing plans appear to be a good turnaround tool because the firms that showed the greatest improvement were those that had not been performing well before the profit-sharing plan. Even firms that had good performance before adopting a profit-sharing plan had better performance after the profit-sharing plan.[7]

Succession Planning

Succession planning is a process whereby an organization ensures that employees are recruited and developed to fill each key role within the company. In a recent survey, HR executives and non-HR executives were asked to name their top human capital challenge. Nearly one-third of both executive groups cited succession planning,[8] but less than 20% of companies with a succession plan addressed nonmanagement positions. Slightly more than 40% of firms didn't have a plan in place.

Looking across organizations succession planning takes a number of forms (including no form at all). An absence of succession planning should be a red flag, since the competitive advantage of a growing percentage of firms is predicated on their stock of human capital and ability to manage such capital in the future. One of the overarching themes of becoming better at succession is that effective organizations become much better at developing and promoting talent from within. The figure "Levels of Succession Planning" summarizes the different levels that firms can work toward.

Levels of Succession Planning

- Level 1: No planning at all.
- Level 2: Simple replacement plan. Typically the organization has only considered what it will do if key individuals leave or become debilitated.
- Level 3: The company extends the replacement plan approach to consider lower-level positions, even including middle managers.
- Level 4: The company goes beyond the replacement plan approach to identify the competencies it will need in the future. Most often, this approach is managed along with a promote-from-within initiative.
- Level 5: In addition to promoting from within, the organization develops the capability to identify and recruit top talent externally. However, the primary source of successors should be from within, unless there are key gaps where the organization does not have key capabilities.

7. Magnan, M., & St-Onge, S. (1998). Profit sharing and firm performance: A comparative and longitudinal analysis. Presented at the Academy of Management Conference, August 9–12.
8. Buhler, P. M. (2008, March). Managing in the new millennium; succession planning: not just for the c suite. *Supervision, 69*(3), 19.

Dow Chemical exemplifies some best practices for succession planning:

- Dow has a comprehensive plan that addresses all levels within the organization, not just executive levels.
- CEO reviews the plan, signaling its importance.
- Managers regularly identify critical roles in the company and the competencies needed for success in those roles.
- Dow uses a nine-box grid for succession planning, plotting employees along the two dimensions of potential and performance.
- High potential employees are recommended for training and development, such as Dow Academy or an MBA.

Interpublic Group, a communications and advertising agency, established a formal review process in 2005 in which the CEOs of each Interpublic business would talk with the CEO about the leaders in their organization. The discussions span the globe because half of the company's employees work outside the United States. A key part of the discussions is to then meet with the individual employees to tell them about the opportunities available to them. "In the past, what I saw happen was that an employee would want to leave and then all of a sudden they hear about all of the career opportunities available to them," he says. "Now I want to make sure those discussions are happening before anyone talks about leaving," said Timothy Sompolski, executive vice president and chief human resources officer at Interpublic Group.[9]

The principles of strategic human resource management and high-performance work systems apply to nonprofit enterprises as well as for-profit companies, and the benefits of good HR practices are just as rewarding. When it comes to succession planning, nonprofits face a particularly difficult challenge of attracting workers to a field known for low pay and long hours. Often, the people attracted to the enterprise are drawn by the cause rather than by their own aspirations for promotion. Thus, identifying and training employees for leadership positions is even more important. What's more, the talent shortage for nonprofits will be even more acute: A study by the Meyer Foundation and CompassPoint Nonprofit Service found that 75% of nonprofit executive directors plan to leave their jobs by 2011.[10]

Key Takeaway

A high-performance work system unites the social and technical systems (people and technology) and aligns them with company strategy. It ensures that all the interrelated parts of HR are aligned with one another and with company goals. Technology and structure supports employees in their ability to apply their knowledge and skills to executing company strategy. HR decisions, such as the type of compensation method chosen, improve performance for organizations and enterprises of all types.

Exercises

1. What are some ways in which HR can improve organizational performance?
2. What is the most important aspect of high performance work systems? Name three benefits of high

9. Marquez, J. (2007, September 10). On the front line; A quintet of 2006's highest-paid HR leaders discuss how they are confronting myriad talent management challenges as well as obstacles to being viewed by their organizations as strategic business partners. *Workforce Management, 86*(5), 22.
10. Damast, A. (2008, August 11). Narrowing the nonprofit gap. *BusinessWeek*, p. 58.

performance work systems.

3. How does e-HRM help a company?
4. If you were designing your company's succession planning program, what guidelines would you suggest?

UNIT 8 DISCUSSION

#1
Take each core job dimension and using a 1-10 scale (1 = lowest and 10 = highest), rate each dimension in relation to your current job or a job that you have had in the past. Based on your job experience, how did the job design impact your job satisfaction, loyalty to the organization, and quality of work and performance? Based on your answer, how would you redesign your job in relation to these core dimensions? If you have never had a job, think about a volunteer experience you may have had, or you might try answering the above questions based on your dream job.

8.2: Motion Study

WIKIPEDIA: "TIME AND MOTION STUDY"

Read this page. Pay close attention to the types of time and motion studies and the criticisms associated with this approach. Time motion studies have been used and continue to be used in all types of organizations. This source creates a foundation for application of time motion studies within an operations context.

One or more interactive elements has been excluded from this version of the text. You can view them online here:
https://pressbooks.nscc.ca/operationsmanagement2/?p=245#video-245-1

TIME AND MOTION STUDY

A **time and motion study** (or **time-motion study**) is a business efficiency technique combining the Time Study work of Frederick Winslow Taylor with the Motion Study work of Frank and Lillian Gilbreth (the same couple as is best known through the biographical 1950 film and book *Cheaper by the Dozen*). It is a major part of scientific management (Taylorism). After its first introduction, time study developed in the direction of establishing standard times, while motion study evolved into a technique for improving work methods. The two techniques became integrated and refined into a widely accepted method applicable to the improvement and upgrading of work systems. This integrated approach to work system improvement is known as methods engineering and it is applied today to industrial as well as service organizations, including banks, schools and hospitals.

TIME STUDY

Time study is a direct and continuous observation of a task, using a timekeeping device (e.g., decimal minute stopwatch, computer-assisted electronic stopwatch, and videotape camera) to record the time taken to accomplish a task and it is often used when:

- there are repetitive work cycles of short to long duration,
- wide variety of dissimilar work is performed, or
- process control elements constitute a part of the cycle.

The Industrial Engineering Terminology Standard, defines time study as "a work measurement technique consisting of careful time measurement of the task with a time measuring instrument, adjusted for any observed variance from normal effort or pace and to allow adequate time for such items as foreign elements, unavoidable or machine delays, rest to overcome fatigue, and personal needs."

The systems of **time and motion studies** are frequently assumed to be interchangeable terms, descriptive of equivalent theories. However, the underlying principles and the rationale for the establishment of each respective method are dissimilar, despite originating within the same school of thought.

The application of science to business problems, and the use of **time-study methods** in standard setting and the planning of work, was pioneered by Frederick Winslow Taylor.Taylor liaised with factory managers and from the success of these discussions wrote several papers proposing the use of wage-contingent performance standards based on scientific time study. At its most basic level time studies involved breaking down each job into component parts, timing each part and rearranging the parts into the most efficient method of working. By counting and calculating, Taylor wanted to transform management, which was essentially an oral tradition, into a set of calculated and written techniques.

Taylor and his colleagues placed emphasis on the content of a **fair day's work**, and sought to maximize productivity irrespective of the physiological cost to the worker. For example, Taylor thought unproductive time usage (soldiering) to be the deliberate attempt of workers to promote their best interests and to keep employers ignorant of how fast work could be carried out. This instrumental view of human behavior by Taylor prepared the path for human relations to supersede scientific management in terms of literary success and managerial application.

CRITICISMS

In response to Taylor's time studies and view of human nature, many strong criticisms and reactions were recorded. Unions, for example, regarded time study as a disguised tool of management designed to standardize and intensify the pace of production. Similarly, individuals such as Gilbreth (1909), Cadbury and Marshall heavily criticized Taylor and pervaded his work with subjectivity. For example, Cadbury in reply to Thompson stated that under scientific management employee skills and initiatives are passed from the individual to management, a view reiterated by Nyland. In addition, Taylor's critics condemned the lack of scientific substance in his time studies, in the sense that they relied heavily on individual interpretations of what workers actually do. However, the value in rationalizing production is indisputable and supported by academics such as Gantt, Ford and Munsterberg, and Taylor society members Mr C.G. Renold, Mr W.H. Jackson and Mr C.B. Thompson. Proper time studies are based on repeated observation, so that motions performed on the same part differently by one or many workers can be recorded, to determine those values that are truly repetitive and measureable. Good studies are never studied just once.

MOTION STUDIES

In contrast to, and motivated by, Taylor's time study methods, the Gilbreths proposed a technical language, allowing for the analysis of the labor process in a scientific context.The Gilbreths made use of scientific insights to develop a study method based upon the analysis of **work motions'***, consisting in part of filming the details of a worker's '*activities and their body posture while recording the time. The films served two main purposes. One was the visual record of how work had been done, emphasising areas for improvement. Secondly, the films also served the purpose of training workers about the best way to perform their work.This method allowed the Gilbreths to build on the best elements of these work flows and to create a standardized best practice.

TAYLOR VS. THE GILBRETHS

Although for Taylor, motion studies remained subordinate to time studies, the attention he paid to the motion study technique demonstrated the seriousness with which he considered the Gilbreths' method. The split with Taylor in 1914, on the basis of attitudes to workers, meant the Gilbreths had to argue contrary to the trade unionists, government commissions and Robert Hoxie who believed scientific management was unstoppable. The Gilbreths were charged with the task of proving that motion study particularly, and scientific management generally, increased industrial output in ways which improved and did not detract from workers' mental and physical strength. This was no simple task given the propaganda fuelling the Hoxie report and the consequent union opposition to scientific management. In addition, the Gilbreths credibility and academic success continued to be hampered by Taylor who held the view that motion studies were nothing more than a continuation of his work.

While both Taylor and the Gilbreths continue to be criticized for their respective work, it should be remembered that they were writing at a time of industrial reorganization and the emergence of large, complex organizations with new forms of technology. Furthermore, to equate scientific management merely with time and motion study and consequently labor control not only misconceives the scope of scientific management, but also misinterprets Taylor's incentives for proposing a different style of managerial thought.

DIRECT TIME STUDY PROCEDURE

Following is the procedure developed by Mikell Groover for a direct time study:

1. Define and document the standard method.
2. Divide the task into work elements.
   These first two steps are conducted prior to the actual timing. They familiarize the analyst with the task and allow the analyst to attempt to improve the work procedure before defining the standard time.
3. Time the work elements to obtain the observed time for the task.
4. Evaluate the worker's pace relative to standard performance (performance rating), to determine the normal time.
   Note that steps 3 and 4 are accomplished simultaneously. During these steps, several different work cycles are timed, and each cycle performance is rated independently. Finally, the values collected at these steps are averaged to get the normalized time.
5. Apply an allowance to the normal time to compute the standard time. The allowance factors that are needed in the work are then added to compute the standard time for the task.

CONDUCTING TIME STUDIES

According to good practice guidelines for production studies a comprehensive time study consists of:

1. Study goal setting;
2. Experimental design;
3. Time data collection;
4. Data analysis;

5. Reporting.

The collection of time data can be done in several ways, depending on study goal and environmental conditions. Time and motion data can be captured with a common stopwatch, a handheld computer or a video recorder. There are a number of dedicated software packages used to turn a palmtop or a handheld PC into a time study device. As an alternative, time and motion data can be collected automatically from the memory of computer-control machines (i.e. automated time studies).

8.3: Work Measurement

16.7 TYING IT ALL TOGETHER—USING THE HR BALANCED SCORECARD TO GAUGE AND MANAGE HUMAN CAPITAL, INCLUDING YOUR OWN

Learning Objectives

1. Describe the Balanced Scorecard method and how it can be applied to HR.
2. Discuss what is meant by "human capital."
3. Understand why metrics are important to improving company performance.
4. Consider how your human capital might be mapped on an HR Balanced Scorecard.

You may already be familiar with the Balanced Scorecard, a tool that helps managers measure what matters to a company. Developed by Robert Kaplan and David Norton, the Balanced Scorecard helps managers define the performance categories that relate to the company's strategy. The managers then translate those categories into metrics and track performance on those metrics. Besides traditional financial measures and quality measures, companies use employee performance measures to track their people's knowledge, skills, and contribution to the company.[1]

The employee performance aspects of Balanced Scorecards analyze employee capabilities, satisfaction, retention, and productivity. Companies also track whether employees are motivated (for example, the number of suggestions made and implemented by employees) and whether employee performance goals are aligned with company goals.

APPLYING THE BALANCED SCORECARD METHOD TO HR

Because the Balanced Scorecard focuses on the strategy and metrics of the business, Mark Huselid and his colleagues took the Balanced Scorecard concept a step further and developed the HR and Workforce Scorecard to provide framework specific to HR. According to Huselid, the Workforce Scorecard identifies and measures the behaviors, skills, mind-sets, and results required for the workforce to contribute to the company's success. Specifically, as summarized in the figure, the Workforce Scorecard has four key sequential elements:[2]

- *Workforce Mind-Set and Culture*: First, does the workforce understand the strategy, embrace it, and does it have the culture needed to support strategy execution?

1. Kaplan, R., & Norton, D. (1996). *The Balanced Scorecard*. Boston: Harvard Business School Press.
2. Huselid, M., Becker, B., & Beatty, D. (2005). *The workforce scorecard: Managing human capital to execute strategy*. Boston: Harvard Business School Press.

