unit 5

# Manufacturing Technologies

## Chapters In This Unit:



## Unit Thematic Project Preview

### Making Things Real

As part of this unit, you will learn about how manufacturers use technology to create products in mass quantities. These manufacturing technologies help produce products in the more efficient way possible.

As you read this unit, use this checklist to prepare for the project at the end of this unit:

***PROJECT CHECKLIST***

- ✓ Think of some products you use that are mass-produced.
- ✓ Look up factories that make the products in your area.
- ✓ Find out if the factories use computers and/or robots.

## WebQuest Internet Project

Go to **glencoe.com** to this book's Online Learning Center (OLC) to find the WebQuest activity for Unit 5. Begin by reading the Task. This WebQuest activity will help you understand the history of manufacturing and its effect on our lives since the Industrial Revolution began in the 18th century.

## Explore the Photo

**Mass Production** Making enough products to sell to people all over the country or world requires manufacturing technology. Imagine you got an order to make 10,000 globes in one month. How would you do it? Old and new manufacturing methods can help. *What types of machines do you think help make many items quickly?*

chapter 16

# Manufacturing Systems

## Sections



## What You'll Learn

- **Discuss** how manufacturing evolved.
- **Explain** the difference between durable and non-durable goods.
- **Discuss** the importance of assembly lines and division of labor.
- **Describe** manufacturing systems using the universal systems model.
- **Explain** the concept of added value.
- **Describe** several manufacturing tools and processes.
- **Describe** general steps in setting up and running a small factory.
- **Explain** the function of market research, quality assurance, and just-in-time delivery.

## Explore the Photo

**Waterjets** Waterjet cutting uses water forced through a tiny hole under very high pressure. Openings on the dashboards on many automobiles are cut with waterjets. *What other kinds of technology can be used for cutting?*

Launch the TECHNOLOGY LAB

## Manufacture a Bookstand

At the end of this chapter, you and two teammates will set up a production system to manufacture adjustable bookstands. Get a head start by using this checklist to prepare for the Technology Lab.

### *PROJECT CHECKLIST*

- ✓ Take a look at some bookstands at a furniture store.
- ✓ Bring a pencil and paper with you and make sketches of bookstands.
- ✓ Gather the materials you will need for the project.

section 16.1

# The Evolution of Manufacturing

## Reading Guide

**Before You Read** **Connect** How have manufacturing systems evolved?

### Content Vocabulary

- durable good
- non-durable good
- craft
- Industrial Revolution
- scientific management
- time and motion study
- division of labor
- assembly line

### Academic Vocabulary

You will see these words in your reading and on your tests. Find their meanings at the back of this book.

- period
- establish

### Graphic Organizer

Draw the section diagram. Use it to organize and write down information as you read.

**Manufactured Products**

| Durable Goods | Non-Durable Goods |
|---|---|
| | |

Go to **glencoe.com** to this book's OLC for a downloadable graphic organizer and more.

**TECHNOLOGY STANDARDS**

**STL 2** Core Concepts of Technology

**STL 3** Relationships & Connections

**STL 4** Cultural, Social, Economic & Political Effects

**STL 19** Manufacturing Technologies

**ACADEMIC STANDARDS**

**Social Studies**

**NCSS Content Standard 2** Time, continuity, and change

**English Language Arts**

**NCTE 2** Read literature to build an understanding of the human experience.

**STL** *National Standards for Technological Literacy*

**NCTM** *National Council of Teachers of Mathematics*

**NCTE** *National Council of Teachers of English*

**NSES** *National Science Education Standards*

**NCSS** *National Council for the Social Studies*

## Manufacturing and the Modern World

**As You Read**

**Predict** Think of some products that should not be produced in an assembly operation.

*Why is manufacturing essential to our way of life?*

Most of the things we use every day were manufactured in factories. Manufacturing makes it possible to have a modern way of life. Without factories, we would not have cars, clothing, televisions, breakfast cereals, books, microwave ovens, or cell phones.

## Products and Consumers

Manufactured products are sent to stores. Consumers are people who buy and use the products. We consume products by using soap, wearing clothes, and reading books. Without consumers, there would be no manufacturers.

## Durable and Non-Durable

All products are either durable or non-durable. The federal government defines **durable goods** as those expected to last three years or longer. Television sets, hammers, and bicycles are all examples of durable goods. **Non-durable goods** are expected to last less than three years. Calendars and packaged foods are examples.

Reading Check

**Contrast** What is the difference between durable and non-durable goods?

# Early Manufacturing

*How has the evolution of manufacturing changed society?*

The products that people used in the past were not always made in factories. People had to make their own fabric for clothing, farming tools, candles, wagons, furniture, and even their children's toys. It took a long time to make each item.

Not everyone could do a good job at making so many different things. Some people could make good wagons but not good tools. Others were better at making cloth. People soon began to specialize in just one type of **craft**, such as wagon making or shoemaking.

