**Chapter 15**

**OPERATIONS, QUALITY, AND PRODUCTIVITY**

Chapter Outline

1. TIME-BASED COMPETITION AND OPERATIONS
2. CLASSIFYING OPERATIONS SYSTEMS
3. Tangibility of Products
4. Level of Customer Involvement
5. Operations Flexibility
6. Resources and Technology Management
7. Multiple Classifications
8. DESIGNING OPERATIONS SYSTEMS
9. Product Mix and Design
10. Facility Layout
11. Facility Location and Capacity Planning
12. Managing Operations Systems AND THE SUPPLY CHAIN
13. Planning Schedules and Project Management
14. Inventory Control
15. Materials Requirement Planning (MRP)
16. Supply Chain Management
17. Quality Control
18. PRODUCTIVITY AND THE BALANCED SCORECARD
19. Measuring and Increasing Productivity
20. The Balanced Scorecard

Changes from 5e to 6e Chapter 15

* Chapter 15 was Chapter 14 with the same title in the 5e.
* The chapter has been updated, and 95 percent of the references are new to this edition.
* The first section, Time-Based Competition and Operations, has been rewritten and now includes a short discussion on the transition from manufacturing to services and how technology and 3D printing are transforming operations and will bring back some jobs to the United States.
* The subsection on Resources and Technology Management has been shortened by deleting the third-level heading discussion on Ways of Managing Manufacturing Technology and Ways of Managing Service Technology.
* The subsection on Facilities Layout has been rewritten with new examples to better distinguish between the four layouts.
* The two subsections Facility Location and Capacity Planning have been combined and shortened.
* The subsection Productivity Measures for the Functional Areas has been deleted, including Exhibit 15–11 Financial Area Ratios and its accompanying Applying the Concept.

Lecture Outline

**Note:** The textbook supplements include a PowerPoint presentation for each chapter, which can be used rather than or in addition to this lecture outline.

1. TIME-BASED COMPETITION AND OPERATIONS

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| Learning Outcome (LO) 15–1. Describe time-based competition and why it is important.  Time-based competition refers to the use of strategies to increase the speed with which an organization goes from creativity to delivery. It is important because speed gives an organization a first-mover competitive advantage. |

**Time-based** **competition** refers to the use of strategies to increase the speed with which an organization goes from creativity to delivery. An organization that can turn a creative idea into an innovation, sell it, and deliver it to increase customer value has a first-mover competitive advantage. The time required to complete this process is called *throughput time*.

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| WORK APPLICATION Example student answer  **15–1. Is your present or past organization concerned about time-based competition? If so, what functional areas are primarily responsible for speed?**  I work for Domino’s Pizza, which is concerned about time-based competition. Both the pizza makers and delivery people still have to work fast to deliver, even though Domino’s no longer has its guaranteed 30-minute delivery. |

**Operations** is the function concerned with transforming resource inputs into product outputs.A **product** is a good, a service, or a combination of the two. Exhibit 15–1 lists the ways systems to manage operations are classified, designed, and managed.

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| **Review Question (RQ) 15–1. What does the operations department do?**  The operations department transforms resource inputs into product outputs. |

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| **Communication Skills Question (CSQ) 15–1. Why are some companies (such as Apple) innovative when it comes to changing products and processes, while others (such as Eastman Kodak) are slow to innovate and change?**  Answers will vary. |

1. CLASSIFYING OPERATIONS SYSTEMS

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| LO 15–2. Explain the differences among operations systems with respect to tangibility of products, levels of customer involvement, operations flexibility, and management of resources and technology.  A product can be a tangible good, an intangible service, or a combination of the two. The three levels of customer involvement refer to whether a standard product is made to stock, customer-specific products are made to order, or a standard product with some customized features is assembled to order. Operations flexibility refers to whether the products are produced continuously in nondiscrete units, repetitively on an assembly line for one product, in batches with the same resources used for multiple products, individually to customer specifications at the seller’s facilities, or individually over a long period of time at sites including the customer’s facilities. Resources may be capital intensive (if machines do most of the work), labor intensive (if human resources do most of the work), or a balance of the two. |

Operations systems can be classified by the tangibility of products, level of customer involvement, operations flexibility, and management of resources and technology.

1. **Tangibility of Products**

The *tangibility of products* refers to whether the products are tangible, intangible, or mixed.

1. **Tangible Products**

Goods are *tangible products*.

1. **Intangible Products**

Services are *intangible products*.

1. **Mixed Products**

*Mixed products* are made up of both tangible products and intangible services.

1. **Level of Customer Involvement**

The level of **customer involvement** refers to the amount of input from customers, which determines whether operations are make-to-stock, assemble-to-order, or make-to-order.

1. **Make-to-Stock (MTS) Operations**

*Make-to-stock operations* produce products with a common design and price in anticipation of demand. Therefore, there is a low level of customer involvement.

1. **Assemble-to-Order (ATO) Operations**

*Assemble-to-order operations* produce a standard product with some customized features. Some services and goods, such as those built with optional features, can be produced only after the receipt of an order. Therefore, there is a moderate level of customer involvement.

1. **Make-to-Order (MTO) Operations**

*Make-to-order operations* are carried out only after an order has been received from a specific customer. Here, there is a high level of customer involvement.

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| **RQ 15–2. Is the level of customer involvement highest with make-to-stock, assemble-to-order, or make-to-order operations?**  Make-to-order operations are carried out only after an order has been received from a specific customer. Therefore, it has the highest level of customer involvement. |

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| **CSQ 15–2. Can a standard make-to-stock product (such as soda) also be made to order? If so, how?**  Yes. It is being done now by changing repetitive-process operations outputs to batch-process operations outputs. For example, you can now have your name put on M&M candy and NIKE sneakers. |

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| APPLYING THE CONCEPT Answers  AC 15–1—Level of Customer Involvement  c 1. Make-to-order. The copies are made and sent only after an order has been received from the customer. Therefore, there is a high level of customer involvement.  a 2. Make-to-stock. The iPad is a standard product. The customer has a low level of involvement because he or she either takes the product as is or doesn’t buy it.  c 3. Make-to-order. The hair is cut to the made-to-order specifications of the customer. The customer has to be there to cut the hair, which requires a high level of involvement.  a 4. Make-to-stock. The can of soda is a standard product. The customer has a low level of involvement because he or she either takes the product as is or doesn’t buy it.  b 5. Assemble-to-order. An ice cream cone is a standard product. The coffee ice cream in a sugar cone is a customized feature. The customer has to be there to order it; therefore, there is a moderate level of involvement. |

1. **Operations Flexibility**

**Operations flexibility** refers to the amount of variety in the products an operation produces, which determines whether the products are produced continuously, repetitively, in batches, or individually.Flexibility is based on product volume (how many units of one product are produced) and variety (how many different products the operation produces).

1. **Continuous-Process Operations (CPO)**

*Continuous-process operations* produce outputs that are not in discrete units. They tend to produce goods rather than services. With little to no variety and high volume, continuous-process operations are the least flexible of the operations systems. Therefore, they are used for made-to-stock goods.

1. **Repetitive-Process Operations (RPO)**

*Repetitive-process operations* produce outputs in an assembly-line structure, where employees and equipment are quite specialized in function and location. Each unit of output follows the same path through labor and equipment. Repetitive-process operations have some variety and a high volume of similar units. Therefore, they are primarily used for made-to-stock or assembled-to-order goods.

1. **Batch-Process Operations (BPO)**

*Batch-process operations* produce different outputs with the same resources. When both the volume and the variety of products are moderate, flexibility is needed, especially if the organization cannot justify the investment required to dedicate labor or equipment to a single product. With moderate variety and volume of similar units, batch-process operations are primarily used for made-to-stock or assembled-to-order goods.

Batch-process operations require more controls than do continuous-process and repetitive-process operations to monitor the coordination of inputs, the transformation process, and the inventory of finished outputs. Businesses using batch-process operations have to be sure not to sell all of one product or have too much of one product in stock.

1. **Individual Process Operations (IPO)**

*Individual process operations* produce outputs to customer specifications. They have high variety and low volume and so are used for made-to-order goods and services. Used by the large majority of retailers and service organizations, individual process operations have the most flexibility.

Like batch-process operations, individual process operations require controls to monitor the coordination of inputs and the transformation process.

1. **Project Process Operations (PPO)**

*Project process operations* are another type of process operation that is low in volume and high in variety. They produce outputs that require a relatively long period of time to complete. Project process operations are commonly completed by sending the resources to the customer’s site rather than working on the project at the seller’s facilities.

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| **RQ 15–3. Which type of process operation is the most flexible? Least flexible?**  Individual-process operations are the most flexible and continuous-process operations are the least flexible. |

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| **RQ 15–4. Which type of process operation is most commonly used by retailers and service organizations?**  Individual-process operations are most commonly used by retailers and service organizations. |

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| APPLYING THE CONCEPT Answers  AC 15–2—Flexibility of Operations  e 6. PPO. Project process operations are used in the construction industry.  b 7. RPO. Automobiles are commonly made on an assembly line.  e 8. PPO. Swimming pools are installed at the customer’s site.  a 9. CPO. Asphalt is not made in discrete units.  c 10. BPO. Because Trident has a variety of flavors that can be easily made on the same machine, it probably makes its gum in batches. |

1. **Resources and Technology Management**

Operations is the function through which inputs are transformed into product outputs, but**technology** is the process used to transform inputs into outputs. Manufacturing technology can be used to create a competitive advantage. Important operations decisions concerning the management of resources and technology include how labor and capital intensive the operations to make the product will be, how the customer will be served, and how the manufacturing or service technology will be managed.