- *Workforce Competencies*: Second, does the workforce, especially in the strategically important or "A" positions, have the skills it needs to execute strategy? ("A" positions are those job categories most vital to the company's success.)
- *Leadership and Workforce Behaviors*: Third, are the leadership team and workforce consistently behaving in a way that will lead to attaining the company's key strategic objectives?
- *Workforce Success*: Fourth, has the workforce achieved the key strategic objectives for the business? If the organization can answer "yes" to the first three elements, then the answer should be yes here as well.[3]

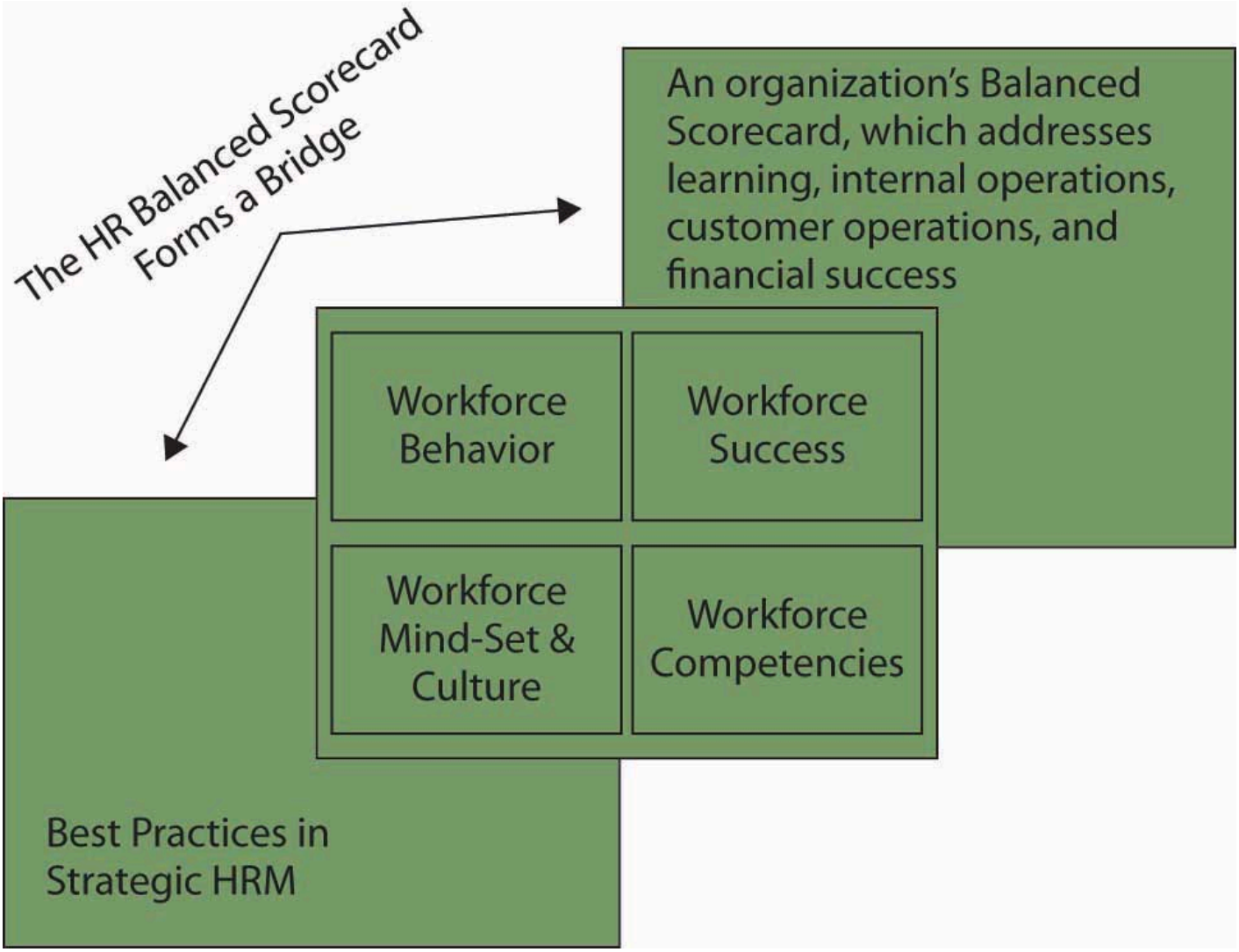

Figure 16.10 The HR Balanced Scorecard bridges HR best practices and the firm's comprehensive Balanced Scorecard.

HUMAN CAPITAL

Implementing the HR scorecard requires a change in perspective, from seeing people as a cost to seeing people as the company's most important asset to be managed—human capital. According to the Society of Human Resource Management's *Research Quarterly*, "A company's human capital asset is the collective sum of the attributes, life

3. Huselid, M.A., Beatty, R.W., & Becker, B.E (2005, December). "A players" or "A positions"? The strategic logic of workforce management. *Harvard Business Review*.

experience, knowledge, inventiveness, energy and enthusiasm that its people choose to invest in their work."[4] As you can tell by the definition, such an asset is difficult to measure because it is intangible, and factors like "inventiveness" are subjective and open to interpretation. The challenge for managers, then, is to develop measurement systems that are more rigorous and provide a frame of reference. The metrics can range from activity-based (transactional) metrics to strategic ones. Transactional metrics are the easiest to measure and include counting the number of new people hired, fired, transferred, and promoted. The measures associated with these include the cost of each new hire, the length of time and cost associated with transferring an employee, and so forth. Typical ratios associated with transactional metrics include the training cost factor (total training cost divided by the employees trained) and training cost percentage (total training cost divided by operating expense).[5] But, these transactional measures don't get at the strategic issues, namely, whether the right employees are being trained and whether they are remembering and using what they learned. Measuring training effectiveness requires not only devising metrics but actually changing the nature of the training.

The Bank of Montreal has taken this step. "What we're trying to do at the Bank of Montreal is to build learning into what it is that people are doing," said Jim Rush of the Bank of Montreal's Institute for Learning. "The difficulty with training as we once conceived it is that you're taken off your job, you're taken out of context, you're taken away from those things that you're currently working on, and you go through some kind of training. And then you've got to come back and begin to apply that. Well, you walk back to that environment and it hasn't changed. It's not supportive or conducive to you behaving in a different kind of way, so you revert back to the way you were, very naturally." To overcome this, the bank conducts training such that teams bring in specific tasks on which they are working, so that they learn by doing. This removes the gap between learning in one context and applying it in another. The bank then looks at performance indices directly related to the bottom line. "If we take an entire business unit through a program designed to help them learn how to increase the market share of a particular product, we can look at market share and see if it improved after the training," Rush said.[6]

Motorola has adopted a similar approach, using action learning in its Senior Executives Program. Action learning teams are assigned a specific project by Motorola's CEO and are responsible for implementing the solutions they design. This approach not only educates the team members but also lets them implement the ideas, so they're in a position to influence the organization. In this way, the training seamlessly supports Motorola's goals.

As we can see in these examples, organizations need employees to apply the knowledge they have to activities that add value to the company. In planning and applying human capital measures, managers should use both retrospective (lagging) and prospective (leading) indicators. Lagging indicators are those that tell the company what it has accomplished (such as the Bank of Montreal's documenting the effect that training had on a business unit's performance). Leading indicators are forecasts that help an organization see where it is headed. Leading indicators include employee learning and growth indices.[7]

THE PAYOFF

Given the complexity of what we've just discussed, some managers may be inclined to ask, "Why bother doing all this?" Research by John Lingle and William Schiemann provides a clear answer: Companies that make a concerted effort to measure intangibles such as employee performance, innovation, and change in addition to measuring financial measures perform better. Lingle and Schiemann examined how executives measured six strategic

4. Weatherly, L. (2003, March). Human capital—the elusive asset; measuring and managing human capital: A strategic imperative for HR. *Research Quarterly*, Society for Human Resource Management. Retrieved June 1, 2003, from http://www.shrm.org/research/quarterly/0301capital.pdf.
5. Saratoga Institute—2003 SHRM National Conference, as quoted in Weatherly, L. (2003). The value of people: The challenges and opportunities of human capital measurement and reporting. *SHRM Research Quarterly, 3*, 14–25.
6. Rush, J. (1995 July). Interview backgrounder for *Fast Company*.
7. Weatherly, L. A. (2003). The value of people: The challenges and opportunities of human capital measurement and reporting. *SHRM Research Quarterly*, *3*, 26–31.

performance areas: financial performance, operating efficiency, customer satisfaction, employee performance, innovation and change, and community/environment issues. To evaluate how carefully the measures were tracked, the researchers asked the executives, "How highly do you value the information in each strategic performance area?" and "Would you bet your job on the quality of the information on each of these areas?" The researchers found that the companies that paid the closest attention to the metrics and had the most credible information were the ones identified as industry leaders over the previous three years (74% of measurement-managed companies compared with 44% of others) and reported financial performance in the top one-third of their industry (83% compared with 52%).

The scorecard is vital because most organizations have much better control and accountability over their raw materials than they do over their workforce. For example, a retailer can quickly identify the source of a bad product, but the same retailer can't identify a poor-quality manager whose negative attitude is poisoning morale and strategic execution.[8]

APPLYING THE BALANCED SCORECARD METHOD TO YOUR HUMAN CAPITAL

Let's translate the HR scorecard to your own Balanced Scorecard of human capital. As a reminder, the idea behind the HR scorecard is that if developmental attention is given to each area, then the organization will be more likely to be successful. In this case, however, you use the scorecard to better understand why you may or may not be effective in your current work setting. Your scorecard will comprise four sets of answers and activities.

1. **What is your mind-set and values**? Do you understand the organization's strategy and embrace it, and do you know what to do in order to implement the strategy? If you answered "no" to either of these questions, then you should consider investing some time in learning about your firm's strategy. For the second half of this question, you may need additional coursework or mentoring to understand what it takes to move the firm's strategy forward.
2. **What are your work-related competencies**? Do you have the skills and abilities to get your job done? If you have aspirations to key positions in the organization, do you have the skills and abilities for those higher roles?
3. **What are the leadership and workforce behaviors**? If you are not currently in a leadership position, do you know how consistently your leaders are behaving with regard to the achievement of strategic objectives? If you are one of the leaders, are you behaving strategically?
4. **Your success**? Can you tie your mind-set, values, competencies, and behaviors to the organization's performance and success?

This simple scorecard assessment will help you understand why your human capital is helping the organization or needs additional development itself. With such an assessment in hand, you can act to help the firm succeed and identify priority areas for personal growth, learning, and development.

Key Takeaway

The Balanced Scorecard, when applied to HR, helps managers align all HR activities with the company's strategic goals. Assigning metrics to the activities lets managers track progress on goals and ensure that they are working toward strategic objectives. It adds rigor and lets managers quickly identify gaps. Companies that measure intangibles such as employee performance, innovation, and change perform better financially than companies that don't use such metrics. Rather than

8. Becker, B., & Huselid, M. (2006). Strategic human resources management: Where do we go from here? *Journal of Management*, *32*, 898–925.

investing equally in training for all jobs, a company should invest disproportionately more in developing the people in the key "strategic" ("A") jobs of the company on which the company's success is most dependent.

Exercises

1. Define the Balanced Scorecard method.
2. List the elements of a Workforce Scorecard.
3. Discuss how human capital can be managed like a strategic asset.
4. Why is it important to align HR metrics with company strategy?
5. What kind of metrics would be most useful for HR to track?

8.4: Project Management Issues

INDIAN INSTITUTE OF TECHNOLOGY: PROFESSOR ARUN KANDA'S "PROJECT MANAGEMENT: AN OVERVIEW"

Watch this lecture, which presents a very nice overview of projects including some examples along with common features shared by a diverse range of projects.

One or more interactive elements has been excluded from this version of the text. You can view them online here:
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Unit 8 Activity and Grading Rubric

Complete this activity, in which you identify the operational processes in your own organization.

Learning Outcome
Identify the operational processes in the student's own organization.

Specifications:

- 2-3 page paper
- Created in a Word document
- Follows APA, 6th edition formatting
- Includes a Reference page for cited sources

Instructions: Continuing the plan, compose a 2-3 page paper, using at least 4 scholarly sources, that identifies the following elements of your organization:

- **Industry analysis:** Use the following market research website* to help you research the industy/market your business intends to serve.
- **Mission statement:** Your business will need a mission statement and the following link for Fast Company Magazine* will help you in composing an effective statement for your organization.
- **Business goals:** These are specific interim or ultimate time-based measurements to be achieved by implementing strategies in pursuit of the company's objectives, for example, to achieve sales of 3 million dollars in three years. Goals should be quantifiable, consistent, realistic, and achievable. They can relate to factors like market (sizes and shares), products, finances, profitability, utilization, and efficiency.
- **Project objectives:** State the business's objectives in terms of the results it needs/wants to achieve in the medium/long term. Aside from presumably indicating a necessity to achieve regular profits (expressed as return on shareholders' funds), objectives should relate to the expectations and requirements of all the major stakeholders, including employees, and should reflect the underlying reasons for running the business. These objectives could cover growth, profitability, technology, offerings, and markets.
- **Value proposition:** The Kinesis Company provides information on how to write a value proposition. Using the company website, you will find information you may use as a guide to identify your company's value proposition.
- **Products and services:** You may refer to "Developing Your Brand" points 1-7 as a guide. A one or two

line response per element that addresses what you intend to do with your business specifically.

Please score your paper or have a friend score your paper using the following “rubric,” or “scoring guide.” The levels will equate to the following letter grades:

4 = A; 3 = B; 2 = C; 1 = D; and 0 = F

Level	Criterion
	Research and Documentation (40%)
4	Any research sources utilized should come from scholarly sources (i.e. textbooks, scholarly articles, etc.). This activity requires the use of at least 4 scholarly sources. Any in-text citations MUST be cited in APA format using the APA Manual 6th edition. You should also include a References page, also in APA format, at the end of your paper to cite any sources used.
3	The paper uses at least three scholarly sources to support your content, but it does not meet the minimum requirement for 4 sources.
2	Three or more popular sources (i.e. newspapers, internet sites, magazines, etc.) make up a majority of the references to support your content. The paper lacks credible, scholarly sources and does not meet the minimum number of sources required.
1	The paper includes one or two sources. The paper lacks the use of credible, scholarly sources and may focus on using popular sources. The number of sources used does not meet the minimum requirement (4 sources) and the resources used may not fully support the content of your paper.
0	The paper fails to cite referenced sources, or does not include any research or sources to support ideas. The paper is based off of non-original content.
	Analysis and Argument (40%)
4	Your paper Must address ALL of the following concepts from the activity instructions: industry analysis, mission statement, business goals, project objectives, value proposition, and products and services.
3	The content addresses only some of the questions presented in the instructions section and reflects minimal original thought and /or critical analysis relative to the business.
2	The content is vague and is weakly supported by researched evidence. The essay lacks critical analysis relative to the business.
1	The content does not address the required elements; ideas presented are not supported by research or critical analysis.
0	There is a lack of critical analysis for the operation management plan, and/or the essay does not address the business content from the Unit 1 Activity.
	Grammar/Style (15%)
4	The content contains a maximum of two grammatical, citation, and punctuation errors. The ideas are concise and presented in a logical manner that is easy for the reader to follow.
3	The content contains three or four grammatical, citation, punctuation, and/or spelling errors. The sentence structure flows in a concise, logical manner.
2	The paper contains more than four grammatical, citation, punctuation and/or spelling errors that distract the reader from the comprehension of ideas being presented.
1	The paper demonstrates poor writing skills, reflected by lack of syntax and proper grammar, which makes ideas difficult to communicate. Ideas are not presented in a logical manner that is easy to follow.
0	The paper contains numerous grammatical, citation, punctuation, and/or spelling errors.
	Format (5%)

4	The paper should properly formatted (paragraph style, margins, etc.), using the APA Manual, 6th edition. The content is typed in MS Word format, labeled with the student's name and the activity title/unit number, and a reference section to cite any outside sources used.	
3	The paper meets most of the requirements for formatting, using the APA Manual, 6th edition, though may contain some errors.	
2	The paper lacks proper formatting, based on the APA Manual, 6th edition, and it may use another style of formatting (i.e. MLA, Chicago, etc.).	
1	The paper is typed in a format other than MS Word. A style of formatting other than APA may be used, or there are numerous formatting errors that distract the reader's comprehension.	
0	The formatting does not comply with the APA Manual, 6th edition and is not created in MS Word.	

UNIT 9: INVENTORY

Unit 9: Inventory

In a manufacturing context, inventory includes raw materials, work that is in process, and finished goods. Running out of a necessary component in the middle of production can be very costly for a manufacturer. The goal of inventory management is to balance the cost of ordering and storing material with the cost of not having that material available when it is needed. Effective inventory management combines elements of accounting, sales, and operations management. Certain aspects of this unit will feel like a review of accounting, but we will be discussing accounting from the perspective of the operation manager. There are a number of strategies for managing inventory. Because direct costs can be calculated based on the length of time an inventory is in storage, accountants and operations managers try to prevent inventory from "sitting around."

An example of one of the most successful implementers of inventory management is Walmart. Walmart uses vendor-managed inventory, meaning that its merchandise does not sit in a Walmart warehouse. Instead, it stays with the manufacturer until Walmart learns from its stores that more is needed. This keeps Wal-Mart from having to pay to store all of the products it sells. In this unit, we will consider how demand influences the operations manager's choice of inventory management system. We will also examine models for determining how much inventory to order and when to order it.

Unit 9 Learning Outcomes

Learning Objectives

Upon successful completion of this unit, you will be able to:

- explain the impact that the type of demand for goods and services (dependent and independent) has on the inventory management system;
- describe the three general classifications of inventory:
  - raw materials,
  - work-in-progress (WIP), and
  - finished goods;
- explain the inventory management models that help plan the timing and volume of inventory orders;
- apply the EOQ Model to calculate inventory order volume; and
- calculate the reorder point to prevent a stock-out from occurring.