## The Industrial Revolution

Around 1750, great changes started to take place around the world because of new methods of manufacturing. Because new methods were so important, that period of time is called the **Industrial Revolution**. A revolution brings about great changes. Goods once produced by hand were then produced by machines in factories.

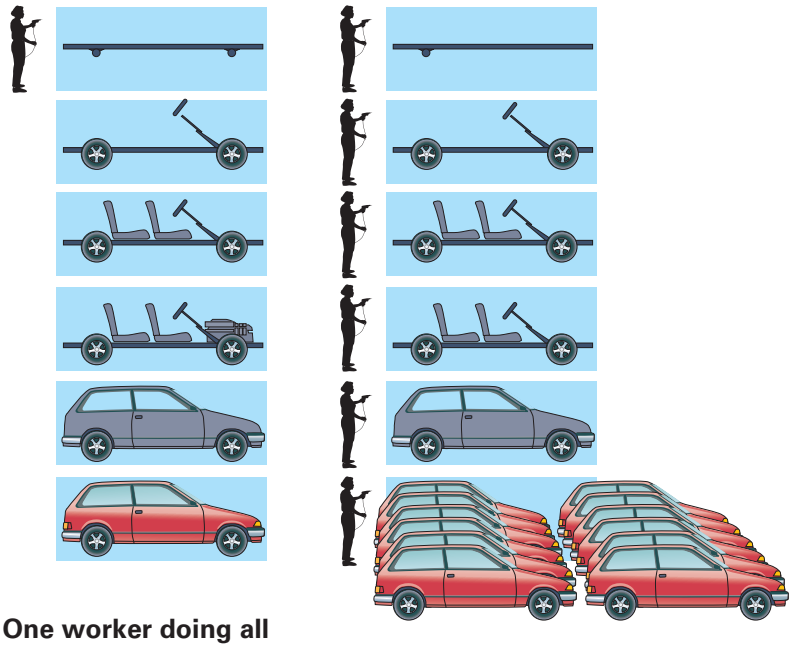
Cities grew in size when factories drew people from farms to cities. The Industrial Revolution was a great turning point in the history of the world, and it caused many social changes. It changed the U.S. economy from an economy based on farming to one based on industry. However, factories were wasteful of workers' efforts.

**Producing Change** Factories like this one were built during the Industrial Revolution, which was a great turning point in world history. *What kind of economy did the U.S. have before the Industrial Revolution?*

Raymond Forbes/age fotostock

**Figure 16.1** **Division of Labor**

**Efficiency** With division of labor, fewer workers are needed to manufacture larger quantities of high-quality products. *How does a flow chart help in establishing a division of labor?*



**One worker doing all six required steps in manufacturing a product can make one unit.**

**Six workers, each specializing in one of six steps, can make twelve units in the same amount of time.**

## Improvements in Manufacturing

As factory production increased, people began to look for better ways to do things. Frederick Taylor was the first person to develop standard ways of doing things. He made it easier for workers to manufacture products. Taylor's method is called **scientific management** and is an important part of modern factories.

The husband-and-wife team of Frank and Lillian Gilbreth also worked on better ways of doing things. Like Taylor, they worked in the new field of **time and motion study**. Time and motion study is a method of finding the way to do a job in the shortest time with the fewest movements. The Gilbreths improved factory working conditions and developed many techniques to measure factory efficiency.

Reading Check **Summarize** How has manufacturing evolved?

# Modern Manufacturing

*How can all factories be different and similar at the same time?*

Early experts provided the foundation for establishing factories to manufacture products. However, each product is different and requires different materials and methods.

Reading Check **Predict** What is division of labor?

## Division of Labor

Many companies use a **division of labor**. This means dividing the work into smaller steps done by certain groups of people. Workers develop specific skills. See **Figure 16.1**. A person who is good at electrical wiring will wire while someone good at painting will paint. Sometimes a flow chart is drawn showing the steps for producing the product and how they relate.

## Assembly Lines

Many companies use **assembly lines** or some type of assembly operation. In an assembly line, the workers often stay in one place and work on the product as it passes by. Automobiles and vacuum cleaners are put together this way.

Some products are assembled automatically by machines. For example, most medicines and foods are automatically processed and packaged. Other products do not lend themselves to an assembly operation. Examples include gas, paint, and tissue paper.

## Quality Control

During the manufacturing operation, each company makes many checks on the product's quality. A company making canned soup has to keep the machinery and the food very clean. The product has to taste good and be nutritious. Such companies also have strict governmental regulations they must follow regarding content, safety, and portion size.

### Academic Connections — Social Studies

**Sales of Durable Goods** To determine the state of the economy, government officials often use the most recent data for the sales of durable goods. Durable goods are usually more expensive than non-durable goods. If people are willing to invest in cars, televisions, and washing machines, they may be confident about the economy.

**Apply** Find out what kinds of durable goods are being manufactured. Make a list of the top five. Compare the list to the top five from 10 or 20 years ago.