1. **Intensity**

In *capital-intensive operations*, machines do most of the work. Manufacturing companies that use continuous and repetitive operations processes are generally capital intensive. These companies tend to use high levels of technology, much of which has been developed by other companies.

In *labor-intensive operations*, human resources do most of the work. Organizations that use individual process operations tend to be labor intensive. Retail and service organizations are generally less capital intensive than manufacturing firms and tend to use lower levels of technology.

Manufacturing firms use a balance of capital and labor in batch- and individual-process operations, because it takes skilled workers to use flexible machines. Many large retailers have a balance of capital (because of the high cost of renting space at malls or buying a store in a good location) and labor (because they have a lot of employees).

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| **RQ 15–5. Are services generally more capital or labor intensive than manufacturing? Why?**  Service organizations are generally less capital intensive than manufacturing firms because they tend to use lower levels of technology. |

1. **Ways of Serving Customers**

Customers can be served by people, machines, or both.

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| WORK APPLICATION Example student answer  **15–2. Using Exhibit 15–2, identify the operations system where you work or have worked based on product tangibility, customer involvement, flexibility, and resources.**  I work for Sears.  (1) We sell tangible products, but we offer service warranties on our appliances; therefore, we sell goods with a service, or mixed products.  (2) We are a retailer that buys and sells make-to-stock items.  (3) Sears uses batch-process operations to buy and individual process operations to sell.  (4) Sears is a balanced-intensity operation. There are high costs of buying a store in a good location, but the stores always have a lot of employees. |

1. **Multiple Classifications**

Exhibit 15–2 shows the four criteria for classifying operations systems. Notice that the focus on the left side of the exhibit is on manufacturing goods, while the focus on the right side is on providing services. However, it is not always easy to classify an organization’s operations system, either because it falls at some intermediate point on the continuum in Exhibit 15–2 or because it encompasses more than one type of operation.

1. DESIGNING OPERATIONS SYSTEMS

In a changing environment, operations systems must be continually redesigned. The interrelated areas of product mix and design, facility layout, facility location, and capacity planning must all be considered.

1. **Product Mix and Design**

Based on the organization’s mission and objectives, top-level managers select the product mix. The *product mix* includes the number of product lines, the number of products offered within each line, and the mixture of goods and services within each line.

*Product design* refers to new or improved product development. Successful companies integrate design and manufacturing rather than treating them as separate steps in product development. Many successful companies include suppliers and customers in the design process to help ensure the success of new products.

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| **CSQ 15–3. Is the trend toward broader product mix with unrelated diversification? Why or why not?**  No. The general trend is to keep the product mix to related diversification. The major reason for this trend is globalization. To be successful globally, many companies are specializing by staying with their core competencies. |

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| WORK APPLICATION Example student answer  **15–3. List the product mix for an organization for which you work or have worked. Be sure to identify the number of major product lines, the number of products within one of the major lines offered, and the mixture of goods and services within that one major line.**  I work at McDonald’s. There are eight different major product lines at McDonald’s: sandwiches, side items and snacks, chicken (breast strips and McNuggets), salads/dressings, breakfast, desserts, McCafé, and beverages. Within the breakfast category, there are breakfast sandwiches (McMuffins and McGriddles), breakfast burritos, and additional breakfast items such as Hotcakes, hash browns, and Cinnamon Melts. |

1. **Quality Is a Virtue of Design**

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| LO 15–3. Discuss what is meant by “quality is a virtue of design.”  “Quality is a virtue of design” means that if products are well designed, with cross-functional team input to ensure customer value, there will be fewer operations problems, the product will be easier to sell, and servicing the product will be less costly. |

The throughput stages, Exhibit 15–3, must be well coordinated and controlled. As you can see, the first stage is to design the product. “Quality is a virtue of design” means that if products are well designed, with cross-functional team input to ensure customer value, there will be fewer operations problems, the product will be easier to sell, and servicing the product will be less costly. Therefore, it is important for all functional areas to work together on the design of new products.

1. **Balancing Time-Based Competition and Design**

While companies need to increase innovation and speed products to market, they also need to have quality products to succeed. Rushing through the design process can lead to operations problems that can’t be easily fixed, in turn leading to sales problems and high repair costs. Thus, it can result in companies’ losing money rather than making profits.

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| **RQ 15–6. Why is it important to balance time-based competition and design?**  While companies need to increase innovation and speed products to market, they also need to have quality products to succeed. Rushing through the design process can lead to operations problems that can’t be easily fixed, in turn leading to sales problems and high repair costs. |

1. **Facility Layout**

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| LO 15–4. Explain product, process, cellular, and fixed-position facility layouts in terms of their level of customer involvement and flexibility.  Product layout is associated with make-to-stock and assemble-to-order levels of customer involvement and relatively inflexible repetitive or continuous-process operations. Process layout is associated with a make-to-order level of customer involvement and flexible individual process operations. Cellular layout is associated with make-to-stock and assemble-to-order levels of customer involvement and relatively flexible batch-process operations. Fixed-position layout is associated with make-to-order and assemble-to-order levels of customer involvement and flexible project process operations. |

*Facilities* are the physical resources used in the operations process. The building, machines, furniture, and so on are part of the facility. **Facility layout** refers to the spatial arrangement of physical resources relative to each other. Operations use product, process, cellular, or fixed-position layouts. The type of facility layout selected is based on the classification of the operations system and the product design. An important consideration in layout is the flow of the product throughout its transformation.

1. **Product Layout**

*Product layout* is associated with make-to-stock and assemble-to-order levels of customer involvement, relatively inflexible repetitive-process or continuous-process operations, and capital intensity.

Organizations with high volume and low variety have to decide what the sequence of assembly-line flow will be.

1. **Process Layout**

*Process* or *functional, layout* is associated with a make-to-order level of customer involvement, flexible individual-process operations, and labor intensity or a balanced intensity.

Organizations with high variability and low volume whose products/customers have different needs and use only some processes/functions have to decide how the layout should be arranged.

1. **Cellular Layout**

*Cellular layout* is associated with make-to-stock and assemble-to-order levels of customer involvement, relatively flexible batch-process operations, and a balanced intensity.

Organizations with products of moderate variability and volume must decide how to group technology so that all the activities involved in creation of a product are located near one another. Grouping technology into cells provides some of the efficiencies of both product and process layouts. Multiple cells make it easy for employees with different skills to work together to deliver the final product.

1. **Fixed-Position Layout**

*Fixed-position layout* is associated with make-to-order and assemble-to-order levels of customer involvement, flexible-project-process operations, and balanced intensity.

Organizations with low-volume products that take a relatively long time to complete must determine the sequence of steps required of workers during the construction of each unit.

Exhibit 15–4 compares the four types of layouts with respect to their level of customer involvement and flexibility of operations and provides an illustration of each systems process.

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| **RQ 15–7. Which two facility layouts are the most flexible? Which two layouts are the least flexible?**  The process and cellular layouts are the most flexible. The product and fixed-position layouts are the least flexible. |

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| **CSQ 15–4. Think about your career and the ideal job you are planning to obtain. Use Exhibit** 15–**2 to classify the operations systems and Exhibit** 15–**4 to identify the facility layout where you will work.**  Answers will vary. |

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| WORK APPLICATION Example student answer  **15–4. Identify the facility layout used where you work or have worked. Draw the physical arrangement of the facilities.**  I worked at a pharmacy, which used a process layout with three aisles. When you walked in the store, on your right was Aisle 1. On this aisle was the soda fountain with stools and a cash register at the end, followed by candy and cigarettes. On your left in Aisle 3 were newspapers and magazines, followed by personal products such as shampoo and deodorant. In front of you in the middle, Aisle 2, was a freezer with ice cream in it and boxes of chocolates on top of it. Behind the freezer, the center of the store was split in two. On the right was a greeting card display on two sides, and on the left was a display of over-the-counter drugs such as aspirin, digestive aids, and so on. Along the entire back wall was the pharmacy section with a cash register off-center to the right. |

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| APPLYING THE CONCEPT Answers  AC 15–3—Facility Layout  c 11. Cellular. A pizza is assembled by customer specifications and both labor and capital (oven) are used to prepare it. Also, most restaurants use a cellular layout for simplification to reduce cost and improve productivity.  a 12. Product. Most traditional automotive plants use repetitive-process operations in which the automobiles are made on an assembly line.  a 13. Product. DVD players are most likely made on an assembly line at RCA.  d 14. Fixed-position. The house would be built at the site by the crew.  b 15. Process. Fingernails have a make-to-order level of customer involvement with individual process operations. |

1. **Facility Location and Capacity Planning**

*Location* is the physical geographic site of facilities. The facility location must be determined based on the classification of the operations system and the organization’s product mix, layout requirements, and capacity planning. Major factors that are considered when making the location decision include cost; proximity to inputs, customers, and/or competitors; transportation; access to human resources; and number of facilities.

NOTE: The information below is taken from the 5e and is no longer in the textbook, but you can use it to get into more detail.

1. **Cost**

Cost includes the cost of buying and renting land and the facility, as well as operating expenses such as utilities, taxes, and insurance.