9.1: Inventory Management

INDIAN INSTITUTE OF TECHNOLOGY: PROFESSOR ARUN KANDA'S "BASIC INVENTORY PRINCIPLE"

Watch this lecture, which describes basic inventory principles. Effective management of the inventory is crucial to a streamlined organization focused on managing the cost structure.

One or more interactive elements has been excluded from this version of the text. You can view them online here:
https://pressbooks.nscc.ca/operationsmanagement2/?p=259#oembed-1

INVENTORY TYPES

Most manufacturing organizations usually divide their inventory into raw materials, work in process, finished goods, and goods for sales.

Learning Objectives

Differentiate the different types of inventory based on it stage of proudction

Key Takeaways

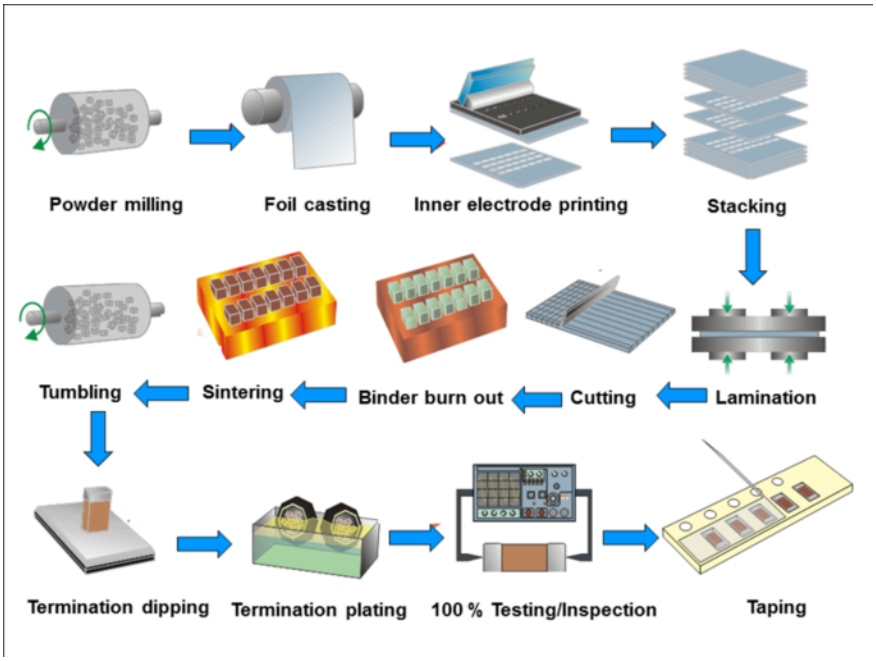
Key Points

- 1. Raw materials: Materials and components scheduled for use in making a product.
- 2. Work in process, WIP: Materials and components that have began their transformation to finished goods.
- 3. Finished goods: Goods ready for sale to customers.
- 4. Goods for resale – returned goods that are salable.

Key Terms

- **supply chain**: A system of organizations, people, technology, activities, information, and resources involved in moving a product or service from supplier to customer.

Most manufacturing organizations usually divide their inventory into raw materials, work in process, finished goods, and goods for sales. A good purchased as a "raw material" goes into the manufacture of a product. A good only partially completed during the manufacturing process is called "work in process. " When the good is completed as to manufacturing but not yet sold or distributed to the end-user, it is called a "finished good. "



Manufacturing process: From raw materials to work in process to finished goods.

1. Raw materials: Materials and components scheduled for use in making a product.
2. Work in process, WIP: Materials and components that have began their transformation to finished goods. These items are not yet completed but either just being fabricated or waiting in a queue for further processing or in a buffer storage. The term is used in production and supply chain management. Optimal production management aims to minimize work in process. Work in process requires storage space, represents bound capital not available for investment, and carries an inherent risk of earlier expiration of shelf life of the products. A queue leading to a production step shows that the step is well buffered for shortage in supplies from preceding steps, but may also indicate insufficient capacity to process the output from these preceding steps. Just-in-time (acronym: JIT) production is a concept to reduce work in process with respect to a continuous configuration of product. Sometimes, outside of a production and construction context "work in process" is used erroneously where the status "work in progress" would be correctly used to describe more broadly work that is not yet a final product.
3. Finished goods: Goods ready for sale to customers. Finished goods is a relative term. In a supply chain management flow; the finished goods of a supplier can constitute the raw material of a buyer.
4. Goods for resale: Returned goods that are salable.

INVENTORY TECHNIQUES

FIFO, LIFO, and average cost methods are accounting techniques used in managing inventory.

Learning Objectives

Differentiate between the different type of inventory accounting techniques

Key Takeaways

Key Points

- FIFO stands for first-in, first-out, meaning that the oldest inventory items are recorded as sold first but do not necessarily mean that the exact oldest physical object has been tracked and sold.
- LIFO stands for last-in, first-out, meaning that the most recently produced items are recorded as sold first.
- Average cost method takes the weighted average of all units available for sale during the accounting period and then uses that average cost to determine the value of COGS and ending inventory.

Key Terms

- **taxable income**: Taxable income refers to the base upon which an income tax system imposes tax.

FIFO, LIFO, and average cost methods are accounting techniques used in managing inventory involving the amount of money a company has tied up within inventory of produced goods, raw materials, parts, components. These methods are used to manage assumptions of cost flows related to inventory.

Inventory: *Inventories U.S. Army unit badges from a wall of military uniform items*

FIFO

FIFO stands for first-in, first-out, meaning that the oldest inventory items are recorded as sold first but do not necessarily mean that the exact oldest physical object has been tracked and sold. This expression describes the principle of a queue processing technique or servicing conflicting demands by ordering process by first come, first served (FCFS) behavior, where the persons leave the queue in the order they arrive, or waiting one's turn at a traffic control signal.

LIFO

LIFO stands for last-in, first-out, meaning that the most recently produced items are recorded as sold first. Since the 1970s, some U.S. companies shifted towards the use of LIFO, which reduces their income taxes in times of inflation, but with International Financial Reporting Standards banning the use of LIFO, more companies have gone back to FIFO. LIFO is only used in Japan and the United States,

LIFO Reserve

The difference between the cost of an inventory calculated under the FIFO and LIFO methods is called the LIFO reserve. This reserve is essentially the amount by which an entity's taxable income has been deferred by using the LIFO method.

Average Cost

Average cost method is quite straightforward. It takes the weighted average of all units available for sale during the accounting period and then uses that average cost to determine the value of COGS and ending inventory. There are two commonly used average cost methods: Simple weighted average cost method and moving average cost method.

Weighted average cost method:

It takes Cost of Goods Available for Sale and divides it by the total amount of goods from Beginning Inventory and Purchases. This gives a Weighted Average Cost per Unit. A physical count is then performed on the ending inventory to determine the amount of goods left. Finally, this amount is multiplied by Weighted Average Cost per Unit to give an estimate of ending inventory cost.

Moving average cost method:

Assume that both Beginning Inventory and beginning inventory cost are known. From them the Cost per Unit of Beginning Inventory can be calculated. During the year, multiple purchases are made. Each time, purchase costs are added to beginning inventory cost to get Cost of Current Inventory. Similarly, the number of units bought is added to beginning inventory to get Current Goods Available for Sale. After each purchase, Cost of Current Inventory is divided by Current Goods Available for Sale to get Current Cost per Unit on Goods. Also during the year, multiple sales happen. The Current Goods Available for Sale is deducted by the amount of goods sold, and the Cost of Current Inventory is deducted by the amount of goods sold times the latest (before this sale) Current Cost per Unit on Goods. This deducted amount is added to Cost of Goods Sold. At the end of the year, the last Cost per Unit on Goods, along with a physical count, is used to determine ending inventory cost.

ABC TECHNIQUE

The ABC analysis is an inventory categorization technique often used in material management wherein accuracy and control decreases from A to C.

Learning Objectives

Differentiate different types of inventory items based on ABC inventory analysis

Key Takeaways

Key Points

- A items: very tight control and accurate records; B items: less tightly controlled and good records; C items: simplest controls possible and minimal records.
- The ABC analysis provides a mechanism for identifying items that will have a significant impact on overall inventory cost, while also providing a mechanism for identifying different categories of stock that will require different management and controls.
- The ABC analysis suggests that inventories of an organization are not of equal value.

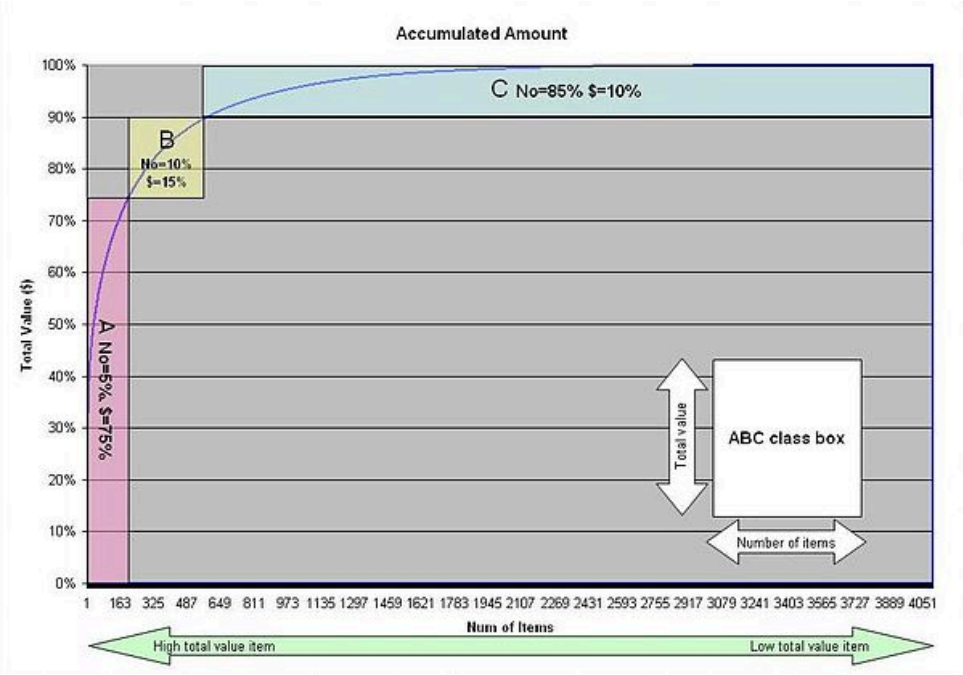
Key Terms

- **Just in Time**: Just in time (JIT) is a production strategy that strives to improve a business return on investment by reducing in-process inventory and associated carrying costs.

The ABC analysis is a business term used to define an inventory categorization technique often used in material management. It is also known as "Selective Inventory Control. " Policies based on ABC analysis:

- A ITEMS: very tight control and accurate records
- B ITEMS: less tightly controlled and good records
- C ITEMS: simplest controls possible and minimal records

The ABC analysis provides a mechanism for identifying items that will have a significant impact on overall inventory cost, while also providing a mechanism for identifying different categories of stock that will require different management and controls.



ABC analysis: Actual distribution of ABC class in the electronics manufacturing company with 4051 active parts.

The ABC analysis suggests that inventories of an organization are not of equal value. Thus, the inventory is grouped into three categories (A, B, and C) in order of their estimated importance.

A items are very important for an organization. Because of the high value of these A items, frequent value analysis is required. In addition to that, an organization needs to choose an appropriate order pattern (e.g., "Just-in- time") to avoid excess capacity.

B items are important, but of course less important, than A items and more important than C items. Therefore, B items are intergroup items.

C items are marginally important.

The following is an example of the Application of Weighed Operation based on ABC class in the electronics manufacturing company with 4,051 active parts.

Using this distribution of ABC class and change total number of the parts to 4,000.

Distribution of ABC class

ABC class	Number of items	Total amount required
A	5%	70%
B	10%	15%
C	85%	15%
Total	100%	100%

ABC techniques: Distribution of ABC class

- Uniform Purchase: When you apply equal purchasing policy to all 4,000 components, example weekly delivery and re-order point (safety stock) of two-week supply assuming that there are no lot size constraints, the factory will have a 16,000 delivery in four weeks and the average inventory will be 2.5 weeks supply.

- Weighed Purchase: In comparison, when weighed purchasing policy applied based on ABC class, example C class monthly (every four weeks) delivery with re-order point of three-week supply, B class Bi-weekly delivery with re-order point of two-week supply, A class weekly delivery with re-order point of one-week supply, total number of delivery in four weeks will be (A 200×4=800)+(B 400 x2=800) + (C 3400×1=3400)=5000 and average inventory will be (A 75%x1.5weeks)+(B 15%x3weeks)+ (C 10%x3.5weeks)= 1.925 week supply.

By applying weighed control based on ABC classification, required man hours and inventory level are drastically reduced.

SEASONAL PRODUCTION

Learning Objectives

Recognize the relevance in time of year to overall demand

Key Takeaways

Key Points

- Many industries do better in some months than others, for a wide variety of reasons. This can have opportunity costs from a production and inventory stand point, if not planned for properly.
- Timing, uncertainty, economies of scale, and potential appreciation are all good reasons to have extra inventory on hand.
- When it comes to seasonality of demand, production and inventory can be managed based upon data points from the past.
- Perishable goods, from food to fashion to technology, are worth noting when it comes to seasonal production and storage. Minimizing over production by making accurate projections can create serious cost savings.

Key Terms

- **seasonality**: From the business perspective, this refers to fluctuations in demand based upon time of year.
- **perishable goods**: Goods that will expire. This isn't just limited to food, clothes go out of fashion and technology becomes rapidly outdated.

Many industries are subject to dips and rises and demand as a result of seasonality. Logically, sourcing the same amount of a given product each month for inventory is not a practical choice in these industries. Inventory management in seasonally impacted businesses can become quite complex, as the accuracy of inaccuracy of forecasts can have substantial impacts on overall profitability.

Reasons to Keep Inventory

In an ideal world, a business would avoid the need for inventory through perfect operational management

and completely accurate projections. Of course, this is impossible. As a result, business must balance risk and opportunity to ensure that inventory is available when it is needed and waste is minimized. Inventories are kept due to:

- Time – No supply chain is perfect, and often enough time lags can ruin potential business opportunities. Playing it safe and have certain items in stock ahead of time can avoid opportunity costs.
- Uncertainty – Supply and demand are not perfectly predictable. Uncertainty means keeping enough on hand to fill fluctuations in demand.
- Economies of scale – Many business exist solely because they take the risk of buying a high volume a given product at a lower price in hopes of marking up the price and selling each one individually to customers. This is called economies of scale, and by nature it requires some storage and inventory. Grocery stores function this way.
- Appreciation in Value – Some business keep inventory as an investment. Fine wines and cheese, for example, will appreciate in value over time. The downside is it will cost money to keep them (both require appropriate temperature conditions, for example).

Determining Seasonality

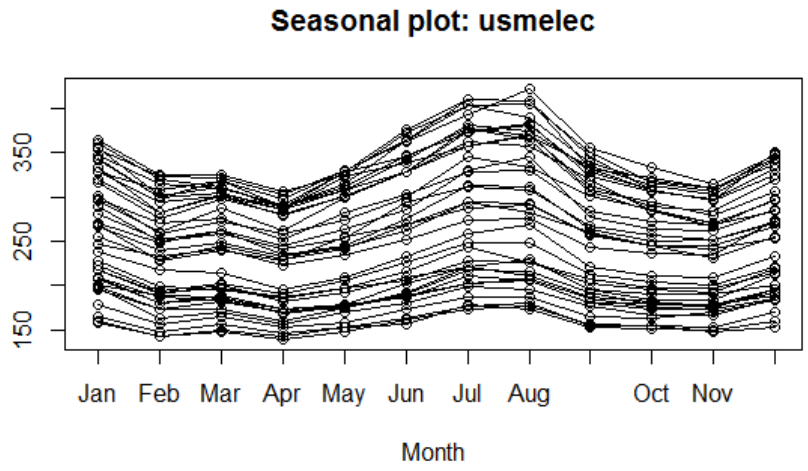
Among the many reasons to keep inventory is planning for seasonality. Businesses should first measure whether or not consumer demand and subsequent inventory requirement are subjected to predictable seasonal trends. There are a number of ways to do this utilizing existing historical sales data as well as data from external research on the industry itself. There are countless models and methods of organizing seasonal data to determine, but from the managerial frame mostly analysts preferred distribution of data should ultimately communicate the same correlations (or lack thereof) for differences in sales on a monthly basis.