## section 16.1 assessment

### After You Read — Self-Check

1. Identify examples of durable and non-durable goods.
2. Explain effects of the Industrial Revolution.
3. Define a division of labor.

### Think

4. Do you think all goods should be durable? Explain.

### Practice Academic Skills

**English Language Arts/Writing**

5. Read a novel that takes place in England or the United States during or after the Industrial Revolution. Write a short report describing everyday life during the time in which the novel is set. Some examples of novels to choose are *David Copperfield* and *Oliver Twist* by Charles Dickens and *The Jungle* by Upton Sinclair.

**STEM — Mathematics**

6. Renée works at a tire shop. Her main responsibility is repairing flat tires that people bring to the shop. One day she repaired 12 tires during a 7-hour period. If she is paid $6.75 an hour, how much was she paid for each tire she repaired?

Math Concept **Multi-Step Problems** Multi-step problems require extra attention to solve.

1. Figure out how much Renée made during her work day.
2. Next divide her wages for the day by the number of tires she repaired.

For help, go to **glencoe.com** to this book's OLC and find the Math Handbook.

section 16.2

# Organizing a Manufacturing System

## Reading Guide

**Before You Read** **Preview** How is a manufacturing system organized?

### Content Vocabulary

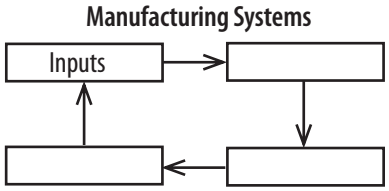
- added value
- abrading
- resin

### Academic Vocabulary

- distribute
- purchase

### Graphic Organizer

Draw the section diagram. Use it to organize and write down information as you read.




Go to **glencoe.com** to this book's OLC for a downloadable graphic organizer and more.

**TECHNOLOGY STANDARDS**

**STL 2** Core Concepts of Technology

**STL 17** Information & Communication Technologies

**STL 19** Manufacturing Technologies

**ACADEMIC STANDARDS**

**Science**

**NSES Content Standard E** Understandings about science and technology

**English Language Arts**

**NCTE 3** Apply strategies to interpret texts.

**STL** *National Standards for Technological Literacy*

**NCTM** *National Council of Teachers of Mathematics*

**NCTE** *National Council of Teachers of English*

**NSES** *National Science Education Standards*

**NCSS** *National Council for the Social Studies*

## Inputs

***What inputs are needed by manufacturing systems?***

All manufacturing companies use the same system inputs to produce their products. They are people, materials, tools and machines, energy, information, capital, and time.

### People

Larger companies have many engineers and technologists. Some people design the products the companies make. They are called "design engineers" or "designers/drafters." Production engineers decide the best way to manufacture the products. Quality control engineers and technicians inspect the product. Many people operate manufacturing machinery, while others set up or adjust the machines. Then people distribute and sell it.

**As You Read**

**Connect** Think of some examples of manufacturing tools.

## Production Materials

The materials companies use to make their products are called production materials, or engineering materials. They are different from raw materials. Raw materials are materials in their natural state, such as iron ore, trees, and raw cotton. Most production materials have already been processed to some degree. For example, trees have already been cut into lumber and dried. Materials are chosen for their different properties. Plastic used to make balloons, for example, has to be soft and stretchy.

**You've Got Nails** The steel wire used to make these nails is more valuable now. *What has been added to the wire?*

### Added Value

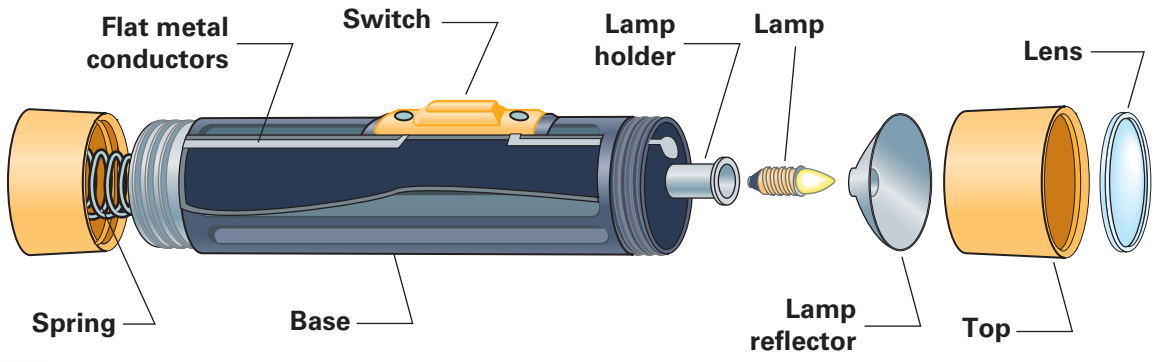
Companies stay in business by adding value to production materials. **Added value** is the increase in a material's worth after it has been processed into a finished product. For example, a nail is a one-piece product made from a roll of strong steel wire. A nail-making machine puts a point at one end and flattens the other end. Companies add value to steel wire by changing it into nails.