1. **Proximity to Inputs, Customers, and/or Competitors**

Location is key for businesses. They must take into consideration their proximity to inputs needed, where they will draw the most customers, and where their competitors are located.

1. **Transportation**

Manufacturers need access to air, rail, truck, and water transportation to get inputs and to deliver outputs.

1. **Access to Human Resources**

Certain types of skilled labor can be found more easily in certain locations. Another consideration is that the cost of labor can be much lower in countries other than the United States.

1. **Number of Facilities**

Global companies have headquarters in one country and facilities in others. Companies need to determine the right number of facilities for ease of distribution.

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| JOIN THE DISCUSSION: ETHICS & SOCIAL RESPONSIBILITY – 15–1  Factory Conditions  Answers will vary based on opinion. |

**Capacity** is the amount of products an organization can produce.

In most cases, capacity planning is done under conditions of uncertainty and high risk (Chapter 3), because it usually requires a large capital investment and is based on a long-term sales forecast. After capacity is set, some scheduling techniques can be used to help optimize it.

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| **RQ 15–8. Why is capacity planning so important?**  Capacity planning is a decision made under conditions of uncertainty and high risk, because it usually requires a large capital investment. Too large or too small a facility will have negative effects on the business. |

1. MANAGING OPERATIONS SYSTEMS AND THE SUPPLY CHAIN

After operations systems have been designed, they must be managed. The principles of organization—authority, delegation, and especially organizational and job design (Chapter 5)—must be used, as well as the leadership theories in Chapter 9.

1. **Planning Schedules and Project Management**

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| LO 15–5. Describe the similarities and differences among the planning sheet, Gantt chart, and PERT network.  Similarities include the fact that all three are scheduling techniques and list activities that must be performed to accomplish an objective. Activities are listed in sequence, with the time needed to complete each. The primary differences concern their format and use. Planning sheets state an objective and list the sequence of activities required to meet the objective, when each activity will begin and end, and who will complete each activity. Gantt charts use bars to graphically illustrate a schedule and progress toward the objective over a period of time. Gantt charts, like planning sheets, are appropriate when independent sequential steps are needed to accomplish the objective. The Gantt chart has an advantage over the planning sheet in that it places progress toward the objective on the chart as a control technique. PERT is a network scheduling technique that illustrates the dependence of activities. When some activities are dependent and some independent, PERT is more appropriate. |

*Scheduling* is the process of listing activities that must be performed to accomplish an objective; the activities are listed in sequence, along with the time needed to complete each one. Scheduling answers the planning questions: Which employees will make which products? What specific products will be produced? When will they be produced? Where will they be produced? How will they be produced? How many of each will be produced?

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| **RQ 15–9. Why is scheduling important?**  Scheduling is the process of listing activities that must be performed to accomplish an objective. Scheduling answers the planning questions: Which employee will make which products? What specific products will be produced? When will they be produced? Where will they be produced? How will they be produced? How many of each will be produced? |

An important part of scheduling is routing. **Routing** is the path and sequence of the transformation of a product into an output. Routing for each of the four facility layouts is illustrated with arrows in Exhibit 15–4. Notice that with process and cellular layouts, routing is complex.

**Priority scheduling** is the continuing evaluation and reordering of the sequence in which products will be produced. The method of priority scheduling depends on the layout used. Three simple methods are used to schedule operations:

* ***First come–first served.*** Jobs are scheduled in the order in which they are received. This method is common in service organizations.
* ***Earliest due date.*** The job with the earliest promised delivery date is scheduled first.
* ***Shortest operating time.*** Jobs that take the least amount of time are scheduled first.

Many organizations use a combination of the three methods.

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| WORK APPLICATION Example student answer  **15–5. Identify which priority scheduling method(s) the organization for which you work or have worked uses.**  I work in a supermarket. It uses the first come–first served method, as people are waited on in the order they get in line. |

1. **The Planning Sheet**

**Planning sheets** state an objective and list the sequence of activities required to meet the objective, when each activity will begin and end, and who will complete each activity. The planning sheet in Exhibit 15–5 shows the transformation process for a monthly marketing letter, which is mailed to 300 potential customers.

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| WORK APPLICATION Example student answer  **15–6. Give an example of a project in an organization for which you work or have worked that is suitable for scheduling using the planning sheet.**  The Mail Box store taught me how to prepare mass mailings that would go out in bulk mail. The manager just told me the procedural steps and went over them multiple times. If Mail Box used the planning sheet, the manager could give it to new people to train them to do the job. |

1. **Gantt Chart**

**Gantt charts** use bars to graphically illustrate a schedule and progress toward the objective over a period of time. The different activities to be performed are usually listed vertically, with time shown horizontally. The resources to be allocated, such as people or machines, are also commonly shown on the vertical axis. Gantt charts, like planning sheets, are appropriate when independent sequential steps are needed to accomplish the objective. The Gantt chart has an advantage over the planning sheet in that it places progress toward the objective on the chart as a control technique. In other words, a Gantt chart is both a planning and a control tool. Another important advantage of the Gantt chart over the planning sheet and PERT is that it can show multiple projects on one chart. This helps in prioritizing and scheduling project activities that use the same resources.

Exhibit 15–6 illustrates a Gantt chart for multiple orders in an operations department.

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| **RQ 15–10. What does a Gantt chart show that a planning sheet and PERT network don’t show?**  The Gantt chart has an advantage over the planning sheet in that it places progress toward the objective on the chart as a control technique. Another important advantage of the Gantt chart over the planning sheet and PERT is that it can show multiple projects on one chart. |

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| WORK APPLICATION Example student answer  **15–7. Give an example of a project in an organization for which you work or have worked that would be appropriate to schedule using a Gantt chart.**  I was an intern at Springfield Marketing Services. On a wall in the office was a giant Gantt chart that showed the schedule of all training programs offered over the next six months by room number used for the training. |

1. **Performance Evaluation and Review Technique (PERT)**

Multiple activities are considered to be independent when they can be performed simultaneously; they are considered to be dependent when one must be completed before the next activity can begin. Planning sheets and Gantt charts are useful tools when the activities follow each other in a dependent series. However, when some activities are dependent and some are independent, PERT (critical path) is more appropriate. **PERT** is a network scheduling technique that illustrates the dependence of activities. Exhibit 15–7 shows a PERT network.

The key components of PERT are activities, events, times, and the critical path. With complex projects, it is common to have multiple activities represented as one event. The **critical path** is the most time-consuming series of activities in a PERT network. The critical path is important to know because it determines the length of time it will take to complete a project. Any delay in the steps in the critical path will delay the entire project. The cost of each activity is sometimes shown with the time.

The following steps explain how the PERT network in Exhibit 15–7 was completed.

**Step 1. List all the activities/events that must be completed to reach the specific objective.** Assign a letter to each one.

**Step 2. Determine the time it will take to complete each activity/event.**

**Step 3. Arrange the tasks on the diagram in the sequence in which they must be completed.**

**Step 4. Determine the critical path.**

To summarize, planning sheets and Gantt charts are commonly used to develop procedures for routine standing plans, whereas PERT is commonly used for single-use program plans for a complex project with dependent activities. However, all three types of schedules can be used for either standing or single-use plans.

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| **RQ 15–11. When would you use a PERT network rather than a Gantt chart?**  You would use a PERT network when you have some activities that are dependent and some that are independent. |

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| **CSQ 15–5. Assume you are planning a major event or project, such as a big wedding. (If you have an actual future event or project, use it rather than selecting an assumed event.) Would you use the planning sheet, Gantt chart, or PERT to plan and control the event? Why? Identify the major things that you need to plan for and make, and put them on the actual form using either Exhibit 15–5, 15–6, or 15–7 as a guide.**  Answers will vary. |

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| WORK APPLICATION Example student answer  **15–8. Give an example of a project in an organization for which you work or have worked that would be appropriate to schedule using a PERT network.**  I was in the Navy, and PERT was actually developed for use in building the Polaris submarine weapon system back in 1958. |

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| APPLYING THE CONCEPT Answers  AC 15–4—Scheduling Tools  c 16. PERT network. Building a new submarine will have both dependent and independent activities.  b 17. Gantt chart. Gantt charts are good for allocating room resources to courses so you can see at a glance which rooms are being used when, why, and by which program.  b 18. Gantt chart. Gantt charts can show the progress of multiple products.  c 19. PERT network. Building a house requires a set sequence of relatively complex activities.  a 20. Planning sheet. Planning sheets are good for developing procedures. |

1. **Inventory Control**

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| LO 15–6. Explain the relationship among inventory control, just-in-time (JIT) inventory, and materials requirement planning (MRP).  Inventory control is the process of managing raw materials, work in process, finished goods, and in-transit goods. JIT is an inventory method in which necessary parts and raw materials are delivered shortly before they are needed. MRP is a system that integrates operations and inventory control. JIT is part of inventory control, and both are part of MRP. |

**Inventory** is the stock of materials held for future use. Thus, inventory is an idle resource. Inventory is needed to transform inputs into outputs. Inventory control, also called *materials control*, is an important responsibility of the operations manager, because in many organizations, purchasing, moving, storing, insuring, and controlling materials is costly. Clearly, decisions that determine the control of materials through operations have a significant effect on whether a firm meets its objectives.

**Inventory control** is the process of managing raw materials, work in process, finished goods, and in-transit goods.

* ***Raw materials.*** Raw materials are input materials that have been received but have not yet been transformed in any way by the operations department.
* ***Work in process.*** Work in process is material that has had some transformation but is not yet an output.
* ***Finished goods.*** Finished goods are transformed outputs that have not yet been delivered to customers.
* ***In-transit (pipeline) goods.*** In-transit goods are finished goods being delivered to the customer.