Once seasonality is determined, business should measure the fluctuations from year to year and the opportunity costs of having too much or too little on hand. Once this is accomplished, the business can order the ideal amount based on data-driven projections to capture as much opportunity as possible without taking the risk of over ordering (and thus overpaying for storage).

Perishable Goods

An important aspect of seasonal inventory management is the concept of perishable goods. From food to fashion to technology, many goods simply either go bad or lose most of their value for no other reason that culture has passed it by. This is called a perishable good. Perishable goods have an even greater opportunity cost when it comes to mismanaging (and erroneously predicting) demand. If too much of a perishable good is ordered, not only will it cost the organization in unnecessary inventory fees, but also adds the risk of never been sold at all (a complete sunk cost at that point).

As a result, understanding the shelf life of a good, the risk of over or under stocking, and recognizing the ebb and flow of seasonal demand can add a great deal to the profitability of an organization.



Seasonality Plot Example: In this chart, consumption (demand) of electricity over a twelve month time frame is illustrated over time. Higher capacities are required in certain months (in this case – August) and capacity must be expanded to take this into account.

IMPACT OF INFLATION ON INVENTORY MANAGEMENT

High inflation encourages companies to keep a high level of inventories.

Learning Objectives

Explain how inflation influences inventory levels

Key Takeaways

Key Points

- Inflation is a rise in the general level of prices of goods and services in an economy over a period of time. It reflects an erosion in the purchasing power of money.
- If inflation is rapid enough, shortages of goods as consumers begin hoarding out of concern that prices will increase in the future. Therefore, high inflation encourages companies to keep a high level of inventories.
- The Mundell-Tobin effect also suggests a rise in inventory level in case of high inflation.

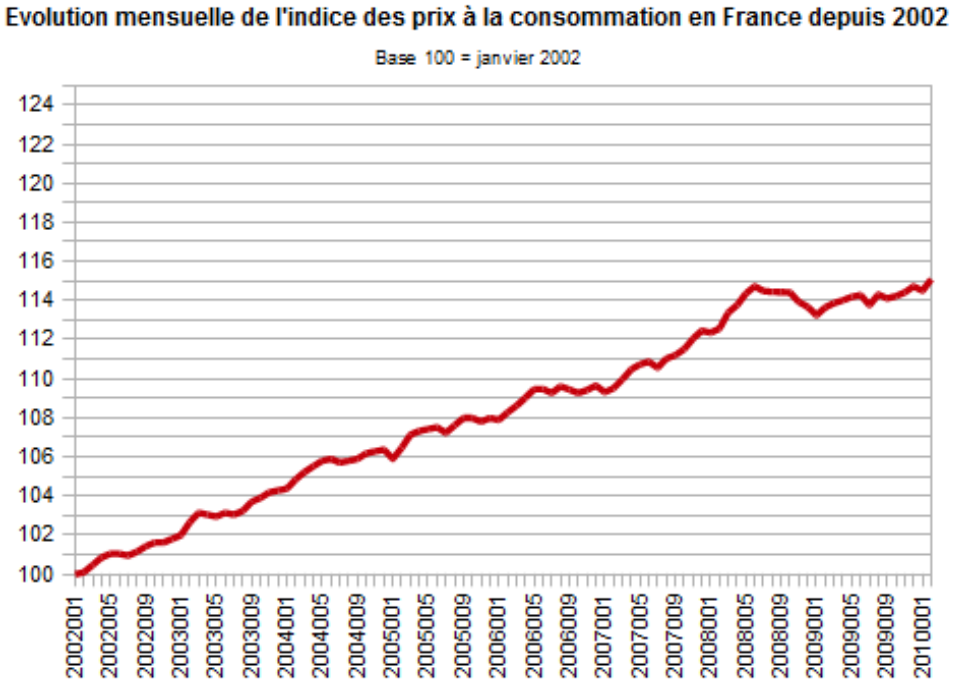
Key Terms

- **physical capital**: In economics, physical capital, or just capital refers to a factor of production (or input into the process of production), such as machinery, buildings, or computers.
- **purchasing power**: Purchasing power (sometimes retroactively called adjusted for inflation) is the amount of goods or services that can be purchased with a unit of currency.

Inflation is a rise in the general level of prices of goods and services in an economy over a period of time. When the

general price level rises, each unit of currency buys fewer goods and services. Consequently, inflation also reflects an erosion in the purchasing power of money–a loss of real value in the internal medium of exchange and unit of account in the economy.

Inflation's effects on an economy are various and can be simultaneously positive and negative. Negative effects of inflation include an increase in the opportunity cost of holding money; uncertainty over future inflation which may discourage investment and savings; and if inflation is rapid enough, shortages of goods as consumers begin hoarding out of concern that prices will increase in the future. Therefore, high inflation encourages companies to keep a high level of inventories.



Inflation: Inflation in France in 2002

The Nobel laureate Robert Mundell noted that moderate inflation would induce savers to substitute lending for some money holding as a means to finance future spending. That substitution would cause market clearing real interest rates to fall. Nobel laureate James Tobin noted that moderate inflation would cause businesses to substitute investment in physical capital (plant, equipment, and inventories) for money balances in their asset portfolios. That substitution would mean choosing the making of investments with lower rates of real return. (The rates of return are lower, because the investments with higher rates of return were already being made before.) To put it in a word, companies purchase more inventories in case of high inflation. The two related effects are known as the Mundell-Tobin effect. Unless the economy is already over-investing according to models of economic growth theory, that extra investment resulting from the effect would be seen as positive.

INVENTORY COSTS

Inventory costs depends on methods used, which include Specific Identification, Weighted Average Cost, Moving-Average Cost, FIFO, and LIFO.

Learning Objectives

Identify the different types of assumptions a company can make when valuing its inventory

Key Takeaways

Key Points

- There are, in fact, so many things that can vary hidden under this appearance of simplicity that a variety of 'adjusting' assumptions may be used. These include: Specific Identification, Weighted Average Cost, Moving-Average Cost, FIFO, and LIFO.
- Specific identification requires a detailed physical count, so that the company knows exactly how many of each goods brought on specific dates remained at year end inventory.
- Weighted Average Cost is also known as AVCO. It takes Cost of Goods Available for Sale and divides it by the total amount of goods from Beginning Inventory and Purchases.
- Moving-Average (Unit) Cost is a method of calculating Ending Inventory cost. Assume that both Beginning Inventory and beginning inventory cost are known. From them the Cost per Unit of Beginning Inventory can be calculated.
- FIFO stands for first-in, first-out, meaning that the oldest inventory items are recorded as sold first, but do not necessarily mean that the exact oldest physical object has been tracked and sold.
- LIFO stands for last-in, first-out, meaning that the most recently produced items are recorded as sold first.

Key Terms

- **ABC analysis**: The ABC analysis is a business term used to define an inventory categorization technique often used in materials management. It is also known as Selective Inventory Control. Policies based on ABC analysis: A ITEMS, very tight control and accurate records; B ITEMS, less tightly controlled, and good records; and C ITEMS, simplest controls possible and minimal records.

Inventory management is primarily about specifying the shape and percentage of stocked goods. It is required at different locations within a facility or within many locations of a supply network to precede the regular and planned course of production and stock of materials.

Inventory management involves a retailer seeking to acquire and maintain a proper merchandise assortment while ordering, shipping, handling, and related costs are kept in check. It also involves systems and processes that identify inventory requirements, set targets, provide replenishment techniques, report actual and projected inventory status, and handle all functions related to the tracking and management of material. This would include the monitoring of material moved into and out of stockroom locations and the reconciling of the inventory balances. It also may include ABC analysis, lot tracking, cycle counting support, etc. Management of the inventories, with the primary objective of determining/controlling stock levels within the physical distribution system, functions to balance the need for product availability against the need for minimizing stock holding and handling costs.

Inventory: The inventory costs depend on which method is used.

There are, in fact, so many things that can vary hidden under this appearance of simplicity that a variety of 'adjusting' assumptions may be used. These include:

Specific Identification

Specific identification is a method of finding out ending inventory cost. It requires a detailed physical count, so that the company knows exactly how many of each goods brought on specific dates remained at the yearend inventory. When this information is found, the amount of goods is multiplied by their purchase cost at their purchase date, to get a number for the ending inventory cost.

This method is also a very hard to use on interchangeable goods. For example, it is hard to relate shipping and storage costs to a specific inventory item. These number will need to be estimated, therefore reducing the specific identification's benefit of being extremely specific.

Weighted Average Cost

Weighted Average Cost is a method of calculating Ending Inventory cost. It is also known as AVCO. It takes Cost of Goods Available for Sale and divides it by the total amount of goods from Beginning Inventory and Purchases. This gives a Weighted Average Cost per Unit. A physical count is then performed on the ending inventory to determine the amount of goods left. Finally, this amount is multiplied by Weighted Average Cost per Unit to give an estimate of ending inventory cost.

Moving-Average Cost

Moving-Average (Unit) Cost is a method of calculating Ending Inventory cost. Assume that both Beginning Inventory and beginning inventory cost are known. From them the Cost per Unit of Beginning Inventory can be calculated. During the year, multiple purchases are made. Each time, purchase costs are added to beginning inventory cost to get Cost of Current Inventory. Similarly, the number of units bought is added to beginning

inventory to get Current Goods Available for Sale. After each purchase, Cost of Current Inventory is divided by Current Goods Available for Sale to get Current Cost per Unit on Goods.

Also during the year, multiple sales happen. The Current Goods Available for Sale is deducted by the amount of goods sold. The Cost of Current Inventory is deducted by the amount of goods sold times the latest (before this sale) Current Cost per Unit on Goods. This deducted amount is added to Cost of Goods Sold.

At the end of the year, the last Cost per Unit on Goods, along with a physical count, is used to determine ending inventory cost.

FIFO and LIFO

FIFO stands for first-in, first-out, meaning that the oldest inventory items are recorded as sold first, but do not necessarily mean that the exact oldest physical object has been tracked and sold.

LIFO stands for last-in, first-out, meaning that the most recently produced items are recorded as sold first. Since the 1970's, some U.S. companies shifted towards the use of LIFO, which reduces their income taxes in times of inflation. However, with International Financial Reporting Standards banning the use of LIFO, more companies have gone back to FIFO. LIFO is only used in Japan and the U.S.

The difference between the cost of an inventory calculated under the FIFO and LIFO methods is called the LIFO reserve. This reserve is essentially the amount by which an entity's taxable income has been deferred by using the LIFO method.

ECONOMIC ORDER QUANTITY TECHNIQUE

Economic order quantity is the order quantity that minimizes total inventory holding costs and ordering costs: $${ \text{Q} }^{ * }=\left(\frac { 2\text{DS} }{ \text{H} } \right) ^{ \frac { 1 }{ 2 } }$$.

Learning Objectives

Calculate a company's optimal order quantity

Key Takeaways

Key Points

- Economic order quantity is the order quantity that minimizes total inventory holding costs and ordering costs.
- EOQ determines the optimal number of units to minimize the total cost associated with the purchase, delivery, and storage of the product.
- Q* = (DS/H)^1/2 where Q = order quantity, Q*= optimal order quantity, D = annual demand quantity, S = fixed cost per order, H = annual holding cost per unit.

Key Terms

- **holding cost**: In business management, holding cost is money spent to keep and maintain a stock of goods in storage.

Economic order quantity is the order quantity that minimizes total inventory holding costs and ordering costs. It is one of the oldest classical production scheduling models. The framework used to determine this order quantity is also known as "Barabas EOQ Model" or "Barabas Formula. " The model was developed by Ford W. Harris in 1913, but R. H. Wilson, a consultant who applied it extensively, is given credit for his in-depth analysis.

We want to determine the optimal number of units to order so that we minimize the total cost associated with the purchase, delivery, and storage of the product. The required parameters to the solution are the total demand for the year, the purchase cost for each item, the fixed cost to place the order, and the storage cost for each item per year. Note that the number of times an order is placed will also affect the total cost, though this number can be determined from the other parameters.

Underlying assumptions are:

- The ordering cost is constant.
- The rate of demand is known, and spread evenly throughout the year.
- The lead time is fixed.
- The purchase price of the item is constant (i.e., no discount is available).
- The replenishment is made instantaneously; the whole batch is delivered at once.
- Only one product is involved.

Variables for the function are: Q = order quantity, Q*= optimal order quantity, D = annual demand quantity, S = fixed cost per order (not per unit, typically cost of ordering and shipping and handling. This is not the cost of goods), H = annual holding cost per unit (also known as carrying cost or storage cost) (warehouse space, refrigeration, insurance, etc., usually not related to the unit cost).

The single-item EOQ formula finds the minimum point of the following cost function:

$$TC = PD + \frac{DS}{Q} + \frac{HQ}{2}$$

Economic order quantity: Economic order quantity function solving for Q.

Total Cost = purchase cost + ordering cost + holding cost

- Purchase cost: This is the variable cost of goods: purchase unit price × annual demand quantity. This is P×D.
- Ordering cost: This is the cost of placing orders: each order has a fixed cost S, and we need to order D/Q times per year. This is S × D/Q.
- Holding cost: the average quantity in stock (between fully replenished and empty) is Q/2, so this cost is H × Q/2.

To determine the minimum point of the total cost curve, partially differentiate the total cost with respect to Q (assume all other variables are constant) and set to 0:

$$0 = -\frac{DS}{Q^2} + \frac{H}{2}$$

Equation: Equation to determine the minimum point of the total cost curve.

Solving for Q gives Q* (the optimal order quantity):

$$Q^* = \sqrt{\frac{2DS}{H}}$$

*Equation 3: Equation solving for Q**

JUST-IN-TIME TECHNIQUE

Just in time (JIT) is a production strategy that strives to reduce in-process inventory and carrying costs in a manufacturing system.

Learning Objectives

Discuss the benefits and disadvantages of using a Just-In-Time (JIT) inventory system

Key Takeaways

Key Points

- JIT focuses on continuous improvement and can improve a manufacturing organization's return on investment, quality and efficiency.
- JIT relies on efficient coordination of elements in the inventory chain.
- There are many benefits of JIT. It improves the flow of goods from warehouse to shelves, reduces set up time and efficiently uses human resources.

Key Terms

- **carrying costs**: carrying cost refers to the total cost of holding inventory. This includes warehousing costs such like utilities and salaries; financial costs like opportunity cost; and inventory costs related to perishability, shrinkage and insurance.

Just in time (JIT) is a production strategy striving to improve a business return on investment by reducing in-process inventory and associated carrying costs. To meet JIT objectives, the process relies on signals or Kanban between different points in the process. Kanban are usually "tickets" but can be simple visual signals, like the

presence or absence of a part on a shelf. Implemented correctly, JIT focuses on continuous improvement and can improve a manufacturing organization's return on investment, quality and efficiency. To achieve continuous improvement, key areas of focus are:

- flow
- employee involvement
- quality.