### Combining Materials

Other companies combine several different materials or make a product with many different parts. An ordinary flashlight has ten parts: plastic base, top, lens, switch, lamp (bulb) holder, spring, two flat pieces of metal, lamp reflector, and metal lamp conductor. The two batteries and lamp are purchased from other companies. See **Figure 16.2**.

Some companies make products that have hundreds, or even thousands of parts. You probably have some complicated products right in your own home.

**Figure 16.2** The Parts of a Flashlight




**Fitting Together** A flashlight has parts made from different materials. All the parts have to fit well and work together. *What parts of a flashlight are purchased from other companies?*

Bill Aron/Photo Edit

**Power Tools** Portable power tools are useful for many kinds of manufacturing processes. *What are some other examples of portable power tools?*

## Tools and Machines

During manufacturing, tools and machines change the shape of materials and fasten them to other materials. Hand tools, portable power tools, and machine tools and their many purposes are discussed in Chapter 3.

### Machine Tools

Machine tools are bolted to the floor and operated by electric motors. They are some of the most important tools used in a factory. Some are as large as a room. Others are smaller, such as a drill press. Machine tools are used for such jobs as drilling holes in jet engines and bending steel for car doors.

### Portable Power Tools

A portable power tool uses a small motor for power and is usually handheld. Some power tools, such as a table saw, cannot be held in your hands or easily moved. People use power tools for such jobs as sanding flat surfaces on wooden furniture and assembling electronic parts.

## Other Inputs

Energy is needed to run machines, heat buildings, and provide light. Capital (money) is needed to build factories, buy production materials, and pay workers. Of course, time is needed to do all the different jobs. Another important input is information. Workers need information in the form of drawings and instructions to make products.

Reading Check

**Explain** How do companies add value to production materials?

# Processes

***What are some manufacturing processes?***

Almost everything that takes place during manufacturing involves processes. Someone has to design and develop the product. Other people must organize and manage all the jobs that are done, make the product, and distribute and sell it. After the consumer has bought the product, another process involves servicing the product or making any repairs to a product that is returned.

## Changing Size and Shape

Processing often involves changing the shape or size of a material. The shape or size of materials is often changed by cutting, bending, casting, forging, or extruding, which are processes discussed in Chapter 3. **Abrading** means to scrape or rub off small pieces. Filing, sanding, and grinding remove material by abrading it.

## Chemical Processing

Conditioning is another process discussed in Chapter 3. Conditioning changes materials by using chemicals. Chemicals are used for etching the circuit boards in your computer.

Plastics are often processed from chemicals. The basic material is called a **resin**. Other ingredients are added to produce special properties, such as strength.

## Fastening

Fastening is combining two or more parts together. Furniture, for example, is fastened together with nails, screws, and glue. Nails and screws are mechanical fasteners. Many companies use screws because they have more holding strength than nails. Glue is an adhesive, which is a chemical fastener.

### Tech Stars

#### George C. Devol, Jr. and Joseph Engelberger

***Developers and Promoters of the First Robot***

In 1954, George C. Devol, Jr. developed and patented Unimate I,the first industrial robot. He then joined forces with Joseph Engelberger in 1956 to form the company Unimation, Inc., which built and promoted the robots.

Devol's invention combined computer processing, electricity, and hydraulics. The Unimate I was able to respond to 200 commands. A self-made engineer, Devol also made contributions to the fields of industrial automation in machine vision and bar coding. He has over 40 U.S. patents.

**Spreading the Word** Engelberger was also an engineer, but it was his skills as an entrepreneur that helped launch Unimation. He was a vocal advocate of robotic technology in fields such as the service industry, manufacturing, health care, and space exploration.

**English Language Arts/Writing** Write a short essay explaining what types of commands you would want a robot to be able to perform.

Go to **glencoe.com** to this book's OLC to learn about young innovators in technology.

EcoTech

## Packaged with Care

Wasteful packaging from the past includes long cardboard boxes for CDs and Styrofoam for take-out food. Today you can promote sustainable living by buying products that are packaged with reusable, recyclable, or biodegradable materials.

**Try This** When wrapping gifts, reuse materials such as newspaper, shopping bags, or used gift-wrap.

Plastic parts can be fastened with snaps. A small extension on one part snaps into a hole in another and holds everything together. This method allows the parts to be easily taken apart and recycled.

Plastic and metal parts can also be fastened by melting. Some plastic CD or DVD cases are heated and melted together. No mechanical fasteners or adhesives are necessary. Many metal parts of a car body are welded (melted) together with high heat.

Reading Check **List** Give some examples of manufacturing processes.

# Outputs and Feedback

***What outputs and feedback are part of a manufacturing system?***

The products themselves are the main outputs of a manufacturing system. Another is providing jobs for a community. Waste or pollution might be another.

Feedback can also come in many forms. High demand or low demand for the product is part of feedback. The manufacturer must review what went right or wrong to determine if changes need to be made to the product and system. What changes might be needed if a product is *too* successful?