Exhibit 15–8 illustrates how inventory control fits into the systems process.

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| **RQ 15–12. What are the four types of inventory?**  The four types of inventory include (1) raw materials, (2) work in process, (3) finished goods, and (4) in-transit goods. |

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| WORK APPLICATION Example student answer  **15–9. Identify the type of inventory and how it is controlled where you work or have worked.**  I worked at a company that manufactured boxes. We used pulp raw material that the purchasing department bought for us. The pulp was transformed into boxes quickly, but most boxes were sent to work-in-process inventory, which the labeling department took to put the name of the buyer on them before sending them to the shipping department as a finished good. Concurrent control was used to inspect the boxes as they were made. The shipping department kept the finished goods until they were ready to send out. The boxes were usually error-free, so very little rework control was needed. If any of the boxes were damaged (smashed, punctured, etc.) or lost while in transit to customers, we would replace the customer’s order free of charge. |

1. **Retailing and Services Inventory**

Retail inventory control, including *purchasing*, is concerned almost exclusively with finished goods for resale as is. However, many retailers do have in-transit inventory.

Most service organizations deal only with the finished-goods inventory they create by providing the service. However, some services have in-transit inventory.

1. **Just-in-Time (JIT) Inventory**

The objective of inventory control is to have the correct amount of all four types of inventory available when and where they are needed while minimizing waste and the total cost of managing and storing inventory. To accomplish this objective, many organizations now use JIT. **Just-in-time (JIT) inventory** is a method by which necessary parts and raw materials are delivered shortly before they are needed.

1. **Materials Requirement Planning (MRP)**

**Materials requirement planning (MRP)** is a system that integrates operations and inventory control with complex ordering and scheduling. MRP involves developing a process for ordering raw materials and components at the right time and in the right quantity so that they arrive shortly before their scheduled transformation into outputs and appropriate work in process is ready as needed. JIT is part of inventory control, which is part of MRP.

MRP is commonly used by companies that have different delivery systems and lead times.

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| **RQ 15–13. What does materials requirement planning integrate?**  Materials requirement planning (MRP) is a system that integrates operations and inventory control with complex ordering and scheduling. |

1. **Enterprise Resource Planning (ERP)**

ERP takes MRP a step further, as it collects, processes, and provides information about a firm’s entire enterprise*.* Ordering, product design, production, purchasing, inventory, distribution, human resources, receipt of payments, and forecasting of future demand are incorporated into one network system.

1. **Economic Order Quantity (EOQ)**

The EOQ is the optimal quantity of a product to order, determined on the basis of a mathematical model. The more often you order, the higher the ordering cost—but if you order less often, your holding cost goes up. By using the EOQ, you can minimize ordering and holding costs without running out of stock.

Calculating EOQs is a part of MRP. However, many small businesses that want to calculate EOQs don’t need MRP. Such businesses can determine EOQ using a calculator, as follows:

EOQ = =  =  =  = 353.55

where

EOQ = optimal quantity to reorder

*R* = total required over planning horizon (usually one year); here, 5,000

*S* = cost of preparing one order (or setup); here, $25

*H* = cost of holding one unit for the planning horizon; here, $2

1. **Supply Chain Management**

**Supply chain management** is the process of coordinating all the activities involved in producing a product and delivering it to the customer. To provide high-quality products at the lowest cost, supply chain management starts with forecasting demand for a product and then moves on to planning and managing supply and demand, acquiring materials, scheduling and producing the product, warehousing, controlling inventory, distributing the product, and delivering it. The final stage involves customer service. Raw materials, including component parts, are expensive for many manufacturers. Thus, keeping inventory costs down while ensuring that good-quality materials are available when needed is important in the supply chain. Just-in-time inventory is used to control costs and to avoid stocking inventories that may not be sold.

The supply chain includes every organization a firm buys supplies from, as well as those that help sell and deliver the products to final customers. Like any chain, the supply chain is only as good as its weakest link, so the firm needs to establish strong relationships throughout the chain. Good relationships are based on information, which is potentially the biggest driver of performance in the supply chain, as it directly affects the other three drivers—operations facilities, inventory, and transportation—enabling the entire chain to be more responsive and efficient.

1. **Radio-Frequency Identification (RFID) Technology**

*Radio-frequency identification (RFID)* is an automatic identification method, relying on strong and remotely retrieving data using devices called RFID tags. An RFID tag is an object that can be stuck on or incorporated into a product, animal, or person for the purpose of identification using radio waves.

RFID tags serve the same purpose as a bar code or a magnetic strip on the back of a credit card or ATM card; they provide a unique identifier for that object.

Today, a significant use of RFID is in supply chain management, improving the efficiency of inventory tracking and management. Benefits of using RFID include the reduction of labor costs, the simplification of business processes, and the reduction of inventory inaccuracies.

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| **CSQ 15–6. Many companies are now using radio-frequency identification (RFID) technology. RFID is revolutionary and is helping businesses improve supply chain management. However, critics are concerned about protecting people’s privacy. For example, with RFID, businesses will better know consumers’ shopping habits and purchases. Do you want businesses to know where you live and the products you have in your house? Explain.**  Answers will vary. |

1. **Quality Control**

**Quality control** is the process of ensuring that all types of inventory meet standards. As you can tell by the definition, quality control and inventory control overlap. The top row in Exhibit 15–8 shows the systems process steps, the second row shows the four inventory stages, and the third row shows the four types of quality control.

*Quality assurance* requires that you must “build in” quality; you cannot “inspect it in.”

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| **RQ 15–14. What is the relationship between inventory and quality control?**  Quality control is the process of ensuring that all types of inventory meet standards. |

1. **Customer Quality Control**

Exhibit 15–9 lists five rules that will help ensure quality customer service. If you follow these rules, you will increase your chances of developing effective human relations skills and ensuring a high-quality product for your customer.

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| **RQ 15–15. What are the five rules of customer relations?**  The five rules of customer relations are:  1. Put people before things.  2. Always be nice—no matter how busy you are.  3. Take your time with people.  4. Be polite; say “please,” “thank you,” and “you’re welcome.”  5. Don’t discriminate with your service (treat everyone well). |

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| **CSQ 15–7. What is your view of the quality of products you have purchased over the past year compared to previous years? Did you have to return and exchange products or have them repaired? Do you think that quality is getting better with time?**  Answers will vary. |

1. **TQM**

The four major TQM principles are (1) focus on delivering customer value, (2) continually improve systems and processes, (3) focus on managing processes rather than people, and (4) use teams to continually improve. A few of the differences between TQM and quality control follow:

TQM is much broader in scope than quality control because part of its core value is to make the job of everyone in the organization to improve quality. Under quality control, the operations department is solely responsible for product quality.

With TQM, quality is determined by customers, who compare actual use with requirements to determine value, or purchasing benefits. With quality control, quality is determined by the standards set for acceptability.

The focus in TQM is not on acceptance or rejection of the product but on continuous improvement. With quality control, if products don’t meet quality requirements, corrective action is taken to make them acceptable or they are rejected.

1. **The International Standards Organization**

The **International Standards Organization** **(ISO)** certifies firms that meet set quality standards. Both manufacturing and services sectors are applying for ISO certification to improve their management systems and operational control. JIT and TQM are part of ISO 9000 certification, as organizations must document policies that address quality management, continuous improvement, and customer satisfaction. Most multinational corporations have ISO 9000 certification, and they require the suppliers they do business with to be certified to ensure the quality of materials used.

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| JOIN THE DISCUSSION: ETHICS & SOCIAL RESPONSIBILITY – 15–2  Social Accountability International  Answers will vary based on opinion. |

1. **Six Sigma**

Six Sigma’s goal is only 3.4 defects or mistakes per million operations. *Sigma* is a letter from the Greek alphabet used to represent a statistical measure of deviations from a standard. Most companies operate at the Three-Sigma level of 66,000 defects per million. Six Sigma is grounded in math, statistics, data analysis, finance, and computer skills. There is a heavy emphasis on measurement and achieving measurable bottom-line results.

1. **Statistical Quality Control**

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| LO 15–7. Explain how statistical process control (SPC) charts and the exception principle are used in quality control.  The statistical process control chart is used to graph actual performance to see whether it is within an acceptable standard range. According to the exception principle, if performance is within the acceptable range, do nothing; if it is out of the control limits, take corrective action. |

*Statistical quality control* is a management science technique that uses a variety of statistical tests based on probability to improve quality of decision making. Statistics are employed to improve the probability of identifying and eliminating quality problems. The most common test is statistical process control, a standard TQM technique that is part of Six Sigma.

**Statistical process control (SPC)** aids in determining whether quality is within an acceptable standard range. It is called a process control because it is concurrent; quality is measured and corrected during the transformation process. SPC is used to monitor operations and to minimize variances in the quality of products. Implementing SPC requires four steps:

**Step 1. Set the desired quality standard and a range.** The range includes the highest (upper control limit, or UCL) and the lowest (lower control limit, or LCL) level of acceptable quality, with the desired standard in the middle. This desired standard is called the *mean*, which is an average. The narrower the range, the higher the quality consistency between products.