Noticing that stock depletion requires personnel to order new stock is critical to the inventory reduction at the center of JIT. But JIT relies on other elements in the inventory chain. Therefore, JIT is best implemented as one part of an overall lean manufacturing system.

Benefits of JIT:

- Reduced setup time. Cutting setup time allows the company to reduce or eliminate inventory for "changeover" time.
- The flow of goods from warehouse to shelves improves. Small or individual lot sizes reduce lot delay inventories, which simplifies inventory flow and its management.
- Employees with multiple skills are used more efficiently. Having employees trained to work on different parts of the process allows companies to move workers where they are needed.
- Production scheduling and work hour consistency are synchronized with demand. If there is no demand for a product at the time, it is not made. This saves the company money, either by not having to pay workers overtime or by having them focus on other work.
- Increased emphasis on supplier relationships. A company without inventory does not want a supply system problem that creates a part shortage. This makes supplier relationships extremely important.
- Supplies come in at regular intervals throughout the production day. Supply is synchronized with production demand and the optimal amount of inventory is on hand at any time. When parts move directly from the truck to the point of assembly, the need for storage facilities is reduced.
- Minimizes storage space needed.
- Smaller chance of inventory breaking/expiring.

Drawbacks

Just-in-time operation can leave suppliers and downstream consumers open to supply shocks and large supply or demand changes. In addition, very low stock levels means shipments of the same part can come in several times per day. This means firms favoring JIT are especially susceptible to flow interruption.

BENEFITS OF INVENTORY MANAGEMENT

Improved inventory management can lead to increased revenue, lower handling and holding costs, and improved cash flows.

Learning Objectives

Discuss the benefits of inventory management

Key Takeaways

Key Points

- Inventory management is primarily about specifying the shape and percentage of stocked goods.
- Inventory management leads to optimal inventory levels.
- Management of the inventories, with the primary objective of determining/controlling stock levels within the physical distribution system, functions to balance the need for product availability against the need for minimizing stock holding and handling costs.
- Inventory management can also help companies improve cash flows.

Key Terms

- **holding cost**: In business management, holding cost is money spent to keep and maintain a stock of goods in storage.
- **ABC analysis**: The ABC analysis is a business term used to define an inventory categorization technique often used in materials management. It is also known as Selective Inventory Control. Policies based on ABC analysis: A ITEMS, very tight control and accurate records; B ITEMS, less tightly controlled, and good records; and C ITEMS, simplest controls possible and minimal records.

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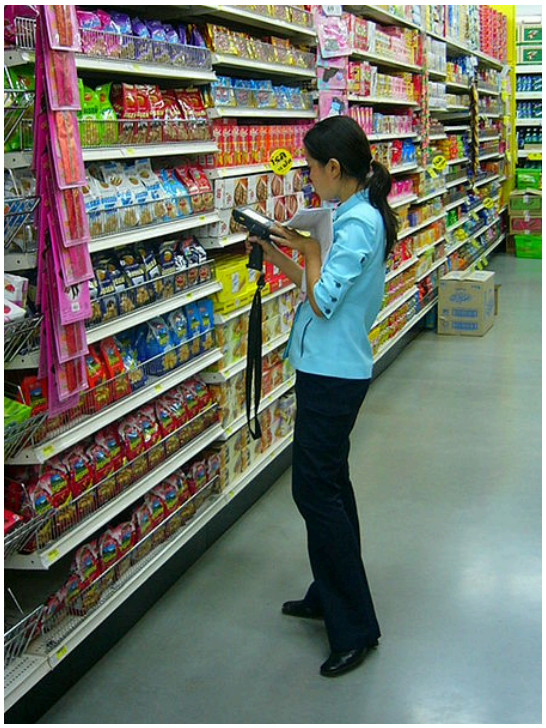


Inventory management: Female clerk doing inventory work using a handheld computer in a Tesco Lotus supermarket in Sakon Nakhon, Thailand.

The intent of inventory management is to continuously hold optimal inventory levels. The scope of inventory management concerns the fine lines between replenishment lead time, carrying costs of inventory, asset management, inventory forecasting, inventory valuation, inventory visibility, future inventory price forecasting, physical inventory, available physical space for inventory, quality management, replenishment, returns and defective goods, and demand forecasting. Balancing these competing requirements leads to optimal inventory levels, which is an on-going process as the business needs shift and react to the wider environment.

Management of the inventories, with the primary objective of determining/controlling stock levels within the physical distribution system, functions to balance the need for product availability against the need for minimizing stock holding and handling costs. Inventory management involves systems and processes that identify inventory requirements, set targets, provide replenishment techniques, report actual and projected inventory status, and handle all functions related to the tracking and management of material. This would include the monitoring of material moved into and out of stockroom locations and the reconciling of the inventory balances. It also may include ABC analysis, lot tracking, cycle counting support, etc. All of these practices leads to optimal product storage, helping minimize holding and handling costs.

Inventory management also can help companies improve cash flows. Companies with effective inventory management do not have to spend large capital balances for purchasing enormous amounts of inventory at once. This also saves handling and holding costs.

DANGERS INVOLVED IN INVENTORY MANAGEMENT

Excessive inventory means idle funds which earn no profits; inadequate inventory means lost sales.

Learning Objectives

Discuss the difficulties of managing inventory

Key Takeaways

Key Points

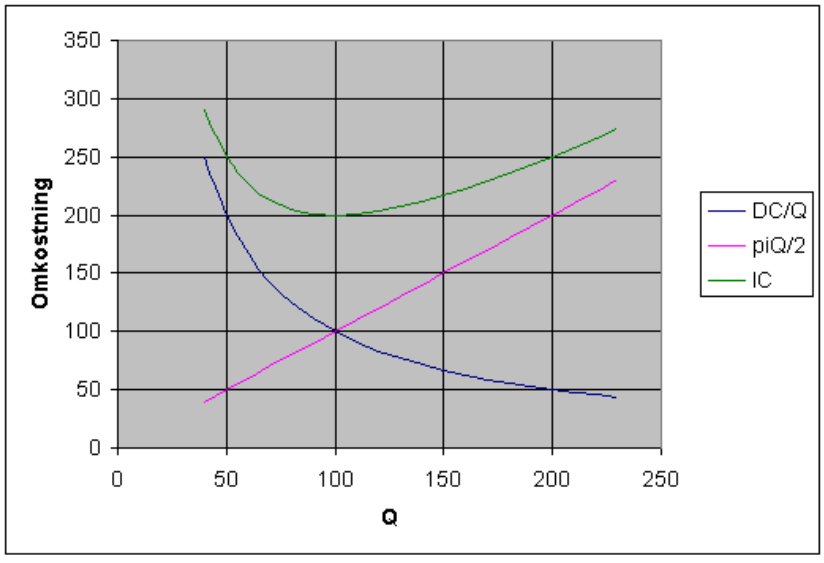
- Excessive inventory means the firm has idle funds which earn no profits for the firm. In addition, excessive inventory incurs extra handling and holding costs.
- Inadequate inventory means the firm does not have sufficient raw materials for production. This also means insufficient ample goods to sell for merchandising companies.
- Inventory management will be more complicated as moderate inflation and seasonality get involved.

Key Terms

- **seasonality**: Variation with the seasons
- **holding cost**: In business management, holding cost is money spent to keep and maintain a stock of goods in storage.

Inventory management is primarily about specifying the size and placement of stocked goods. Inventory management is required at different locations within a facility or within multiple locations of a supply network to protect the regular and planned course of production against the random disturbance of running out of materials or goods.

The scope of inventory management also concerns the fine lines between replenishment lead time, carrying costs of inventory, asset management, inventory forecasting, inventory valuation, inventory visibility, future inventory price forecasting, physical inventory, available physical space for inventory, quality management, replenishment, returns, and defective goods and demand forecasting. Balancing these competing requirements leads to optimal inventory levels, which is an on-going process as the business needs shift and react to the wider environment.



***Inventory control**: Inventory control – inventory cost elements (holding cost, order cost, total)Parameters: Order-cost (C) 10, demand (D) 1000, holding cost (i) 20% (of price), price (p) 10 => EOQ = 100*

Excessive inventory means the firm has idle funds which earn no profits for the firm. In addition, excessive inventory incurs extra handling costs and holding costs. However, it is not well advised for the firm to keep low inventory levels, since inadequate inventory means the firm does not have sufficient raw materials for production. When items are required on a breakdown basis and find out that there is not enough stock as a result of reducing it, this could lead to loss of production. Inadequate inventory also means not ample goods to sell. The company, as a result, faces the risk of losing customers to competitors.

Inventory management will be more complicated as moderate inflation and seasonality gets involved. Inflation encourages the firm to purchase more inventory, exposing them to excessive inventory. Without an accurate sales forecast, companies operating in sectors affected by seasonality face shortage during high time and excess of inventory during low time of the year.

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[/hidden-answer]

9.2: Types of Inventory and Inventory Decisions

Read this section, which will help you understand the ABC analysis method and the application to inventory categorization. The ABC analysis is important because this method helps control overall inventory cost by using selective inventory control policies.

ABC TECHNIQUE

The ABC analysis is an inventory categorization technique often used in material management wherein accuracy and control decreases from A to C.

Learning OBJECTIVE

- Differentiate different types of inventory items based on ABC inventory analysis

KEY POINTS

- A items: very tight control and accurate records; B items: less tightly controlled and good records; C items: simplest controls possible and minimal records.
- The ABC analysis provides a mechanism for identifying items that will have a significant impact on overall inventory cost, while also providing a mechanism for identifying different categories of stock that will require different management and controls.
- The ABC analysis suggests that inventories of an organization are not of equal value.

TERM

- **Just in Time:** Just in time (JIT) is a production strategy that strives to improve a business return

on investment by reducing in-process inventory and associated carrying costs.

FULL TEXT

The ABC analysis is a business term used to define an inventory categorization technique often used in material management. It is also known as "Selective Inventory Control. " Policies based on ABC analysis:

- A ITEMS: very tight control and accurate records
- B ITEMS: less tightly controlled and good records
- C ITEMS: simplest controls possible and minimal records

The ABC analysis provides a mechanism for identifying items that will have a significant impact on overall inventory cost, while also providing a mechanism for identifying different categories of stock that will require different management and controls.

The ABC analysis suggests that inventories of an organization are not of equal value. Thus, the inventory is grouped into three categories (A, B, and C) in order of their estimated importance.

A items are very important for an organization. Because of the high value of these A items, frequent value analysis is required. In addition to that, an organization needs to choose an appropriate order pattern (e.g., "Just-in- time") to avoid excess capacity.

B items are important, but of course less important, than A items and more important than C items. Therefore, B items are intergroup items.

C items are marginally important.

The following is an example of the Application of Weighed Operation based on ABC class in the electronics manufacturing company with 4,051 active parts.

Using this distribution of ABC class and change total number of the parts to 4,000.

ABC Techniques

Distribution of ABC class

- Uniform Purchase: When you apply equal purchasing policy to all 4,000 components, example weekly delivery and re-order point (safety stock) of two-week supply assuming that there are no lot size constraints, the factory will have a 16,000 delivery in four weeks and the average inventory will be 2.5 weeks supply.
- Weighed Purchase: In comparison, when weighed purchasing policy applied based on ABC class, example C class monthly (every four weeks) delivery with re-order point of three-week supply, B class Bi-weekly delivery with re-order point of two-week supply, A class weekly delivery with re-order point of one-week supply, total number of delivery in four weeks will be (A 200×4=800)+(B 400 x2=800) + (C 3400×1=3400)=5000 and average inventory will be (A 75%x1.5weeks)+(B 15%x3weeks)+ (C 10%x3.5weeks)= 1.925 week supply.

By applying weighed control based on ABC classification, required man hours and inventory level are drastically reduced.

CHAPTER ATTRIBUTION

Boundless: *Finance* “Chapter 18, Section 5, Part 3: ABC Technique”

9.3: Inventory Control

BOUNDLESS: *FINANCE* "CHAPTER 18, SECTION 5, PART 9: BENEFITS OF INVENTORY MANAGEMENT"

Read this section and explore the fundamentals of inventory management. The benefits to improved inventory management processes are lower costs and improved cash flows. A skill in inventory management is necessary for sound operations.

BENEFITS OF INVENTORY MANAGEMENT

Improved inventory management can lead to increased revenue, lower handling and holding costs, and improved cash flows.

LEARNING OBJECTIVE

- Discuss the benefits of inventory management

KEY POINTS

- Inventory management is primarily about specifying the shape and percentage of stocked goods.
- Inventory management leads to optimal inventory levels.
- Management of the inventories, with the primary objective of determining/controlling stock levels within the physical distribution system, functions to balance the need for product availability against the need for minimizing stock holding and handling costs.
- Inventory management can also help companies improve cash flows.

TERMS

- **ABC analysis**: The ABC analysis is a business term used to define an inventory categorization technique often used in materials management. It is also known as Selective Inventory Control. Policies based on ABC analysis: A ITEMS, very tight control and accurate records; B ITEMS, less tightly controlled, and good records; and C ITEMS, simplest controls possible and minimal records.
- **holding cost**: In business management, holding cost is money spent to keep and maintain a stock of goods in storage.

FULL TEXT

Inventory management is primarily about specifying the shape and percentage of stocked goods. It is required at different locations within a facility or within many locations of a supply network to precede the regular and planned course of production and stock of materials.

The intent of inventory management is to continuously hold optimal inventory levels. The scope of inventory management concerns the fine lines between replenishment lead time, carrying costs of inventory, asset management, inventory forecasting, inventory valuation, inventory visibility, future inventory price forecasting, physical inventory, available physical space for inventory, quality management, replenishment, returns and defective goods, and demand forecasting. Balancing these competing requirements leads to optimal inventory levels, which is an on-going process as the business needs shift and react to the wider environment.

Management of the inventories, with the primary objective of determining/controlling stock levels within the physical distribution system, functions to balance the need for product availability against the need for minimizing stock holding and handling costs. Inventory management involves systems and processes that identify inventory requirements, set targets, provide replenishment techniques, report actual and projected inventory status, and handle all functions related to the tracking and management of material. This would include the monitoring of material moved into and out of stockroom locations and the reconciling of the inventory balances. It also may include ABC analysis, lot tracking, cycle counting support, etc. All of these practices leads to optimal product storage, helping minimize holding and handling costs.

Inventory management also can help companies improve cash flows. Companies with effective inventory management do not have to spend large capital balances for purchasing enormous amounts of inventory at once. This also saves handling and holding costs.

BOUNDLESS: *BUSINESS* "CHAPTER 16, SECTION 4, PART 2: INVENTORY MANAGEMENT"

Read this section, which will help you understand how companies keep and manage inventory. There are basic reasons for keeping inventory on hand. The important part is that these reasons are evaluated for the needs of

each organization and an inventory management system is created that allows for the highest level of efficiency possible.

INVENTORY MANAGEMENT

Inventory represents finished and unfinished goods that have not yet been sold by a company.

LEARNING OBJECTIVE

- Explain why and how companies keep inventory

KEY POINTS

- Inventories are maintained because time lags in moving goods to customers could otherwise put sales at risk.
- Inventories are maintained as buffers to meet uncertainties in demand, supply and movements of goods.
- There are four stages of inventory: raw material, work in progress, finished goods, and goods for resale.

TERMS

- **Finished goods**: Goods ready for sale to customers.
- **raw materials**: Materials and components scheduled for use in making a product.
- **Work in process**: Materials and components that have began their transformation to finished goods.

EXAMPLE

- A canned food manufacturer's materials inventory includes the ingredients to form the foods to be canned, empty cans and their lids (or coils of steel or aluminum for constructing those components), labels, and anything else (solder, glue, etc.) that will form part of a finished can. The firm's work in process includes those materials from the time of release to the work floor until they become complete and ready for sale to wholesale or retail customers. This may be vats of prepared food, filled cans not yet labeled or sub-assemblies of food components. It may also include finished cans that are not yet packaged into cartons or pallets. Its finished good inventory consists of all the filled and labeled cans of food in its warehouse that it has manufactured and wishes to

sell to food distributors (wholesalers), to grocery stores (retailers), and even perhaps to consumers through arrangements like factory stores and outlet centers.