## section 16.2 assessment

After You Read **Self-Check**

1. Compare a design engineer to a production engineer.
2. Identify the difference between production materials and raw materials.
3. Define the term *added value*.

### Think

4. Think of a common manufactured item, such as a bicycle. Use the systems model to describe the system used to make the item.

### Practice Academic Skills

**Social Studies**

5. If you had been a small child 150 years ago, what kinds of toys would you have played with? Think of one example. How do you think that toy would have been manufactured without the use of electricity and power tools? How would you make the same toy today? Write a one paragraph response.

STEM **Mathematics**

6. A flashlight consists of many different parts. A complete flashlight weighs 1.23 pounds. The lamp in the flashlight weighs 0.058 pounds. What percent of the total weight of the flashlight does the lamp represent?

Math Concept **Percents** Think of percents as parts of the whole.

1. Divide the part by the whole to get a decimal equivalent of the percent.
2. Multiply the decimal by 100 to get the percent.

For help, go to **glencoe.com** to this book's OLC and find the Math Handbook.

section 16.3

# Running Your Own Factory

## Reading Guide

**Before You Read** **Connect** How could a teenager start a factory?

### Content Vocabulary

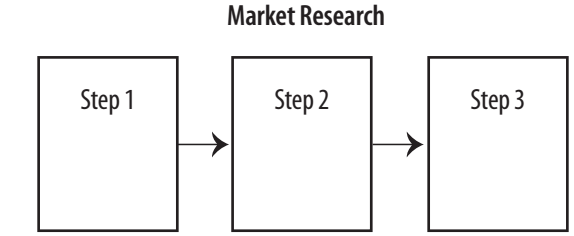
- market research
- supplier
- just-in-time delivery
- quality assurance
- marketing
- commission
- profit

### Academic Vocabulary

- item
- crucial

### Graphic Organizer

Draw the section diagram. Use it to organize and write down information as you read.




Go to **glencoe.com** to this book's OLC for a downloadable graphic organizer and more.

**TECHNOLOGY STANDARDS**

**STL 2** Core Concepts of Technology
**STL 8** Attributes of Design
**STL 9** Engineering Design
**STL 10** Troubleshooting & Problem Solving
**STL 19** Manufacturing Technologies

**ACADEMIC STANDARDS**

**Science**

**NSES Content Standard F** Science and technology in society

**Social Studies**

**NCSS 7** Production, Distribution, and Consumption

**STL** *National Standards for Technological Literacy*
**NCTM** *National Council of Teachers of Mathematics*
**NCTE** *National Council of Teachers of English*
**NSES** *National Science Education Standards*
**NCSS** *National Council for the Social Studies*

## Market Research

***How can you find out what products people will purchase?***

Suppose you have an idea for a new board game for two to four players. In addition to the board, the game will include a colored button for each player and cards with questions written on them. You are on a summer break, so you have time to manufacture and sell the game yourself.

1. You plan the game and make sketches. By putting your idea on paper, you can show others what you are thinking. The drawing is part of your design.

**As You Read**

**Predict** What do you think is necessary to set up your own factory?

BusinessWeek Tech NEWS

### The Chips Have It

In 2007, four of the top 10 fastest-growing tech companies manufactured semiconductors and materials used to make them. Finishing fourth was Cypress Semiconductor, which makes the chips [for] Apple's iPod click wheel. The chip notes how the finger is moving and translates the information into a computer command, such as "more volume" or "next song."

Courtesy of Apple

**Critical Thinking** *What makes a manufacturer successful?*

Go to **glencoe.com** to this book's OLC to read more about this news.

2. You want opinions from other people, so you talk to your friends and teachers. Each person gives you suggestions for how to improve your game. This is market research. **Market research** is a way to find out what people will purchase.
3. You make one complete game to test with friends. After you make some changes, you are satisfied.

**Reading Check** **Describe** What is the purpose of market research?

## Manufacturing the Product

***Who are the suppliers in a manufacturing process?***

4. You want your playing board to fold up like other board games. You can draw the playing surface on paper, but you cannot make the heavy cardboard back. You talk with the owner of a frame shop. He says that he can make 100 cardboard backs for $1.20 each.
5. A friend of yours has a printer that can print on lightweight cardboard. She agrees to print the game's question cards for $1.50 per set. She also agrees to print the instructions. Both the picture framing shop and your friend are your suppliers. A **supplier** is a person or company that provides something for making your manufactured product.

## Ethics in Action

### Outsourcing

U.S. companies are employing more and more people out of the country. This is called "outsourcing." Wages are lower in some countries, so the companies are able to save money. In turn, they can sell products, such as cameras, cell phones, and shoes, at lower prices.

**The Downside** Some people say that outsourcing takes jobs away from Americans. They also point out that working conditions in some developing countries are poor and unsafe.

**English Language Arts/Writing**

**Child Labor Laws** Federal law prohibits you from working at most jobs until you are 14. This is for your protection. In some countries, children work long hours in dangerous conditions and cannot go to school.