**Step 2. Determine the sampling technique and the frequency of measuring performance.** The *sampling technique* determines how many products will be inspected; the range is from 0 to 100 percent. Statistical models can help determine the percentage. As a general rule, the more critical it is to stay within quality range, the more frequent the measures and the larger the sample inspected.

**Step 3. Measure performance and plot it on an SPC chart.** The variance of each sample mean from the desired mean can then be statistically analyzed.

**Step 4. Use the exception principle.** Do nothing if performance is within the acceptable range, but take corrective action if it is out of the control limits.

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| WORK APPLICATION Example student answer  **15–10. Explain quality control in an organization where you work or have worked.**  I worked as an auto mechanic. The service manager would assign cars to be repaired. When we were done, the service manager would test-drive the car to make sure it was OK. If it was, he’d give it to the customer. If not, he’d bring it back to the mechanic to fix again. |

1. **Contributions by Quality Gurus**

The beginning of the quality revolution dates back to May 16, 1924, when Walter Shewhart wrote a memo to his boss at Bell Labs stating that he wanted to use statistics to improve the quality of Bell telephones. Shewhart started the focus on concurrent control by delegating the role of inspector to employees.

**W. Edwards Deming.** In the 1950s, W. Edwards Deming went to Japan to teach quality and is credited with being instrumental in turning Japanese industry into an economic world power. In fact, the highest Japanese award for quality is the Deming Prize. Deming’s contributions were strongest in statistical methods for quality control. He said that improving quality would automatically improve productivity and called for a focus on customer value and continuous improvement. He directed managers’ attention to the fact that most quality problems—up to 90 percent—are not the fault of employees; rather, the system is to blame. Deming developed the world-famous 14 points to improve quality.

**Joseph M. Juran.** Joseph M. Juran also went to Japan to help improve quality, a couple years after Deming, and also received the highest honor the emperor bestows on foreigners. He developed the Juran Trilogy: planning, control, and improvement. Juran stated that 20 percent of the reasons for out-of-control performance cause 80 percent of the quality problems. He called this the *Pareto principle*, more commonly known as the *80–20 rule*. When performance is out of control, manufacturers should first look at the usual “vital few” reasons (20 percent), and most of the time (80 percent) they will have a standing-plan solution.

**Armand V. Feigenbaum.** Armand V. Feigenbaum made his mark in the 1950s by publishing material on total quality control, now more commonly called TQM. Feigenbaum worked to fight the myth that maintaining quality is expensive and focused on improving quality as an important way to lower costs. In fact, he said that investing in quality improvement pays better dividends than any other investment a company can make, hence the emphasis on quality in capital budgeting.

**Philip B. Crosby.** Philip B. Crosby popularized the concepts “quality is free,” “do it right the first time,” and “zero defects” in the late 1970s. Crosby believed that it was possible, and necessary, to measure the costs of poor quality in order to combat the notion that quality was expensive. He stressed that quality is not only free but easy to achieve.

**Genichi Taguchi.** Genichi Taguchi advocated designing quality into each product. Hence, he emphasized quality as a virtue of design.

**(NOTE: not in textbook) Steven Kerr.** Although not a TQM guru, Steven Kerr contributed indirectly to TQM by popularizing the idea that “you get what you reward.” In other words, if you want people to do a quality job, you have to develop a system that really rewards employees for doing a quality job.

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| WORK APPLICATION Example student answer  **15–11. Are any of the gurus’ quality contributions used where you work or have worked? Explain how.**  I work for a Ford auto dealership. “Quality Is Job One” signs are on the walls. We are repeatedly told that the customer comes first (Deming) and to do the job right the first time (Crosby). The computerized service diagnostic equipment uses statistical quality control (Shewhart). If something is out of the acceptable standard range, we recommend having it repaired. Juran’s 80–20 rule is followed when repairing cars. Our dealership invests heavily in quality because winning quality awards helps sales (Feigenbaum). At Ford Motor Company, the Taguchi design focus is taken very seriously. |

1. PRODUCTIVITY AND THE BALANCED SCORECARD
2. **Measuring and Increasing Productivity**

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| LO 15–8. Describe how to measure productivity and list three ways to increase it.  Productivity is measured by dividing outputs by inputs. Productivity can be increased by (1) increasing the value of the outputs while maintaining the value of the inputs, (2) maintaining the value of the outputs while decreasing the value of the inputs, or (3) increasing the value of the outputs while decreasing the value of the inputs. |

1. **Calculating Productivity**

**Productivity** is a performance measure relating outputs to inputs.In other words, productivity is measured by dividing the outputs by the inputs. For example, suppose a trucking company wants to measure productivity of a delivery. The truck traveled 1,000 miles and used 100 gallons of gas. Its productivity was 10 miles to the gallon:





The inputs can be in a variety of forms. In the preceding example, the inputs were gallons of gas. Inputs could also be labor hours, machine hours, number of workers, the cost of labor, and so on.

Following is another fairly simple example involving measuring the productivity of an accounts payable department.

**Step 1. Select a base period of time, such as an hour, day, week, month, quarter, or year.** In this example we will use a week.

**Step 2. Determine how many bills were sent out during that period of time (outputs).** The records show that 800 bills were sent out.

**Step 3. Determine the cost of sending out the bills (inputs).** Determining cost can become complicated if you include overhead, depreciation, and so forth. In this instance, calculate cost based on direct labor charges for the three employees who are each paid $10 per hour. They each worked 40 hours during the week, or a total of 120 hours. The total cost is $10 per hour times 120 hours, or $1,200.

**Step 4. Divide the number of outputs (bills) by the inputs (labor costs) to determine the productivity rate of .67 (800 ÷ $1,200 = .67).** Performance is usually stated as a ratio (in this case, .67:1) or as a percentage (67%). It can also be stated as a labor cost per unit. To determine the *labor cost per unit*, reverse the process and divide the input by the output. In this case, it cost $1.50 to send out each bill ($1,200 ÷ 800).

1. **Calculating Productivity Percentage Changes**

The .67 productivity rate is set as the base standard. The next week, the accounting department again sent out 800 bills, but because of machine problems, concurrent corrective action of having employees work overtime was needed to meet the standard output, at an additional cost of $100. The productivity rate went down to .62 (800 ÷ $1,300). The labor cost per unit to $1.63 ($1,300 ÷ 800). To determine the percentage change, use this formula:

Current productivity rate 62

– Base standard productivity rate – 67

= Change 5

Change ÷ Base productivity rate = (5 ÷ 67) = .0746

There was a 7.46 percent decrease in productivity.

1. **Production versus Productivity**

It is important to calculate productivity rather than just production output, because it is possible to increase production but decrease productivity. For example, if the accounts payable department sends out 850 bills (production) but uses 10 hours of overtime to do so (time-and-a-half at $15.00 per hour × 10 hours = $150), productivity has decreased from .67 to .63 (850 ÷ 1,350). In other words, if you measure only output production and it increases, you can be fooled into thinking you are doing a better job when in reality you are doing a worse job.

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| **RQ 15–16. Why should you measure productivity rather than just production?**  If you measure only output production and it increases, you can be fooled into thinking you are doing a better job when in reality you may be doing a worse job because productivity has decreased. |

1. **Productivity Comparisons**

Productivity measures are more meaningful when they are compared to other productivity rates.

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| APPLYING THE CONCEPT Answers  AC 15–5—Measuring Productivity  .66:1 ratio, 66%, increase/**decrease** of 1.49% 21. 5,900 ÷ 9,000 = .6555  66 – 67 = –1  –1 ÷ 67 = –.0149  .69:1 ratio, 69%, **increase**/decrease of 2.99% 22. 6,200 ÷ 9,000 = .6888  69 – 67 = 2  2 ÷ 67 = .0299  .65:1 ratio, 65%, increase/**decrease** of 2.99% 23. 6,000 ÷ 9,300 = .6451  65 – 67 = –2  –2 ÷ 67 = –.0299  .70:1 ratio, 70%, **increase**/decrease of 4.48% 24. 6,300 ÷ 9,000 = .7000  70 – 67 = 3  3 ÷ 67 = .0448  .72:1 ratio, 72%, **increase**/decrease of 7.46% 25. 6,300 ÷ 8,800 = .7159  72 – 67 = 5  ÷ 67 = .0746 |

1. **Increasing Productivity**

There are three ways to increase productivity:

1. Increase the value of the outputs but maintain the value of the inputs (↑ O ↔ I).
2. Maintain the value of the outputs but decrease the value of the inputs (↔ O ↓ I).
3. Increase the value of the outputs but decrease the value of the inputs (↑ O ↓ I).
4. **The Balanced Scorecard**

The **balanced scorecard (BSC)** measures financial, customer service, and internal business performance, as well as learning and growth performance. All four dimensions of the scorecard are equally important, and results relate to one another through the systems effect. See Exhibit 15–10 for an overview of the BSC.

Employees develop a control system with targets, measures, outcomes, and initiatives to guide improvement in all four dimensions of the BSC. *Targets* are objectives (or metrics) that employees set to improve in the areas critical to success. *Measures* are compared to *outcomes* to determine whether targets are being achieved. *Initiatives* are the strategies and tactics (plans) designed to achieve targets.