FULL TEXT

REASONS FOR KEEPING INVENTORY

In many cases (such as retail), a business must have its product on hand in order to complete a sale. For these companies, the reason for keeping one of each item on hand (in inventory) is that it enables them to make sales and capture revenue. However, many businesses keep more than one of every item on hand and also keep raw materials and unfinished goods on stock in factories. Why do they do this?

There are three basic reasons for keeping an inventory:

- Time: The time lags present in the supply chain, from supplier to user at every stage, requires that you maintain certain amounts of inventory to use in this leadtime. However, in practice, inventory is to be maintained for consumption during variations in lead time. Lead time itself can be addressed by ordering that many days in advance.
- Uncertainty: Inventories are maintained as buffers to meet uncertainties in demand, supply and movements of goods.
- Economies of scale: Ideal condition of "one unit at a time, at a place where a user needs it, when he needs it" principle tends to incur lots of costs in terms of logistics. So bulk buying, movement and storing brings in economies of scale, thus inventory. All these stock reasons can apply to any owner or product.

MANAGING INVENTORY

Inventory management is primarily about specifying the location and amount of stocked goods. Optimizing inventory management requires balancing many factors, including:

- Replenishment lead time
- Carrying costs of inventory
- Asset management
- Inventory forecasting
- Inventory valuation
- Inventory visibility
- Future inventory price forecasting
- Physical inventory
- Available physical space for inventory
- Quality management
- Replenishment
- Returns and defective goods

- Demand forecasting

Balancing these competing requirements leads to optimal inventory levels, which is an on-going process as the business needs to react to the wider environment. Optimal inventory levels are those that maximize profit from sales, while minimizing cost from storage, shipping, and working capital deployment.

While accountants often discuss inventory in terms of goods for sale, other organizations (such as manufacturers, service-providers and not-for-profits) also have inventories (fixtures, furniture, supplies, etc.) that they do not intend to sell. Manufacturers', distributors', and wholesalers' inventory tends to cluster in warehouses. Retailers' inventory may exist in a warehouse or in a shop or store accessible to customers. Inventories not intended for sale to customers or to clients may be held in any premises an organization uses. Stock ties up cash and, if uncontrolled, it will be impossible to know the actual level of stocks, and therefore impossible to control them.

STAGES OF INVENTORY

While the reasons for holding stock were covered earlier, most manufacturing organizations usually divide their "goods for sale" inventory into:

- Raw materials: materials and components scheduled for use in making a product
- Work in process (WIP): materials and components that have began their transformation to finished goods
- Finished goods: goods ready for sale to customers
- Goods for resale: returned goods that are salable

9.2 DEMAND PLANNING AND INVENTORY CONTROL

Learning Objectives

1. Explain why demand planning adds value to products.
2. Describe the role inventory control plays when it comes marketing products.
3. List the reasons why firms collaborate with another for the purposes of inventory control and demand planning.

DEMAND PLANNING

Imagine you are a marketing manager who has done everything in your power to help develop and promote a product—and it's selling well. But now your company is running short of the product because the demand forecasts for it were too low. Recall that this is the scenario Nintendo faced when the Wii first came out. The same thing happened to IBM when it launched the popular ThinkPad laptop in 1992.

Not only is the product shortage going to adversely affect the profitably of your company, but it's going

to adversely affect you, too. Why? Because you, as a marketing manager, probably earn either a bonus or commission from the products you work to promote, depending on how well they sell. And, of course, you can't sell what you don't have.

As you can probably tell, the best marketing decisions and supplier selections aren't enough if your company's demand forecasts are wrong. Demand planning is the process of estimating how much of a good or service customers will buy from you. If you're a producer of a product, this will affect not only the amount of goods and services you have to produce but also the materials you must purchase to make them. It will also affect your production scheduling, or the management of the resources, events, and processes need to create an offering. For example, if demand is heavy, you might need your staff members to work overtime. Closely related to demand forecasting are lead times. A product's lead time is the amount of time it takes for a customer to receive a good or service once it's been ordered. Lead times also have to be taken into account when a company is forecasting demand.

Sourcing decisions—deciding which suppliers to use—are generally made periodically. *Forecasting decisions* must be made more frequently—sometimes daily. One way for you to predict the demand for your product is to look at your company's past sales. This is what most companies do. But they don't stop there. Why? Because changes in many factors—the availability of materials to produce a product and their prices, global competition, oil prices (which affect shipping costs), the economy, and even the weather—can change the picture.

For example, when the economy hit the skids in 2008, the demand for many products fell. So if you had based your production, sales, and marketing forecasts on 2007 data alone, chances are your forecasts would have been wildly wrong. Do you remember when peanut butter was recalled in 2009 because of contamination? If your firm were part of the supply chain for peanut butter products, you would have needed to quickly change your forecasts.

The promotions you run will also affect demand for your products. Consider what happened to KFC when it first came out with its new grilled chicken product. As part of the promotion, KFC gave away coupons for free grilled chicken via Oprah.com. Just twenty-four hours after the coupons were uploaded to the Web site, KFC risked running out of chicken. Many customers were turned away. Others were given "rain checks" (certificates) they could use to get free grilled chicken later.[1]

In addition to looking at the sales histories of their firms, supply chain managers also consult with marketing managers and sales executives when they are generating demand forecasts. Sales and marketing personnel know what promotions are being planned because they work more closely with customers and know what customers' needs are and if those needs are changing.

Firms also look to their supply chain partners to help with their demand planning. Collaborative planning, forecasting, and replenishment (CPFR) is a practice whereby supply chain partners share information and coordinate their operations. Walmart has developed a Web-based CPFR system called Retail Link. Retailers can log into Retail Link to see how well their products are selling at various Walmart stores, how soon more products need to be shipped to the company and where, how any promotions being run are affecting the profitability of their products, and so forth. Because different companies often use different information technology systems and software, Web-based tools like Retail Link are becoming a popular way for supply chain partners to interface with one another.

Not all firms are wild about sharing every piece of information they can with their supply chains partners. Some retailers view their sales information as an asset—something they can sell to information companies like Information Resources, Inc., which provides competitive data to firms that willing to pay for it.[2] By contrast, other firms go so far as to involve their suppliers before even producing a product so they can suggest design changes, material choices, and production recommendations.

1. Joe Weisenthal, "Slammed KFC 'Scrambling to Source More Chicken,'" *The Business Insider*, May 6, 2009, http://www.businessinsider.com/kfc-2009-5 (accessed December 2, 2009).
2. Donald J. Bowersox and David J. Closs, "Ten Mega-Trends That Will Revolutionize Supply Chain Logistics," *Journal of Business Logistics* 21, no. 2 (2000): 11.

Video Clip

Take a Test Drive of the Tata Nano

http://www.youtube.com/watch?v=3sZitve3SUw

Priced at about $2,500 the Tata Nano is the least expensive car ever produced in the world. To make a safe, reliable car at such a low cost, Tata Motors, an Indian company, sought new, innovative design approaches from its suppliers. The elimination of one of the car's two windshield wipers was one result of the collaboration that occurred between Tata and its supply chain partners.[3]

The trend is clearly toward more shared information, or what businesspeople refer to as supply chain visibility. After all, it makes sense that a supplier will be not only more reliable but also in a better position to add value to your products if it knows what your sales, operations, and marketing plans are—and what your customers want. By sharing more than just basic transaction information, companies can see how well operations are proceeding, how products are flowing through the chain, how well the partners are performing and cooperating with one another, and the extent to which value is being built in to the product.

Demand-planning software can also be used to create more accurate demand forecasts. Demand-planning software can synthesize a variety of factors to better predict a firm's demand—for example, the firm's sales history, point-of-sale data, warehouse, suppliers, and promotion information, and economic and competitive trends. So a company's demand forecasts are as up-to-date as possible, some of the systems allow sales and marketing personnel to input purchasing information into their mobile devices after consulting with customers.

Litehouse Foods, a salad dressing manufacturer, was able to improve its forecasts dramatically by using demand-planning software. Originally the company was using a traditional sales database and spreadsheets to do the work. "It was all pretty much manual calculations. We had no engine to do the heavy lifting for us," says John Shaw, the company's Information Technology director. In a short time, the company was able to reduce its inventory by about one-third while still meeting its customers' needs.[4]

INVENTORY CONTROL

Demand forecasting is part of a company's overall inventory control activities. Inventory control is the process of ensuring your firm has an adequate supply of products and a wide enough assortment of them meet your customers' needs. One of the goals of inventory management is to avoid stockouts. A stockout occurs when you run out of a product a customer wants to buy. Customers will simply look elsewhere to buy the product—a process the Internet has made easier than ever.

When the attack on the World Trade Center occurred, many Americans rushed to the store to buy batteries, flashlights, American flags, canned goods, and other products in the event that the emergency signaled a much bigger attack. Target sold out of many items and could not replenish them for several days, partly because its inventory tracking system only counted up what was needed at the end of the day. Walmart, on the other hand, took count of what was needed every five minutes. Before the end of the day, Walmart had purchased enough American flags, for example, to meet demand and in so doing, completely locked up all their vendors' flags. Meanwhile, Target was out of flags and out of luck—there were no more to be had.

To help avoid stockouts, most companies keep a certain amount of safety stock on hand. Safety stock is backup inventory that serves as a buffer in case the demand for a product surges or the supply of it drops off for some reason. Maintaining too much inventory, though, ties up money that could be spent other ways—perhaps on marketing promotions. Inventory also has to be insured, and in some cases, taxes must be paid on it. Products

3. Steven Wingett, "Capro, Saint-Gobain, Denso Win Big with Tata Nano," Automotive News Europe, March 3, 2008, 16.
4. Carol Casper, "Demand Planning Comes of Age," *Food Logistics* 101 (January/February 2008): 19–24.

in inventory can also become obsolete, deteriorate, spoil, or "shrink." Shrinkage is a term used to describe a reduction or loss in inventory due to shoplifting, employee theft, paperwork errors, or supplier fraud.[5]

When the economy went into its most recent slide, many firms found themselves between a rock and a hard place in terms of their inventory levels. On the one hand, because sales were low, firms were reluctant to hold much safety stock. Many companies, including Walmart, cut the number of brands they sold in addition to holding a smaller amount of inventory. On the other hand, because they didn't know when business would pick up, they ran the risk of running out of products. Many firms dealt with the problem by maintaining larger amounts of key products. Companies also watched their supply chain partners struggle to survive. Forty-five percent of firms responding to one survey about the downturn reported providing financial help to their critical supply chain partners—often in the form of credit and revised payment schedules.[6]

JUST-IN-TIME INVENTORY SYSTEMS

To lower the amount of inventory and still maintain they stock they need to satisfy their customers, some organizations use just-in-time inventory systems in both good times and bad. Firms with just-in-time inventory systems keep very little inventory on hand. Instead, they contract with their suppliers to ship them inventory as they need it—and even sometimes manage their inventory for them—a practice called vendor-managed inventory (VMI). Dell is an example of a company that utilizes a just-in-time inventory system that's vendor managed. Dell carries very few component parts. Instead, its suppliers carry them. They are located in small warehouses near Dell's assembly plants worldwide and provide Dell with parts "just-in-time" for them to be assembled.[7]

Dell's inventory and production system allows customers to get their computers built exactly to their specifications, a production process that's called mass customization. This helps keep Dell's inventory levels low. Instead of a huge inventory of expensive, already-assembled computers consumers may or may not buy, Dell simply has the parts on hand, which can be configured or reconfigured should consumers' preferences change. Dell can more easily return the parts to its suppliers if at some point it redesigns its computers to better match what its customers want. And by keeping track of its customers and what they are ordering, Dell has a better idea of what they might order in the future and the types of inventory it should hold. Because mass customization lets buyers "have it their way," it also adds value to products, for which many customers are willing to pay.

PRODUCT TRACKING

Some companies, including Walmart, are beginning to experiment with new technologies such as electronic product codes in an effort to better manage their inventories. An electronic product code (EPC) is similar to a barcode, only better, because the number on it is truly unique. You have probably watched a checkout person scan a barcode off of a product identical to the one you wanted to buy—perhaps a pack of gum—because the barcode on your product was missing or wouldn't scan. Electronic product codes make it possible to distinguish between two identical packs of gum. The codes contain information about when the packs of gum were manufactured, where they were shipped from, and where they were going to. Being able to tell the difference between "seemingly" identical products can help companies monitor their expiration dates if they are recalled for quality of safety reasons. EPC technology can also be used to combat "fake" products, or knockoffs, in the marketplace.

5. Shari Waters, "Shrinkage," About.com, http://retail.about.com/od/glossary/g/shrinkage.htm (accessed December 2, 2009).
6. PRTM Management Consultants, "Global Supply Chain Trends 2008–2010," http://www.prtm.com/uploadedFiles/Strategic_Viewpoint/Articles/Article_Content/Global_Supply_Chain_Trends_Report_%202008.pdf (accessed December 2, 2009).
7. Sameer Kumar and Sarah Craig, "Dell, Inc.'s Closed Loop Supply Chain for Computer Assembly Plants," *Information Knowledge Systems Management* 6, no. 3 (2007): 197–214.

Video Clip

The Basics of RFID and EPC Technology

http://www.youtube.com/watch?v=k-w6ZYIo37E

To understand how EPC and RFID technology can help marketers, watch this YouTube video.

Electronic product codes are stored on radio-frequency identification (RFID) tags. A radio-frequency identification (RFID) tag emits radio signals that can record and track a shipment as it comes in and out of a facility. If you have unlocked your car door remotely, microchipped your dog, or waved a tollway tag at a checkpoint, you have used RFID technology.[8] Because each RFID tag can cost anywhere from $0.50 to $50 each, they are generally used to track larger shipments, such cases and pallets of goods rather than individual items. See Figure 9.8 "How RFID Tagging Works" to get an idea of how RFID tags work.