1. Do research and find out what the law says. What jobs can you do now? How does the law protect you?
2. Write a brief report.

6. Of course you also want to sell the game. You check with four stores in your town. Three owners agree to offer your game for sale.
7. The framing shop requires an order of at least 100 cardboard game backs. So you make out a budget based on manufacturing 100 games:

| | |
|---|---|
| 100 cardboard game backs, $1.20 each | $120 |
| 100 packs of question cards, $1.50 per pack | 150 |
| 400 colored buttons, $0.10 each | 40 |
| 100 plastic bags to package games, $0.25 each | 25 |
| Colored pens, paper on which to draw the playing surface, rubber cement, and other items | 65 |
| **TOTAL** | **$400** |

Your parents help you borrow $400 for the project. That money becomes your capital.

8. You ask your suppliers to send you ten game backs and ten sets of question cards each week for ten weeks. You do not have room to store much at home, so you want to use **just-in-time (JIT) delivery** and receive those items just in time to do the work. JIT is used by many manufacturers. With JIT, they do not need extra warehouse space to manage items.
9. Before you draw the playing surface, you get your production materials together. This includes the paper, pens, ruler, and other **items** necessary to draw the playing surface. Now you go into production and draw the playing surface for ten boards. You have added value to the materials.
10. You carefully inspect each playing surface you finish. This inspection is called **quality assurance** or quality control. It means you will meet the requirements, or standards, set for the games. You glue the ten playing surfaces to the cardboard backs. You check the paper to be sure that you did it well. This is also quality assurance. Quality assurance is **crucial** to manufacturing. It enables you to use information about your system to change it as needed.

**Making Sketches** You might sketch out your game on a big piece of paper and then get input from your teachers and friends. *Why would you ask your teachers and friends to give you input on your game?*

11. Now it is time to assemble the game. You ask a friend to help. You place four different-colored buttons in a small plastic bag. You add a pack of question cards. Then you pass the bag to your friend. Your friend places the game board, instructions, and smaller plastic bag into a larger plastic bag. This is like working on an assembly line in a factory.

**Reading Check** **Explain** Why is quality assurance important?

## Marketing and Sales

*What is involved in marketing your product?*

12. Next, you have to plan the **marketing** for your game. In other words, you have to tell people about it. One way to do this would be to create flyers using your computer. You can then print them on a color printer and post them where they will be seen.
13. You drop off two games at each of the stores that agreed to sell them. The store owners will charge you one dollar for each game they sell. This is their commission. A **commission** is payment based on sales.
14. You price the games at ten dollars each. How much profit will you make? **Profit** is the money left over when all your bills are paid. Remember that the loan, too, must be repaid. If you sell all of the games, how much money will you make?

### Imagine This...

**Self-Shifting Bicycle**

Imagine a bicycle that shifts gears for you. The bicycle company Trek is introducing a three-speed bicycle with an automatic transmission. A computer shifts the gears as wheel speed changes. The rider can focus on traffic conditions and not on operating the bicycle. Market research suggested that city dwellers who do not usually ride bicycles might use this bike. *What are some ways to perform quality assurance on a self-shifting bicycle?*

Go to **glencoe.com** to this book's OLC for answers and to learn more about self-shifting bicycles.

## section 16.3 assessment

**After You Read** **Self-Check**

1. Define the term *market research.*
2. Identify the meaning of JIT.
3. Describe the purpose of quality assurance.

### Think

4. Name some ways that a saw mill adds value to trees and a furniture company adds value to lumber.

### Practice Academic Skills

**English Language Arts/Writing**

5. Suppose several customers returned the board games discussed in this section. They report such problems as missing cards or buttons, a loose playing surface, and instructions that are hard to follow. Outline a maintenance system for inspecting and servicing these products so they will function properly.

**STEM** **Science**

6. The Industrial Revolution brought manufacturing into factories, especially after Henry Ford developed a moving assembly line. Research some of the other changes the manufacturing process has seen over the ages. Write a few paragraphs describing what you find. Include a discussion of where you think the manufacturing process is headed.

# Exploring Careers in Technology

## Catherine Andrae

### PROCESS ENGINEER

**Q:** *What do you do on a typical day?*

**A:** My company manufactures custom color and additive masterbatches used in the production of plastics. Each day, I review incomplete tasks from the previous day. I talk to the supervisors, operators, and mixers to evaluate the different products processed during the evening shift and weigh concerns, comments, or suggestions. I participate in the facility-wide, walk-around meeting to keep up with the larger-scale concerns and projects. Lately I also deal with reformulating several products to improve processing and reduce variation. Each day I review products and adjust the process settings to reflect optimal conditions.

**Q:** *What kind of training and education did you need to get this job?*

**A:** Polymer and fiber engineering was my major at Georgia Tech. I learned about polymer processing, completed hands-on lab experiments for colorants and additives, and mastered technical data about antioxidants, waxes, and processing aids. I also completed three internships, which really drove home several key areas of knowledge I need to do my job.