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| **CSQ 15–8. The balanced scorecard (BSC) calls for measuring performance in four areas. If a business is making good profits, should it bother with the other three nonfinancing measures? Why or why not?**  Yes. Customer service performance, internal business performance, and learning and growth performance all contribute to financial performance. If you don’t know if you are satisfying your customers, you can lose them. If you don’t increase internal business performance, competitors may get an advantage. If you don’t have satisfied employees, they will not be motivated to work hard. |

LEARNING OUTCOMES AND ANSWERS

The chapter summary is organized to answer the learning objectives for Chapter 15. They are also found at the end of the chapter and can be used as short answer questions on exams.

*These learning objectives are included in the test bank in the concept section.*

15–1. **Describe time-based competition and why it is important.**

Time-based competition refers to the use of strategies to increase the speed with which an organization goes from creativity to delivery. It is important because speed gives an organization a first-mover competitive advantage.

15–2. **Explain the differences among operations systems with respect to tangibility of products, levels of customer involvement, operations flexibility, and management of resources and technology.**

A product can be a tangible good, an intangible service, or a combination of the two. The three levels of customer involvement refer to whether a standard product is made to stock, customer-specific products are made to order, or a standard product with some customized features is assembled to order. Operations flexibility refers to whether the products are produced continuously in nondiscrete units, repetitively on an assembly line for one product, in batches with the same resources used for multiple products, individually to customer specifications at the seller’s facilities, or individually over a long period of time at sites including the customer’s facilities. Resources may be capital intensive (if machines do most of the work), labor intensive (if human resources do most of the work), or a balance of the two.

15–3. **Discuss what is meant by “quality is a virtue of design.”**

“Quality is a virtue of design” means that if products are well designed, with cross-functional team input to ensure customer value, there will be fewer operations problems, the product will be easier to sell, and servicing the product will be less costly.

15–4. **Explain product, process, cellular, and fixed-position facility layouts in terms of their level of customer involvement and flexibility.**

Product layout is associated with make-to-stock and assemble-to-order levels of customer involvement and relatively inflexible repetitive or continuous-process operations. Process layout is associated with a make-to-order level of customer involvement and flexible individual process operations. Cellular layout is associated with make-to-stock and assemble-to-order levels of customer involvement and relatively flexible batch-process operations. Fixed-position layout is associated with make-to-order and assemble-to-order levels of customer involvement and flexible project process operations.

15–5. **Describe the similarities and differences among the planning sheet, Gantt chart, and PERT network.**

Similarities include the fact that all three are scheduling techniques and list activities that must be performed to accomplish an objective. Activities are listed in sequence, with the time needed to complete each. The primary differences concern their format and use. Planning sheets state an objective and list the sequence of activities required to meet the objective, when each activity will begin and end, and who will complete each activity. Gantt charts use bars to graphically illustrate a schedule and progress toward the objective over a period of time. Gantt charts, like planning sheets, are appropriate when independent sequential steps are needed to accomplish the objective. The Gantt chart has an advantage over the planning sheet in that it places progress toward the objective on the chart as a control technique. PERT is a network scheduling technique that illustrates the dependence of activities. When some activities are dependent and some independent, PERT is more appropriate.

15–6. **Explain the relationship among inventory control, just-in-time (JIT) inventory, and materials requirement planning (MRP).**

Inventory control is the process of managing raw materials, work in process, finished goods, and in-transit goods. JIT is an inventory method in which necessary parts and raw materials are delivered shortly before they are needed. MRP is a system that integrates operations and inventory control. JIT is part of inventory control, and both are part of MRP.

15–7. **Explain how statistical process control (SPC) charts and the exception principle are used in quality control.**

The statistical process control chart is used to graph actual performance to see whether it is within an acceptable standard range. According to the exception principle, if performance is within the acceptable range, do nothing; if it is out of the control limits, take corrective action.

15–8. **Describe how to measure productivity and list three ways to increase it.**

Productivity is measured by dividing outputs by inputs. Productivity can be increased by (1) increasing the value of the outputs while maintaining the value of the inputs, (2) maintaining the value of the outputs while decreasing the value of the inputs, or (3) increasing the value of the outputs while decreasing the value of the inputs.

WORK APPLICATION SAMPLE ANSWERS

(Most of the answers are actual student answers or based on student answers. You may give these answers as part of your lecture before, after, or in place of getting student answers.)

*These work applications are included in the test bank in the application section.*

15–1. **Is your present or past organization concerned about time-based competition? If so, what functional areas are primarily responsible for speed?**

I work for Domino’s Pizza, which is concerned about time-based competition. Both the pizza makers and delivery people still have to work fast to deliver, even though Domino’s no longer has its guaranteed 30-minute delivery.

15–2. **Using Exhibit 15–2, identify the operations system where you work or have worked based on product tangibility, customer involvement, flexibility, and resources.**

I work for Sears.

1. We sell tangible products, but we offer service warranties on our appliances; therefore, we sell goods with a service, or mixed products.
2. We are a retailer that buys and sells make-to-stock items.
3. Sears uses batch-process operations to buy and individual process operations to sell.
4. Sears is a balanced-intensity operation. There are high costs of buying a store in a good location, but the stores always have a lot of employees.

15–3. **List the product mix for an organization for which you work or have worked. Be sure to identify the number of major product lines, the number of products within one of the major lines offered, and the mixture of goods and services within that one major line.**

I work at McDonald’s. There are eight different major product lines at McDonald’s: sandwiches, side items and snacks, chicken (breast strips and McNuggets), salads/dressings, breakfast, desserts, McCafé, and beverages. Within the breakfast category, there are breakfast sandwiches (McMuffins and McGriddles), breakfast burritos, and additional breakfast items such as Hotcakes, hash browns, and Cinnamon Melts.

15–4. **Identify the facility layout used where you work or have worked. Draw the physical arrangement of the facilities.**

I worked at a pharmacy, which used a process layout with three aisles. When you walked in the store, on your right was Aisle 1. On this aisle was the soda fountain with stools and a cash register at the end, followed by candy and cigarettes. On your left in Aisle 3 were newspapers and magazines, followed by personal products such as shampoo and deodorant. In front of you in the middle, Aisle 2, was a freezer with ice cream in it and boxes of chocolates on top of it. Behind the freezer, the center of the store was split in two. On the right was a greeting card display on two sides, and on the left was a display of over-the-counter drugs such as aspirin, digestive aids, and so on. Along the entire back wall was the pharmacy section with a cash register off-center to the right.

15–5. **Identify which priority scheduling method(s) the organization for which you work or have worked uses.**

I work in a supermarket. It uses the first come–first served method, as people are waited on in the order they get in line.

15–6. **Give an example of a project in an organization for which you work or have worked that is suitable for scheduling using the planning sheet.**

The Mail Box store taught me how to prepare mass mailings that would go out in bulk mail. The manager just told me the procedural steps and went over them multiple times. If Mail Box used the planning sheet, the manager could give it to new people to train them to do the job.

15–7. **Give an example of a project in an organization for which you work or have worked that would be appropriate to schedule using a Gantt chart.**

I was an intern at Springfield Marketing Services. On a wall in the office was a giant Gantt chart that showed the schedule of all training programs offered over the next six months by room number used for the training.

15–8. **Give an example of a project in an organization for which you work or have worked that would be appropriate to schedule using a PERT network.**

I was in the Navy, and PERT was actually developed for use in building the Polaris submarine weapon system back in 1958.

15–9. **Identify the type of inventory and how it is controlled where you work or have worked.**

I worked at a company that manufactured boxes. We used pulp raw material that the purchasing department bought for us. The pulp was transformed into boxes quickly, but most boxes were sent to work-in-process inventory, which the labeling department took to put the name of the buyer on them before sending them to the shipping department as a finished good. Concurrent control was used to inspect the boxes as they were made. The shipping department kept the finished goods until they were ready to send out. The boxes were usually error-free, so very little rework control was needed. If any of the boxes were damaged (smashed, punctured, etc.) or lost while in transit to customers, we would replace the customer’s order free of charge.

15–10. **Explain quality control in an organization where you work or have worked.**

I worked as an auto mechanic. The service manager would assign cars to be repaired. When we were done, the service manager would test-drive the car to make sure it was OK. If it was, he’d give it to the customer. If not, he’d bring it back to the mechanic to fix again.

15–11. **Are any of the gurus’ quality contributions used where you work or have worked? Explain how.**

I work for a Ford auto dealership. “Quality Is Job One” signs are on the walls. We are repeatedly told that the customer comes first (Deming) and to do the job right the first time (Crosby). The computerized service diagnostic equipment uses statistical quality control (Shewhart). If something is out of the acceptable standard range, we recommend having it repaired. Juran’s 80–20 rule is followed when repairing cars. Our dealership invests heavily in quality because winning quality awards helps sales (Feigenbaum). At Ford Motor Company, the Taguchi design focus is taken very seriously.

REVIEW QUESTION ANSWERS

*These review questions are included in the test bank in the concept section.*

15–1. **What does the operations department do?**

The operations department transforms resource inputs into product outputs.

15–2. **Is the level of customer involvement highest with make-to-stock, assemble-to-order, or make-to-order operations?**

Make-to-order operations are carried out only after an order has been received from a specific customer. Therefore, it has the highest level of customer involvement.

15–3. **Which type of process operations is the most flexible? Least flexible?**

Individual-process operations are the most flexible and continuous-process operations are the least flexible.

15–4. **Which type of process operation is most commonly used by retailers and service organizations?**

Individual-process operations are most commonly used by retailers and service organizations.

15–5. **Are services generally more capital or labor intensive than manufacturing? Why?**

Service organizations are generally less capital intensive than manufacturing firms because they tend to use lower levels of technology.