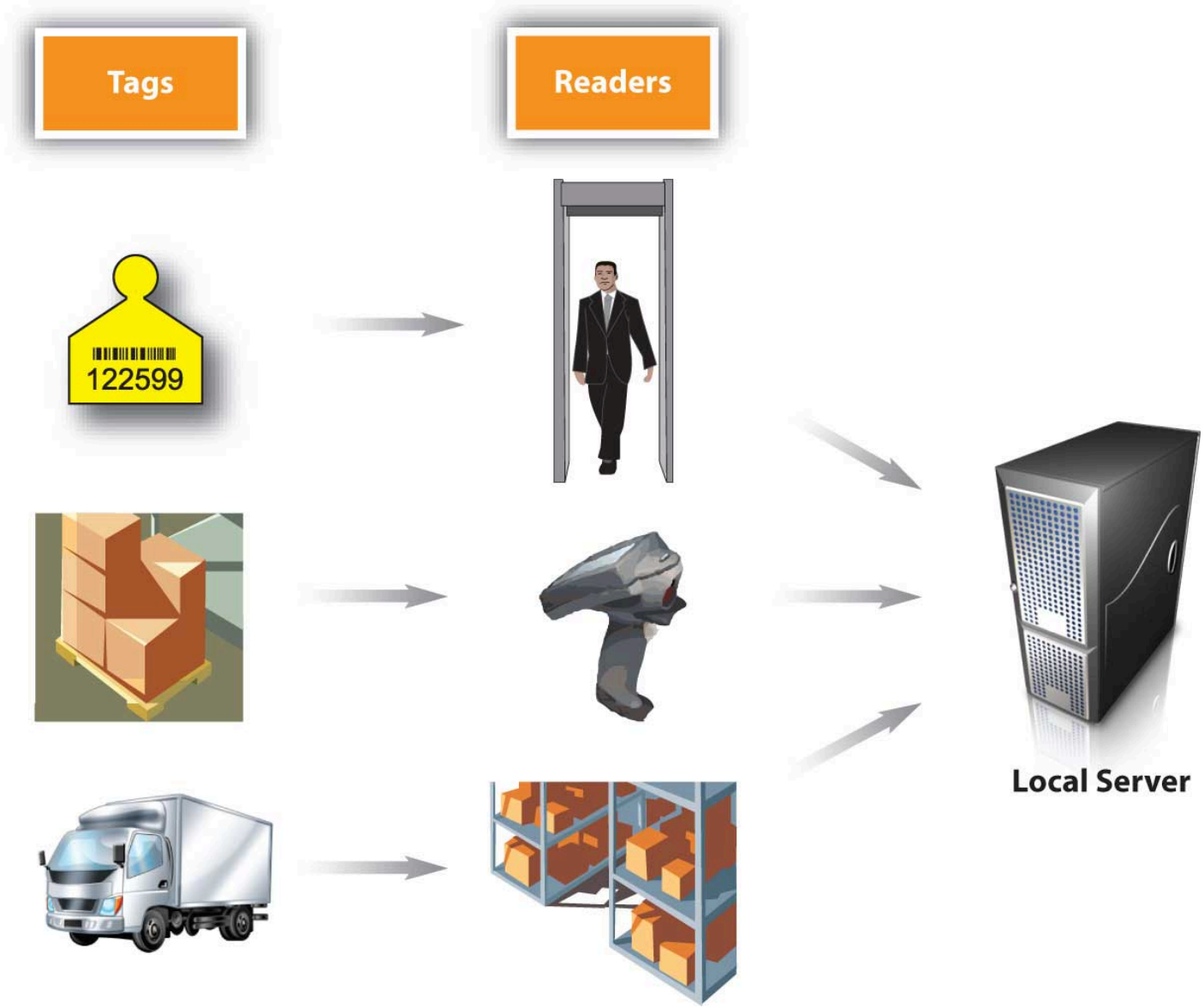


Figure 9.8 How RFID Tagging Works

Some consumer groups worry that RFID tags and electronic product codes could be used to track their

8. "FAQs," *EPCglobal*, http://www.epcglobalinc.org/consumer_info/faq (accessed December 2, 2009).

consumption patterns or for the wrong purposes. But keep in mind that like your car-door remote, the codes and tags are designed to work only within short ranges. (You know that if you try to unlock your car from a mile away using such a device, it won't work.)

Proponents of electronic product codes and RFID tags believe they can save both consumers and companies time and money. These people believe consumers benefit because the information embedded in the codes and tags help prevent stockouts and out-of-date products from remaining on store shelves. In addition, the technology doesn't require cashiers to scan barcodes item by item. Instead an electronic product reader can automatically tally up the entire contents of a shopping cart—much like a wireless network can detect your computer within seconds. As a customer, wouldn't that add value to your shopping experience?

Key Takeaway

The best marketing decisions and supplier selections aren't enough if your company's demand forecasts are wrong. Demand forecasting is the process of estimating how much of a good or service a customer will buy from you. If you're a producer of a product, this will affect not only the amount of goods and services you have to produce but also the materials you must purchase to make them. Demand forecasting is part of a company's overall inventory control activities. Inventory control is the process of ensuring your firm has an adequate amount of products and a wide enough assortment of them meet your customers' needs. One of the goals of inventory control is to avoid stockouts without keeping too much of a product on hand. Some companies are beginning to experiment with new technologies such as electronic product codes and RFID tags in an effort to better manage their inventories and meet their customers' needs.

Review Questions

1. Why are demand forecasts made more frequently than sourcing decisions?
2. How can just-in-time and vendor-managed inventories add value to products for customers?
3. Why and how do companies track products?

WIKIPEDIA: "ECONOMIC ORDER QUANTITY "

Read this description of EOQ, which will help you understand the fundamental function of this equation. EOQ is important because it helps minimize the total holding and ordering costs related to inventory. Pay close attention to when this applies in the production process.

ECONOMIC ORDER QUANTITY

Overview

Economic order quantity (**EOQ**) is the order quantity that minimizes the total holding costs and ordering costs. It is one of the oldest classical production scheduling models. The framework used to determine this order quantity is also known as **Wilson EOQ Model**, **Wilson Formula** or **Andler Formula**. The model was developed by Ford W. Harris in 1913, but R. H. Wilson, a consultant who applied it extensively, and K. Andler are given credit for their in-depth analysis.

EOQ applies only when demand for a product is constant over the year and each new order is delivered in

full when inventory reaches zero. There is a fixed cost for each order placed, regardless of the number of units ordered. There is also a cost for each unit held in storage, commonly known as holding cost, sometimes expressed as a percentage of the purchase cost of the item.

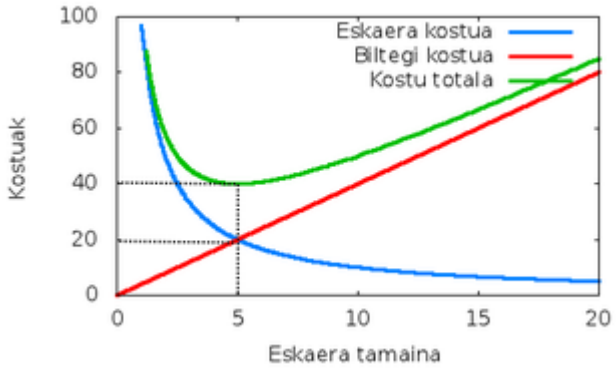
We want to determine the optimal number of units to order so that we minimize the total cost associated with the purchase, delivery and storage of the product.

The required parameters to the solution are the total demand for the year, the purchase cost for each item, the fixed cost to place the order and the storage cost for each item per year. Note that the number of times an order is placed will also affect the total cost, though this number can be determined from the other parameters.

VARIABLES

- P = purchase unit price, unit production cost
- Q = order quantity
- Q^* = optimal order quantity
- D = annual demand quantity
- K = fixed cost per order, setup cost (*not* per unit, typically cost of ordering and shipping and handling. This is not the cost of goods)
- h = annual holding cost per unit, also known as carrying cost or storage cost (capital cost, warehouse space, refrigeration, insurance, etc. usually not related to the unit production cost)

THE TOTAL COST FUNCTION AND DERIVATION OF EOQ FORMULA



Classic EOQ model: trade-off between ordering cost (blue) and holding cost (red). Total cost (green) admits aglobal optimum. Purchase cost is not a relevant cost for determining the optimal order quantity.

The single-item EOQ formula finds the minimum point of the following cost function:

Total Cost = purchase cost or production cost + ordering cost + holding cost

Where:

- Purchase cost: This is the variable cost of goods: purchase unit price × annual demand quantity. This is P × D
- Ordering cost: This is the cost of placing orders: each order has a fixed cost K, and we need to order D/Q times per year. This is K × D/Q
- Holding cost: the average quantity in stock (between fully replenished and empty) is Q/2, so this cost is h

× Q/2

$$TC = PD + \frac{DK}{Q} + \frac{hQ}{2}.$$

To determine the minimum point of the total cost curve, calculate the derivative of the total cost with respect to Q (assume all other variables are constant) and set it equal to 0:

$$0 = -\frac{DK}{Q^2} + \frac{h}{2}$$

Solving for Q gives Q* (the optimal order quantity):

$$Q^{*2} = \frac{2DK}{h}$$

Therefore:

Economic Order Quantity

$$Q^* = \sqrt{\frac{2DK}{h}}$$

Q* is independent of P; it is a function of only K, D, h.

The optimal value Q* may also be found by recognising that[3]

$$TC = \frac{DK}{Q} + \frac{hQ}{2} + PD = \frac{h}{2Q}(Q - \sqrt{2DK/h})^2 + \sqrt{2hDK} + PD,$$

where the non-negative quadratic term disappears for $Q = \sqrt{2DK/h},$ which provides the cost minimum $TC_{min} = \sqrt{2hDK} + PD.$

Example

- Suppose annual requirement quantity (D) = 10000 units
- Cost per order (K) = $2
- Cost per unit (P)= $8
- Carrying cost percentage (h/P)(percentage of P) = 0.02
- Annual carrying cost per unit (h) = $0.16

Economic order quantity = $\sqrt{\frac{2D*K}{h}} = \sqrt{\frac{2*10000*2}{8*0.02}}$ = 500 units

Number of orders per year (based on EOQ) $= \frac{10000}{500} = 20$

Total cost $= P*D + K(D/EOQ) + h(EOQ/2)$

Total cost $= 8*10000 + 2(10000/500) + 0.16(500/2) = \$80080$

If we check the total cost for any order quantity other than 500(=EOQ), we will see that the cost is higher. For instance, supposing 600 units per order, then

Total cost $= 8 * 10000 + 2(10000/600) + 0.16(600/2) = \$80081$

Similarly, if we choose 300 for the order quantity then

Total cost $= 8 * 10000 + 2(10000/300) + 0.16(300/2) = \$80091$

This illustrates that the economic order quantity is always in the best interests of the firm.

QUANTITY DISCOUNTS

An important extension to the EOQ model of Wilson is to accommodate quantity discounts. There are two main types of quantity discounts: (1) all-units and (2) incremental.Here is a numerical example:

- Incremental unit discount: Units 1-100 cost $30 each; Units 101-199 cost $28 each; Units 200 and up cost $26 each. So when 150 units are ordered, the total cost is $30*100 + $28*50.
- All units discount: an order of 1-1000 units costs $50 each; an order of 1001-5000 units costs $45 each; an order of more than 5000 units costs $40 each. So when 1500 units are ordered, the total cost is $45*1500.

DESIGN OF OPTIMAL QUANTITY DISCOUNT SCHEDULES

In presence of a strategic customer, who responds optimally to discount schedule, the design of optimal quantity discount scheme by the supplier is complex and has to be done carefully. This is particularly so when the demand at the customer is itself uncertain. An interesting effect called the "reverse bullwhip" takes place where an increase in consumer demand uncertainty actually reduces order quantity uncertainty at the supplier.

OTHER EXTENSIONS

Several extensions can be made to the EOQ model developed by Mr. Pankaj Mane, including backordering costs and multiple items. Additionally, the economic order interval can be determined from the EOQ and the economic production quantity model (which determines the optimal production quantity) can be determined in a similar fashion.

A version of the model, the Baumol-Tobin model, has also been used to determine the money demand function, where a person's holdings of money balances can be seen in a way parallel to a firm's holdings of inventory.

Malakooti (2013) has introduced the multi-criteria EOQ models where the criteria could be minimizing the total cost, Order quantity (inventory), and Shortages.

IDS355: OPERATIONS MANAGEMENT WIKISPACE: "CHAPTER 12: INVENTORY MANAGEMENT"

Read this chapter summary. Pay close attention to the types of inventory control and the EOQ model. This source is useful because of the detailed information provided related to the function of inventories, reasons for inventory

management, and types of inventory control that is useful. Answer the questions at the end of the summary. Compare your results with the authors

CH.12 INVENTORY MANAGEMENT

Inventory is a stock or storage of goods.

Different types of Inventory:

- **Raw materials and purchased parts**
- **work in process (WIP)**
- **finished goods inventories or merchandise**
- **maintenance and repairs (MRO) inventory**
- **goods-in-transit to warehouses or customers (pipeline inventory)**

Nature and Importance of Inventory
Inventories are necessary for a firm to operate efficiently and almost all business transactions involve the delivery of a product or service in exchange for currency. For this reason, inventory management is a very important part of core operations activities. Most retail businesses and wholesale organizations acquire most of their revenue through the sale of merchandise (inventory). In order for business and supply chains to run effectively, and efficiently they must meet all the listed requirements for effective inventory management. Some of the main concerns are the level of customer service and the cost of ordering, storing, and carrying inventory. Therefore, in order to be a successful and profitable company, inventory management must be managed wisely.

There are certain requirements that must be taken into consideration during the inventory management process. These requirements are: keep track of the inventory, have a reliable forecast of demand, knowledge of lead times and lead time variability, reliable estimates of inventory holding costs, ordering costs, and shortage costs, and have a classification system for inventory items.

Some important Functions of inventories include –
1. to meet anticipated customer demand (to meet the *anticipation stocks*, average demand)
2. to smooth production requirements (create *seasonal inventories* to meet seasonal demand)
3. to decouple operations (eliminate sources of disruptions)
4. to protect against stock-outs (hold *safety stocks* to prevent the risk of shortages)
5. to take advantage of order cycles (buys more quantities than immediate requirements – cycle stock, periodic orders, or order cycles)
6. to hedge against price increases (purchase large order to hedge future price increase or implement volumn discount)
7. to permit operations (Little's Law: the average amount of inventory in a system is equal to the product of the average demand rate and the average time a unit is in the system)
8. to take advantage of quantity discounts (supplies may give discount on large orders)

For company's management, the most important reasons for having an inventory management system is to:
1. track existing inventory
2. know what quantity will be needed

3. know when these items will be needed
4. know how much items will cost

There are two types of inventory control used- Perpetual and Periodic. In a perpetual inventory system (usually used in supermarkets or department stores), a continuousflow of inventory count is tracked using a point of sale (POS) check out system. This system is perfect for companies to manage what is sold and reorder when a reorder point is reached. Another advantage of this system is its ability to account for shrinkage (theft) and inventory turnover. The periodic system (used in smaller retailers) is used to take a physical count of inventory at periodic intervals to replenish the inventory. This system would be most beneficial for companies that do not have products with UPC or bar codes, such as nuts and bolts and are purchased in large quantities at a time. In this case, someone on a line would monitor the level of the bin and notify a manager when an order would need to be placed.

ECONOMIC ORDER QUANTITY MODELS – *THE ORDER SIZE THAT MINIMIZES ANNUAL COSTS* (3 TYPES)

1)Basic economic order quantity model (EOQ)

- used to identify a fixed order size that will minimize the sum of the annual costs of holding inventory and ordering inventory

Assumptions:
1. Only one product involved
2. Annual demand requirements are known
3. Demand is spread evenly throughout the year so that the demand rate is reasonably constant
4. Lead time does not vary
5. Each order is received in a single delivery
6. There are no quantity discounts

2)Economic production quantity model (EPQ)

- the batch mode of production is widely used in production; the reason for this is that capacity to produce a part exceeds the part's usage or demand rate (the larger the run size, the fewer the number of runs needed and, hence, the lower the annual setup cost; as long as production continues, inventory will continue to grow; (see formulas below)

Assumptions:
1. Only one item is involved
2. Annual demand is known
3. Has a constant usage rate
4. Usage occurs continually, but production occurs periodically
5. The production rate is constant
6. Lead time does not vary
7. There are no quantity discounts

3) Quantity discount model

- **Price reductions for large orders offered to customers to induce them to buy in large quantities;**

If quantity discounts are offered, the buyer must weigh the potential benefits of reduced purchase price and fewer orders that will result from buying in large quantities against the increase in carrying costs caused by higher average inventories; The buyers goal is to select the order quantity that will minimize total cost (see total cost formula below);

Equations to know:

Annual carrying cost = (Q/2)*H [Q = Order quantity in units, H = Holding (carrying) cost per unit]
Annual ordering cost = (D/Q)*S [D = Demand, S = Ordering cost]
Total cost (TC) =(Q/2)*H + (D/Q)*S

- **Total cost curve is U-Shape**

Length of order cycle = Q/D

EPQ= square root[(2DS)/H]*square root[p/(p-u)]
p=production or delivery rate
u=usage rate
Reorder Point: ROP=d*LT
d=demand rate(units per period/day/week)
LT=lead time(same units as d)
EOQ=square root of (2DS)/H

Inventory point-of-sale (POS) systems, which record items at time of sale electronically, can help make forecasting more accurate. Knowing the lead time of a product, which is the time interval between ordering and receiving the order, is crucial to the success of a business. Long lead times impair the ability of a supply chain to quickly respond to changing conditions, such as changes in the quantity demanded, product or service design, and logistics.