**Q:** *What do you like most about your job?*

**A:** I really like the freedom I have to tackle problems, as well as the positive feedback I receive from the manufacturing floor when I improve a process or product.

**English Language Arts/Writing**

**Evaluating Choices** What kind of career is best for you?

1. Think of at least two different careers that you find interesting. Research the two careers on the Internet, at a library, or in your school's career center.
2. Make a list of your personal characteristics, including your talents, personality, and subjects and activities you enjoy.
3. Compare the information about the careers with the data you gathered about yourself. Write a 50-word paragraph about the best match.

Go to **glencoe.com** to this book's OLC to learn more about this career.

**Real-World Skills**

Observation, speaking and listening, organization

**Academics and Education**

Chemistry, physical science, mathematics

**Career Outlook**

Growth as fast as average for the next ten years

**Source:** *Occupational Outlook Handbook*

# chapter 16 Review and Assessment

## Chapter Summary

**Section 16.1** Factories make two kinds of goods: durable and non-durable goods. In factories, production materials are converted into finished products. Workers develop special skills partly because the companies use a division of labor. Workers put everything together using an assembly line.

**Section 16.2** To start a company or make a new product, a person first needs an idea and creates a design. The final product will be made from production materials and parts provided by suppliers. The manufacturing process adds value to raw materials.

**Section 16.3** Market research is a way to find out what people will purchase. Suppliers provide materials or products to help you manufacture your own products. Quality assurance is a method for being sure products meet quality standards.

## Review Content Vocabulary and Academic Vocabulary

1. On a sheet of paper, use each of these terms and words in a written sentence.

**Content Vocabulary**

- durable good
- non-durable good
- craft
- Industrial Revolution
- scientific management
- time and motion study
- division of labor
- assembly line
- added value
- abrading
- resin
- market research
- supplier
- just-in-time delivery
- quality assurance
- marketing
- commission
- profit

**Academic Vocabulary**

- period
- establish
- distribute
- purchase
- item
- crucial

## Review Key Concepts

2. **Summarize** the history of manufacturing.
3. **Compare** durable and non-durable goods.
4. **Explain** why having assembly lines and a division of labor is important.
5. **Use** the universal systems model to describe manufacturing systems.
6. **Define** added value.
7. **Name** several tools and processes used in manufacturing.
8. **List** several steps in setting up and running a small factory.
9. **Discuss** the purposes of market research, quality assurance, and just-in-time delivery.
10. **Explain** what is involved in marketing a product.

## Real-World Skills

**11. Time and Motion** Choose a task you and a classmate do on a regular basis, such as getting ready for school. Keep a record of the steps you take to accomplish the task and the time it takes you to do each step. Compare your record with your classmates to see who accomplishes the task more efficiently.

### STEM Technology Skill

**12. Using Presentation Software** Use presentation software to create a slide show about how something is manufactured. You might choose a product such as steel, ceramic tile, or lumber. Research the manufacturing process.

**a.** Create a step-by-step slide show explaining how the material is manufactured.

**b.** Include photographs, charts, and diagrams in your slide show.

## Academic Skills

### Social Studies

**13.** Many companies have been accused of using foreign sweatshops. A sweatshop is a factory that has poor working conditions and pays low wages. Research the issue of sweatshops and write a few paragraphs about what you find.

### STEM Mathematics

**14.** Jason needs to repair the clutch on his car. A mechanic says that the fan belt and flywheel also need work. The total cost will be $409.20. Replacing the fan belt will cost $32.50. The flywheel repair will cost ¼ of the total cost. How much will the clutch cost?

**Math Concept Algebra** You can solve some problems with an equation. An equation is like a sentence that explains what you are trying to solve. The unknowns can be represented as letters $x$ or $y$.

## TSA WINNING EVENTS

### Industrial Engineer

**Situation** Your team will design and mass produce a product made from discarded material solicited from a business.

**Activity** Develop assembly drawings for your product. List the parts, tools, and machines you will need. Develop a flowchart of the production process. Set up your assembly line. Make a series of trial runs, and make changes.

**Evaluation** The production process will be evaluated by these criteria:

- Design of process—thoughtful, complete
- Assembly drawings—accurate, complete
- Materials list—complete, appropriate
- Flowchart—appropriate, clear
- Production run—safe, efficient

Go to **glencoe.com** to this book's OLC for information about TSA events.

## Standardized Test Practice

**Directions** Choose the letter of the best answer. Write the letter on a separate piece of paper.

**1.** How much is $\frac{1}{16}$ of 368?

**A** 16 **C** 32

**B** 22 **D** 23

**2.** Abrading is the process of changing the shape of a material by rubbing off small pieces.

**T** **F**

**Test-Taking Tip** Be alert for multiple ideas or concepts within a true/false statement. All parts must be true or the statement is false.

chapter 16

TECHNOLOGY LAB

# Manufacture a Bookstand

The manufacturing process includes designing, developing, making, and servicing the product. Being organized is important. It may make all the difference in your ability to have a successful manufacturing business.