15–6. **Why is it important to balance time-based competition and design?**

While companies need to increase innovation and speed products to market, they also need to have quality products to succeed. Rushing through the design process can lead to operations problems that can’t be easily fixed, in turn leading to sales problems and high repair costs.

15–7. **Which two facility layouts are the most flexible? Which two layouts are the least flexible?**

The process and cellular layouts are the most flexible. The product and fixed-position layouts are the least flexible.

15–8. **Why is capacity planning so important?**

Capacity planning is a decision made under conditions of uncertainty and high risk, because it usually requires a large capital investment. Too large or too small a facility will have negative effects on the business.

15–9. **Why is scheduling important?**

Scheduling is the process of listing activities that must be performed to accomplish an objective. Scheduling answers the planning questions: Which employees will make which products? What specific products will be produced? When will they be produced? Where will they be produced? How will they be produced? How many of each will be produced?

15–10. **What does a Gantt chart show that a planning sheet and PERT network don’t show?**

The Gantt chart has an advantage over the planning sheet in that it places progress toward the objective on the chart as a control technique. Another important advantage of the Gantt chart over the planning sheet and PERT is that it can show multiple projects on one chart.

15–11. **When would you use a PERT network rather than a Gantt chart?**

You would use a PERT network when you have some activities that are dependent and some that are independent.

15–12. **What are the four types of inventory?**

The four types of inventory include (1) raw materials, (2) work in process, (3) finished goods, and (4) in-transit goods.

15–13. **What does materials requirement planning integrate?**

Materials requirement planning (MRP) is a system that integrates operations and inventory control with complex ordering and scheduling.

15–14. **What is the relationship between inventory and quality control?**

Quality control is the process of ensuring that all types of inventory meet standards.

15–15. **What are the five rules of customer relations?**

The five rules of customer relations are:

1. Put people before things.
2. Always be nice—no matter how busy you are.
3. Take your time with people.
4. Be polite; say “please,” “thank you,” and “you’re welcome.”
5. Don’t discriminate with your service (treat everyone well).

15–16. **Why should you measure productivity rather than just production?**

If you measure only output production and it increases, you can be fooled into thinking you are doing a better job when in reality you may be doing a worse job because productivity has decreased.

COMMUNICATION SKILLS ANSWERS

Applications may also be used as class discussion questions or written assignments to develop communication skills.

*These communication skills questions are included in the test bank in the skills section.*

15–1. **Why are some companies (such as Apple) innovative when it comes to changing products and processes, while others (such as Eastman Kodak) are slow to innovate and change?**

Answers will vary.

15–2. **Can a standard make-to-stock product (such as soda) also be made to order? If so, how?**

Yes. It is being done now by changing repetitive-process operations outputs to batch-process operations outputs. For example, you can now have your name put on M&M candy and NIKE sneakers.

15–3. **Is the trend towards broader product mix with unrelated diversification? Why or why not?**

No. The general trend is to keep the product mix to related diversification. The major reason for this trend is globalization. To be successful globally, many companies are specializing by staying with their core competencies.

15–4. **Think about your career and the ideal job you are planning to obtain. Use Exhibit** 15–**2 to classify the operations systems and Exhibit 15–4 to identify the facility layout where you will work.**

Answers will vary.

15–5. **Assume you are planning a major event or project, such as a big wedding. (If you have an actual future event or project, use it rather than selecting an assumed event.) Would you use the planning sheet, Gantt chart, or PERT to plan and control the event? Why? Identify the major things that you need to plan for and make, and put them on the actual form using either Exhibit 15–5, 15–6, or 15–7 as a guide.**

Answers will vary.

15–6. **Many companies are now using radio-frequency identification (RFID) technology. RFID is revolutionary and is helping businesses improve supply chain management. However, critics are concerned about protecting people’s privacy. For example, with RFID, businesses will better know consumers’ shopping habits and purchases. Do you want businesses to know where you live and the products you have in your house? Explain.**

Answers will vary.

15–7. **What is your view of the quality of products you have purchased over the past year compared to previous years? Did you have to return and exchange products or have them repaired? Do you think that quality is getting better with time?**

Answers will vary.

15–8. **The balanced scorecard (BSC) calls for measuring performance in four areas. If a business is making good profits, should it bother with the other three nonfinancing measures? Why or why not?**

Yes. Customer service performance, internal business performance, and learning and growth performance all contribute to financial performance. If you don’t know if you are satisfying your customers, you can lose them. If you don’t increase internal business performance, competitors may get an advantage. If you don’t have satisfied employees, they will not be motivated to work hard.

APPLYING THE CONCEPT ANSWERS

*There are similar questions in the test bank in the application section.*

AC 15–1—Level of Customer Involvement

c 1. Make-to-order. The copies are made and sent only after an order has been received from the customer. Therefore, there is a high level of customer involvement.

a 2. Make-to-stock. The iPad is a standard product. The customer has a low level of involvement because he or she either takes the product as is or doesn’t buy it.

c 3. Make-to-order. The hair is cut to the made-to-order specifications of the customer. The customer has to be there to cut the hair, which requires a high level of involvement.

a 4. Make-to-stock. The can of soda is a standard product. The customer has a low level of involvement because he or she either takes the product as is or doesn’t buy it.

b 5. Assemble-to-order. An ice cream cone is a standard product. The coffee ice cream in a sugar cone is a customized feature. The customer has to be there to order it; therefore, there is a moderate level of involvement.

AC 15–2—Flexibility of Operations

e 6. PPO. Project process operations are used in the construction industry.

b 7. RPO. Automobiles are commonly made on an assembly line.

e 8. PPO. Swimming pools are installed at the customer’s site.

a 9. CPO. Asphalt is not made in discrete units.

c 10. BPO. Because Trident has a variety of flavors that can be easily made on the same machine, it probably makes its gum in batches.

AC 15–3—Facility Layout

c 11. Cellular. A pizza is assembled by customer specifications and both labor and capital (oven) are used to prepare it. Also, most restaurants are a cellular layout for simplification to reduce cost and improve productivity.

a 12. Product. Most traditional automotive plants use repetitive-process operations in which the automobiles are made on an assembly line.

a 13. Product. DVD players are most likely made on an assembly line at RCA.

d 14. Fixed-position. The house would be built at the site by the crew.

b 15. Process. Fingernails have a make-to-order level of customer involvement with individual process operations.

AC 15–4—Scheduling Tools

c 16. PERT network. Building a new submarine will have both dependent and independent activities.

b 17. Gantt chart. Gantt charts are good for allocating room resources to courses so you can see at a glance which rooms are being used when, why, and by which program.

b 18. Gantt chart. Gantt charts can show the progress of multiple products.

c 19. PERT network. Building a house requires a set sequence of relatively complex activities.

a 20. Planning sheet. Planning sheets are good for developing procedures.

AC 15–5—Measuring Productivity

.66:1 ratio, 66%, increase/**decrease** of 1.49% 21. 5,900 ÷ 9,000 = .6555

66 – 67 = –1

–1 ÷ 67 = –.0149

.69:1 ratio, 69%, **increase**/decrease of 2.99% 22. 6,200 ÷ 9,000 = .6888

69 – 67 = 2

2 ÷ 67 = .0299

.65:1 ratio, 65%, increase/**decrease** of 2.99% 23. 6,000 ÷ 9,300 = .6451

65 – 67 = –2

–2 ÷ 67 = –.0299

.70:1 ratio, 70%, **increase**/decrease of 4.48% 24. 6,300 ÷ 9,000 = .7000

70 – 67 = 3

3 ÷ 67 = .0448

.72:1 ratio, 72%, **increase**/decrease of 7.46% 25. 6,300 ÷ 8,800 = .7159

72 – 67 = 5

5 ÷ 67 = .0746

CASE ANSWERS

Toyota

15–1. **How is Toyota’s operations system and facility layout classified?**

Toyota offers a tangible product, primarily make-to-stock with some assemble-to-order operations, with repetitive-process operations, with a blend of capital- and labor-intensive operations. Toyota has product facility layout to manufacture vehicles.

15–2. **Which types of inventory does Toyota have?**

It has all four: raw material, work-in-process, finished goods, and in-transit. It is often given credit for popularizing the now-famous just-in-time (JIT) inventory system.

15–3. **Which area of the balanced scorecard is causing problems at Toyota?**

The quality problem is part of the *internal business performance*—operations and processes.

15–4. **Can Toyota get quality back on track and stop the recalls? As the chief operations officer, what would you do to improve quality?**

Answers will vary.

Cumulative Case Questions

15–5. **Discuss the ethical issues surrounding this case. (Chapter 2)**

The main ethical issue surrounding this case deals with Toyota’s poor and unsafe vehicle quality driven by the desire to cut costs in order to increase profitability and high-speed growth. The company used *distortion of consequences* as a justification for its actions, figuring that no harm would be caused by reducing vehicle quality. As the case explained, the company was wrong, as Toyota faced a massive amount of recalls and lawsuits due to their negligence to quality.

15–6. **Where in the decision-making process might Toyota have erred when they decided to cut vehicle production costs? (Chapter 4)**

Toyota erred in step 4 of the decision-making process (*analyze alternatives and select the most feasible*). Toyota obviously wanted to create more profitability for the company; however, by decreasing vehicle quality in order to achieve the objective, the company chose the wrong way to go about doing that.