1. Which one is *NOT* a function of inventory? (pg. 543)
a. meet anticipated customer demands
b. smooth production requirements
c. decouple operations
d. protect against stock outs
e. they are all functions of inventory

[reveal-answer q=”257029"]Show Answer[/reveal-answer]
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(answer e.)
[/hidden-answer]

2. When dealing with inventory, the Little’s Law is used for? (pg. 544)
a. counting inventory
b. quantifying pipeline inventory
c. preventing shortages in inventory
d. all of the above
e. none of the above

[reveal-answer q=”39933"]Show Answer[/reveal-answer]
[hidden-answer a=”39933"]
(answer b.)[/hidden-answer]

3. Which of the following are functions of inventory that management is concerned with? (P.544)
a. Make sure you never run out of inventory
b. Make decisions about how much to order
c. Make sure there is enough space available for all the inventory

d. Make decisions about when to order
e. both b and d
[reveal-answer q=”229301"]Show Answer[/reveal-answer]
[hidden-answer a=”229301"]
(answer e)[/hidden-answer]
4. Which of the following best describes lead time? (pg. 547)
a. The time that sales are at a profit
b. The time that the company is ahead of it’s competitors
c. The time interval between submitting and receiving the order
d. The time it takes to record items at time of sale
e. none of the above
[reveal-answer q=”568890"]Show Answer[/reveal-answer]
[hidden-answer a=”568890"]
(answer c)
[/hidden-answer]
5. Which costs is associated with keeping items in inventory? (pg. 547)
a. Holding costs
b. Ordering costs
c. Shortage costs
d. A and B
e. All the above
[reveal-answer q=”407105"]Show Answer[/reveal-answer]
[hidden-answer a=”407105"]
(answer A)[/hidden-answer]
6) Which is the most commonly used measure of managerial performance. Pg. 542
a. Capital structure
b. ROI(return on investment)
c. Demand
d. Inventory costs
e. Forecasting
[reveal-answer q=”402500"]Show Answer[/reveal-answer]
[hidden-answer a=”402500"]
Answer: b[/hidden-answer]
7) What are independent-demand items? Pg. 542
a. Items that are ready to be sold and used
b. Components of products rather than finished products
c. Special order items
d. Products that appeal to a certain demographic of customers
e. Seasonal demand items
Answer: a
8) Which of the following is not a function of inventory? Pg. 543
a. To meet anticipated customer demand
b. To smooth production requirements
c. To protect against stock-outs
d. To know lead times and lead time variability
e. To hedge against price increases

[reveal-answer q=”68520"]Show Answer[/reveal-answer]
[hidden-answer a=”68520"]
Answer: d[/hidden-answer]
9) Which inventory counting system keeps track of removals from inventory on a continuous basis? Pg. 545
a. Two-bin system
b. Periodic system
c. Perpetual system
d. Online system
e. Operations system
[reveal-answer q=”267372"]Show Answer[/reveal-answer]
[hidden-answer a=”267372"]
Answer: c[/hidden-answer]
10) The economic order quantity model (EOQ), identifies: Pg 550
a. Production of batch items or lots
b. A constant usage rate
c. Units received incrementally during production
d. Fixed order size by minimizing the sum of annual costs of holding and ordering inventory.
e. Total cost of all orders produced annually
[reveal-answer q=”43214"]Show Answer[/reveal-answer]
[hidden-answer a=”43214"]
Answer: d[/hidden-answer]

11. Which of the following (is/are) types of inventory?
a. Tools and Supplies
b. Maintenance and Repair (MRO)
c. Pipeline
d. Finished Goods
e. all of the above are inventories

[reveal-answer q=”966626"]Show Answer[/reveal-answer]
[hidden-answer a=”966626"]
answer e. Pg551[/hidden-answer]
12. A perpetual Inventory system takes a physical count of inventory on which of the following intervals?
a. Fixed intervals
b. Annual intervals
c. Periodic intervals
d. A and B
e. A and C

[reveal-answer q=”22439"]Show Answer[/reveal-answer]
[hidden-answer a=”22439"]
answer a Pg 554[/hidden-answer]
13. When the amount on hand reaches a predetermined minimum, which inventory system orders a fixed quantity?
a. Good organization
b. Perpetual inventory
c. Organized inventory

d. Periodic inventory
e. A and C
[reveal-answer q=”488516"]Show Answer[/reveal-answer]
[hidden-answer a=”488516"]
answer b Pg 554[/hidden-answer]
14. Effective inventory management estimates all of the following costs except:
a. Transaction cost
b. Shortage cost
c. Secretary cost
d. Holding cost
e. all of the above

[reveal-answer q=”758222"]Show Answer[/reveal-answer]
[hidden-answer a=”758222"]
answer c Pg556[/hidden-answer]
15. The risk of stock-out increases as?
A. The amount of safety stock increases
B. The amount of safety stock decreases
C. The amount of safety stock remains constant
D. Safety stock has no effect on stock-out
E. none of the above

[reveal-answer q=”634045"]Show Answer[/reveal-answer]
[hidden-answer a=”634045"]
Answer: B pg 572[/hidden-answer]
16. Which of the following are NOT part of the basic functions of inventory systems that management should be concerned with (p 553) ?
a. what quantity will be ordered
b. tracking existing inventory
c. how inventory will be delivered
d. when to order additional inventory
e. none of the above
[reveal-answer q=”406489"]Show Answer[/reveal-answer]
[hidden-answer a=”406489"]
Answer: c[/hidden-answer]
17. Which inventory system is the best method to prevent inventory theft/loss?
a. Perpetual Inventory System
b. Periodic Inventory System
c. Both are equally good
D. none of the above
E. Studies are inconclusive regarding which is the best method

[reveal-answer q=”944283"]Show Answer[/reveal-answer]
[hidden-answer a=”944283"]
Answer: a pg554[/hidden-answer]
18. Which of the following listed is/are function(s) of POS(point-of-sale) system?
a. record actual sales electronically

b. provide forecast of what items will most likely to attract customers and increase sales
c. calculate sum of total sales
d. a&b
e. all of above
[reveal-answer q=”341115"]Show Answer[/reveal-answer]
[hidden-answer a=”341115"]
Answer: d, pg. 555[/hidden-answer]
19. Which one of these assumptions do NOT qualify to create an ideal situation to use the Basic EOQ Model?
a. there are no quantity discount
b. there is only one product involved
c. demand requirements are unknown
d. lead time does not vary
e. none of the above
[reveal-answer q=”748601"]Show Answer[/reveal-answer]
[hidden-answer a=”748601"]
Answer: c, pg. 559[/hidden-answer]
20. Which one of these factors are NOT a determinant of the reorder point?
a. rate of demand
b. acceptable stock-out risk level to management
c. lead time variability
d. All of above are determinants of reorder point.
e. None of the above are determinants of reorder point
[reveal-answer q=”359241"]Show Answer[/reveal-answer]
[hidden-answer a=”359241"]
Answer: d, pg. 571[/hidden-answer]
21. “A physical count of items in inventory made at periodic intervals”, refers to _?
a. periodic system
b. perpetual inventory system
c. two bin system
d. universal product code
e. point of sale
[reveal-answer q=”110096"]Show Answer[/reveal-answer]
[hidden-answer a=”110096"]
Answer: a, pg. 553[/hidden-answer]
22. Which of the following is NOT a function of inventories?
a) to meet anticipated customer demand
b) to smooth production requirement
c) to work more closer with suppliers to coordinate shipments
d) to take advantage of order cycles
e) all of the above
[reveal-answer q=”358612"]Show Answer[/reveal-answer]
[hidden-answer a=”358612"]
Answer: c, pg. 549[/hidden-answer]
23. What is an inventory a stock or store of ?
a) ideas
b) goods
c) shipments

d) networks
e) a and b
[reveal-answer q="173328"]Show Answer[/reveal-answer]
[hidden-answer a="173328"]
Answer: b, pg. 549[/hidden-answer]
24. Which of the following is NOT an order size model?
a) basic economic order quantity model
b) economic production model
c) quantity discount model
d) single period model
e) none of the above
[reveal-answer q="186548"]Show Answer[/reveal-answer]
[hidden-answer a="186548"]
Answer: d, pg. 559[/hidden-answer]
25. Which is not an requirement for effective inventory management?
a) a system to keep track of the inventory
b) A reliable forecast of demand
c) effective transportation analysis
d) knowledge of lead times
e) a classification system
[reveal-answer q="257592"]Show Answer[/reveal-answer]
[hidden-answer a="257592"]
Answer: C, pg. 553[/hidden-answer]
26. Which of the following **is** a function of inventory?
a) To smooth production requirements
b) To meet anticipated customer demand
c) Decouple operations
d) both a and b
e) all of the above
[reveal-answer q="394542"]Show Answer[/reveal-answer]
[hidden-answer a="394542"]
Answer: E, pg. 551-552[/hidden-answer]
27. Which of the following (is/are) a result of a company's failure to manage their inventory properly?
a) Decline in Level of customer service
b) Increase in Ordering,carrying, and storage costs
c) Stock-outs or overstock
d) both a and c
e) all of the above are results of improperly managing inventory
[reveal-answer q="944316"]Show Answer[/reveal-answer]
[hidden-answer a="944316"]
Answer: E, pg. 553[/hidden-answer]
28. Little's Law states**:**
a) The average amount of inventory in a system is constant.
b) The average amount of inventory in a system is equal to the product demand rate and time in the system.
c) The average amount of inventory in a system is equal to last year's forecast.
d) The average amount of inventory cannot be predicted.
e) All the above

[reveal-answer q=”182699"]Show Answer[/reveal-answer]
[hidden-answer a=”182699"]
Answer: B, pg. 552[/hidden-answer]
29. Which of the following is/are acceptable inventory counting systems**?**
a) Perpetual
b) Normal
c) Periodic
d) both a and b
e) both a and c
[reveal-answer q=”300818"]Show Answer[/reveal-answer]
[hidden-answer a=”300818"]
Answer: E, pg. 553-554[/hidden-answer]
30. Which of the following is NOT a requirement for manager to effectively managing inventories?
a) Income from operations must equal income from financing activities
b) Have a reliable forecast of demand that include an indication of past forecast orders
c) Know lead times and lead time variability
d) Have a classification system for inventory items
e) all of the above
[reveal-answer q=”314100"]Show Answer[/reveal-answer]
[hidden-answer a=”314100"]
Answer: A, pg. 553[/hidden-answer]

Unit 9 Activity and Grading Rubric

In this activity, you will continue working on your operations management plan. This final part of your operations management plan requires that you identify the critical factors involved in inventory control systems. After developing this final portion of your plan, compile all of the parts you have work on in the activities for Units 1-9 to develop one comprehensive business plan.

Learning Outcome
Identify the critical factors involved in inventory control systems.

Specifications:

- 2-3 page paper
- Created in a Word document
- Follows APA, 6th edition formatting
- Includes a Reference page for cited sources

Instructions: The operations plan will conclude with a discussion of how you intend to receive, catalog, and store the inventory necessary for the operation of your organization. Write a 2-3 page paper that summarizes your plans for inventory control for your organization. In your operations management plan you should address all aspects of how you intend to acquire, control, and account for your inventory. Make sure that you address the following:

1. Identify the challenges you assume you will face in receiving your inventory (i.e. shipping delays, lack of capital, change in consumer demand, etc.).
2. Explain whether or not you will implement a cataloging system with your inventory or a work schedule to effective place employees in departments that relate to their skills and abilities?
3. Discuss the ways in which you will store your inventory to ensure you have proper levels to meet consumer needs or if you can authorize employees to obtain additional supply (if needed)?

"Array 1.6"

Instructions: You may download free software from the link above that helps you get an idea of how a business controls inventory. Consider applying your results with this software to your 2-3 page paper that discusses your inventory plan.

After you have completed this part of the activity, you should combine your previous papers and this one, assembling the information into one final paper for a complete operations management plan. Make any revisions necessary once you combine the documents into one solid plan.

Please score your paper or have a friend score your paper using the following “rubric,” or “scoring guide.” The levels will equate to the following letter grades:

4 = A; 3 = B; 2 = C; 1 = D; and 0 = F

Level	Criterion
	Research and Documentation (40%)
4	Any research sources utilized should come from scholarly sources (i.e. textbooks, scholarly articles, etc.). This activity should include at least 4 scholarly sources. Any in-text citations MUST be cited in APA format using the APA Manual 6th edition. You should also include a References page, also in APA format, at the end of your paper to cite any sources used.
3	The paper uses at least three scholarly sources to support your content, but it does not meet the minimum requirement for 4 sources.
2	Three or more popular sources (i.e. newspapers, internet sites, magazines, etc.) make up a majority of the references to support your content. The paper lacks credible, scholarly sources and does not meet the minimum number of sources required.
1	The paper includes one or two sources. The paper lacks the use of credible, scholarly sources and may focus on using popular sources. The number of sources used does not meet the minimum requirement (4 sources) and the resources used may not fully support the content of your paper.
0	The paper fails to cite referenced sources, or does not include any research or sources to support ideas. The paper is based off of non-original content.
	Analysis and Argument (40%)
4	Your paper addresses the three questions in the instructions with the use of supporting evidence and specific details and explanation. You effectively address the following:Identify the challenges you assume you will face in receiving your inventory (i.e. shipping delays, lack of capital, change in consumer demand, etc.). Explain whether or not you will implement a cataloging system with your inventory or a work schedule to effective place employees in departments that relate to their skills and abilities? Discuss the ways in which you will store your inventory to ensure you have proper levels to meet consumer needs or if you can authorize employees to obtain additional supply (if needed)?
3	The content addresses only some of the questions presented in the instructions section and reflects minimal original thought and /or critical analysis relative to the business.
2	The content is vague and is weakly supported by researched evidence. The essay lacks critical analysis relative to the business.
1	The content does not address the required elements; ideas presented are not supported by research or critical analysis.
0	There is a lack of critical analysis for the operation management plan, and/or the essay does not address the business content from the Unit 1 Activity.
	Grammar/Style (15%)
4	The content contains a maximum of two grammatical, citation, and punctuation errors. The ideas are concise and presented in a logical manner that is easy for the reader to follow.
3	The content contains three or four grammatical, citation, punctuation, and/or spelling errors. The sentence structure flows in a concise, logical manner.
2	The paper contains more than four grammatical, citation, punctuation and/or spelling errors that distract the reader from the comprehension of ideas being presented.
1	The paper demonstrates poor writing skills, reflected by lack of syntax and proper grammar, which makes ideas difficult to communicate. Ideas are not presented in a logical manner that is easy to follow.

0	The paper contains numerous grammatical, citation, punctuation, and/or spelling errors.
	Format (5%)
4	The paper should properly formatted (paragraph style, margins, etc.), using the APA Manual, 6th edition. The content is typed in MS Word format, labeled with the student's name and the activity title/unit number, and a reference section to cite any outside sources used.
3	The paper meets most of the requirements for formatting, using the APA Manual, 6th edition, though may contain some errors.
2	The paper lacks proper formatting, based on the APA Manual, 6th edition, and it may use another style of formatting (i.e. MLA, Chicago, etc.).
1	The paper is typed in a format other than MS Word. A style of formatting other than APA may be used, or there are numerous formatting errors that distract the reader's comprehension.
0	The formatting does not comply with the APA Manual, 6th edition and is not created in MS Word.

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