## Tools and Materials

- ✓ Three pieces of wood, each about 1 inch thick, 6 inches wide, and 18 inches long
- ✓ Six pieces of wood, each about 1 inch thick, 6 inches wide, and 8 inches long
- ✓ Twelve ⅜-inch-diameter dowels, 1½ inches long
- ✓ Ruler
- ✓ Pencil
- ✓ Glue
- ✓ Hammer
- ✓ Hand drill with ⅜-inch drill bit
- ✓ Fine sandpaper
- ✓ Can of water-based clear finish
- ✓ Paint brush

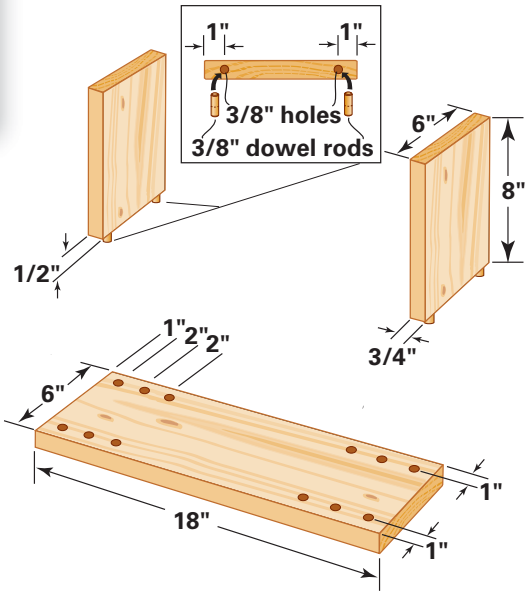
## Set Your Goal

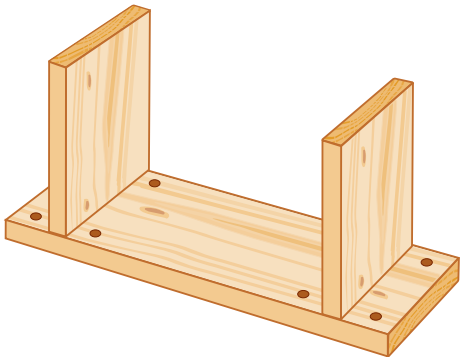
For this activity, you and two teammates will set up a production system to manufacture adjustable bookstands. When you are finished, each of you will have a bookstand to use.

## Know the Criteria and Constraints

In this lab, you will:

1. Use an assembly line and division of labor for part of your operation. After the bookstand is complete, you will turn in a flow chart showing how the materials moved along your assembly line.
2. Establish a method of controlling quality and of servicing products that do not meet quality standards. Turn in a paragraph describing the process you used.
3. The first bookstand you produce will be a prototype. Study it for ways to improve your methods. Keep a record of changes you make.
4. Recycle or discard any waste safely.



## SAFETY

In this lab, you will be using tools and machines. Be sure to always follow appropriate safety procedures and rules so you and your classmates do not get hurt.

## Design Your Project

The following steps are only for making the bookstands. You will determine your own steps for setting up the system.

1. Look at the assembly drawings.
2. Establish methods of controlling quality and of servicing products.
3. Take one of the 6-inch x 8-inch pieces of wood.
   - Drill two ⅜-inch-diameter holes, 1 inch deep, into one end. The center of each hole should be 1 inch from the edge.
   - Repeat for the other five bookstand ends.
4. To attach dowel to bookstand ends:
   - Place a small amount of glue on the end of a 1½-inch-long dowel and insert the dowel in a hole, glue-side down.
   - Tap the dowel with the hammer until it goes into the hole.
   - Repeat for the other 11 dowels and holes.
5. Drill twelve ⅜-inch diameter holes in the 18-inch-long pieces of wood. Drill each hole a little deeper than ½ inch—say, ⅝ inch.
6. After glue is dry, insert the dowel in the holes in the bookstand base.
7. Repeat for making the other two bookstand bases.
8. When your bookstands are complete, sand the surfaces and edges.
9. With proper ventilation, paint the bookstand with clear finish.
10. Write a brief paragraph describing your quality-control process.
11. Create an assembly-line flow chart and write your servicing plan.

## Evaluate Your Results

After you complete the lab, answer these questions on a separate piece of paper.

1. What could you have done to improve the quality of your bookstand?
2. What would you do to make and sell 30 adjustable bookstands?

*Academic Skills Required to Complete Lab*

| Tasks | English Language Arts | Math | Science | Social Studies |
|---|---|---|---|---|
| Set up assembly line for bookstands with teammates. | ✓ | ✓ | ✓ | ✓ |
| Build prototype of bookstand. | ✓ | ✓ | ✓ | |
| Improve method for producing other bookstands. | ✓ | | ✓ | |
| Create a flow chart that describes your assembly line. | ✓ | | ✓ | |
| Write about the plan for quality control and servicing products. | ✓ | ✓ | | ✓ |