15–7. **Discuss whether Toyota’s cost-cutting tactics fit its competitive strategy. (Chapter 5)**

Toyota’s cost-cutting tactics did not fit its competitive strategy. Toyota uses a *differentiation* strategy, as the company has always stressed its core competency in manufacturing superior-quality and reliable vehicles. Cost cutting is a much better tactic for a *cost leadership* strategy.

15–8. **How would you rate Toyota’s ability to change through innovation, and what type of changes has it been making? (Chapter 6)**

Toyota has been very successful in its ability to change through innovation, particularly *product innovation*. For example, it was the first company to commercially mass produce and sell hybrid vehicles. It was also speeding up the development of vehicles that run only on electricity with the vision of mass producing them in the early part of this decade.

Toyota has been making changes in *strategy*.Since the recalls of 2009 and 2010, it has had to shift its strategy back to focusing on quality rather than primarily focusing on cutting costs. Since technology is constantly changing, Toyota is always trying to use *technology* to gain a competitive advantage. The hybrid vehicles discussed above are just one example of how Toyota is using technology to its advantage. With these new technologies being implemented, tasks have changed, therefore causing a change in *people*’s performance and duties.

15–9. **Discuss why negotiation skills are so important at Toyota. (Chapter 10)**

Since both Toyota and the suppliers it purchases parts to make vehicles from are both looking to make a profit, it has to make sure there is a win-win situation created during negotiations.

15–10. **Discuss the importance of motivation (Chapter 11) and leadership (Chapter 12) at Toyota.**

Motivation and leadership are important at Toyota. Toyota’s leaders practice *servant leadership* by simultaneously meeting the needs and goals of employees while meeting the goals of the organization. Toyota’s leaders focus on motivating employees by meeting their highest-level needs: valuing their input, encouraging participation, sharing power, and fostering creativity. Toyota’s leaders provide both *intrinsic* and *extrinsic motivation* by encouraging employees to practice “kaizen,” or continuous improvement, by asking employees to constantly think of ways of reducing costs and wastes and then rewarding employees for their ideas with both monetary rewards and nonfinancial recognition, such as membership in their “Circle of Excellence.”

15–11. **Discuss the need for a team approach at Toyota. (Chapter 8)**

Teams and teamwork are ways of life at Toyota and among the main factors behind its success in becoming an industry leader in manufacturing and production. As a company that understands how teams are the backbone of organizations because of the systems effect and how teamwork-oriented organizational culture can be a source of competitive advantage, Toyota makes continuous efforts to ensure that all employees value teamwork and possess the necessary skills to work in a team.

SKILL BUILDER 15–1 IDEAS AND ANSWERS

**Developing a Plan to Open a Movies & Music Shop**

*Total Time* (0–20 minutes)

You can choose to spend no time on this exercise by having students pass in their work and grade it. You can also just use the handout on page 483 to show the answers, and/or go over the suggested Gantt chart and PERT network during class.

Doing Skill Builder 15–1 in Class

Objective

To develop your skills in planning using a Gantt chart and PERT network.

Preparation

Students should understand the text discussion on how to construct a Gantt chart and PERT network.

Experience

Students will develop a Gantt chart and PERT network for planning to open a movies and music shop.

Procedure (15–20 minutes)

Using the handout on page 483, go over the suggested Gantt chart and PERT network with students.

Conclusion

Lead a class discussion and/or make concluding remarks.

Sharing

Volunteers give their answer to the Apply It section.

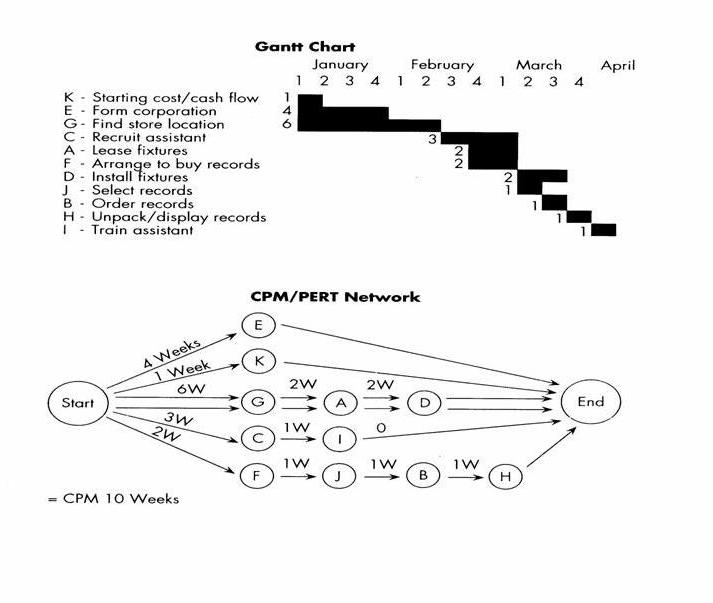
Answers to Gantt Chart and PERT Network Assignments

See the Skill Builder 1 Answers handout on the next page for the solutions to the Gantt chart and PERT network.

Answer to the Conclusion Question

PERT is more appropriate because of the sequence of activities that is required.

SKILL BUILDER 15–1 ANSWERS



SKILL BUILDER 15–2 IDEAS AND ANSWERS

**Economic Order Quantity**

*Total Time* (0–15 minutes)

You can choose to spend no time on this exercise by having students pass in their work and grade it.

Doing Skill Builder 15–2 in Class

Objective

To develop your skill at calculating EOQ.

Preparation

Students should understand the text discussion on how to calculate EOQ.

Experience

Students will calculate the EOQ for the four situations in the exercise.

Procedure (10–15 minutes)

*Option 1.* Call on students to work the problems on the board.

*Option 2.* Go over the answers to the problems with students.

Conclusion

Lead a class discussion and/or make concluding remarks.

Sharing

Volunteers give their answers to the Apply It section.

Answers to the Skill Builder Situations

EOQ = =  =  =  = 109.54

EOQ = =  =  =  = 244.95

EOQ = =  =  =  = 48.30

EOQ = =  =  =  = 275.68

Testing on Skill Builder 15–2

There are problems in the test bank similar to the ones in this Skill Builder exercise.

Test Questions and Answers (Also found in Test Bank)

**EOQ.** Calculate the EOQ with the following information: *R* = 1,000, *S* = $10.00, *H* = $5.00

Solution

EOQ = =  =  =  = 63.25

**EOQ.** Calculate the EOQ with the following information: *S* = $12.00, *R* = 3,000, *H* = $3.00

Solution

EOQ = =  =  =  = 154.92

**EOQ.** Calculate the EOQ with the following information: *H* = $1.50, *R* = 1,000, *S* = $8.00

Solution

EOQ = =  =  =  = 103.28

**EOQ.** Calculate the EOQ with the following information: *R* = 600, *S* = $20.00, *H* = $10.00

Solution

EOQ = =  =  =  = 48.95

SKILL BUILDER 15–3 IDEAS

**Increasing Productivity**

*Total Time* (0–20 minutes)

You can choose to spend no time on this exercise by having students pass in their work.

Doing Skill Builder 15–3 in Class

Objective

To gain experience in determining ways to increase productivity.

Preparation

Students should have read and understand the section on productivity in the chapter text.

Experience

Students will answer the questions in the exercise on ways to improve productivity and share their answers.

Procedure (15–20 minutes)

*Option 1.* Have students break into groups of 4 to 6 and discuss their answers to the questions in the exercise.

*Option 2.* Lead a class discussion by calling on students to share their answers to the questions in the exercise.

Conclusion

Lead a class discussion and/or make concluding remarks.

Sharing

Volunteers give their answers to the Apply It section.

SKILL BUILDER 15–4 IDEAS

**Your Course Self-Assessment**

*Total Time* (25–30 minutes)

The amount of time you spend on this exercise is dependent on which option you choose in the procedure.

Doing Skill Builder 15–4 in Class

Objective

To review your course Self-Assessments.

Preparation

Students should have completed the Self-Assessments from previous chapters.

Experience

Students will share their answers to the Putting It All Together Self-Assessment in groups and with the class.

Procedure (25–30 minutes)

*Option 1.* Have students break into groups of 4 to 6 and discuss their answers to the Putting It All Together Self-Assessment. Then lead a class discussion by calling on students to share their answers as to how the knowledge from this Self-Assessment will help them in their career development.

*Option 2.* Have students break into groups of 4 to 6 and discuss their answers to the Putting It All Together Self-Assessment. Then lead a class discussion by calling on students to share how they plan to apply their self-assessments to their personal and professional life.

Conclusion

Lead a class discussion and/or make concluding remarks.

Sharing

Volunteers give their answers to the Apply It section.

SKILL BUILDER 15–5 IDEAS

**The Most Important Things I Got From This Course**

*Total Time* (25–30 minutes)

You can choose to spend no class time on this exercise by having students pass in their work.

Doing Skill Builder 15–5 in Class

Objective

To review your course learning, critical thinking, and skill development.

Preparation

Students should have written/typed the three or four most important things they learned or skills they developed through this course and how they will help them in their personal and/or professional lives.

Experience

Students will share their answers in groups and with the class.

Procedure (25–30 minutes)

Have students break into groups of 4 to 6 and discuss with each other the three or four most important things or skills they developed through this course and how they will help them in their personal and/or professional lives. Then, lead a class discussion by calling on students to share their answers.

Conclusion

Lead a class discussion and/or make concluding remarks.

Sharing

Volunteers give their answers to the Apply It section.