Saugus Public Schools
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Teaching with Historic Places Lesson Plan

Primary Manufacturing

School: Belmonte Middle School
Subject: Technology Engineering
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Grade: 7-8

Introduction:

The main goal of this unit is to introduce students to the concepts of primary and secondary manufacturing and to discuss the development of manufacturing processes.

Objectives:

- Students will be able to define production and manufacturing.
- Students will be able to discuss the interdependence of systems.
- Students will be able to discuss the development of manufacturing.
- Students will be able to describe primary manufacturing.
- Students will be able to define secondary manufacturing.
- Students will be able to describe primary manufacturing processes.

A tour of the Saugus Iron Works.

Materials:

- The Technology Engineering / Manufacturing Questions sheet (attached)

Activities:

Review the following concepts with class using an overhead projector and have students copy content outline in notebooks. Visit the Saugus Iron Works and learn about manufacturing in colonial times. Follow up with the questions for discussion.

What is Manufacturing?

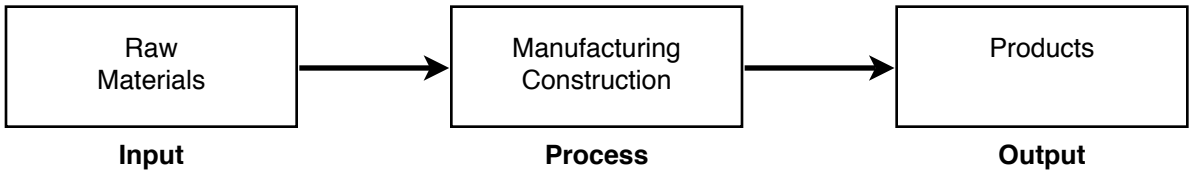
How big would a system have to be to supply all the products we might ever need? Would the word *huge* or *gigantic* express the size of such a system? The system that performs this remarkable task is called a ***production system***. Production systems change materials into more useful forms called products. Production systems are responsible for producing all the products we use each day.

The products of production supply communication, transportation, and biotechnology systems with all the things they need to produce products and services. Telephones, automobiles, medicines, and even buildings make up a tiny example of the work accomplished by production systems.

Production systems create these products through two activities: manufacturing and construction.

What is Production?

Look around your room. Each and every thing you see was produced by a production system. ***Production*** is the manufacture or construction of products. Books, furniture, clothing, windows, even the room itself is a product of this complex system.



The goal of any production system is to create products. When products are produced is a factory, the process is called ***manufacturing***. Books, furniture, windows, and clothing are manufactured items.

Construction is the process of building something on a site. The room you are sitting in is a product of construction; so are houses, bridges, and tunnels.

Production Systems Are Interdependent

Manufacturing and construction systems depend on each other to produce products. That is they are interdependent. Each system is vital to the success of the other. For example, a factory building is the output of a construction system. The people who assembled the building relied on manufactured materials such as bricks, pipes, and wire for its construction. In fact, you will find that all technologies depend on each other.

Let's see how this dependency works…

A factory that manufactures cosmetics relies heavily on transportation systems to deliver products. Most factories own or rent fleets of trucks from manufacturers to accomplish this goal. The trucks travel over roads created by construction systems. Communication systems within the factory store and transfer the information necessary for the production of millions of products each year.

Development of Manufacturing

Modern manufacturing is the result of many changes in how products are made. We can look back as some of these changes by studying the people who created them.

Early craftspeople were responsible for providing communities with everyday products. If you lived during the 1800s, you might have been one of these craftspeople. You might have been a tailor, for example.

Tailors provided people with custom-made clothing. Working in a small shop, the tailor fitted, cut, and sewed by hand garments such as shirts and dresses. The tailor worked on one garment at a time until it was completed.

The Industrial Revolution brought new machines and techniques to production. This changed forever the methods used to produce products. Factories were soon equipped with sewing machines and hundreds of people to operate them. These factories could mass-produce hundreds of garments at a time. The impact of the Industrial Revolution on the tailor's role as a producer of garments was disastrous.

Mass production is the process of producing large quantities of products in factories. In a clothing factory, fabric travels from one machine to another on an assembly line. One machine operator performs one process, such as sewing the front and back together. The operator then passes the garment on to the next operator, who sews on a sleeve. Each operator does exactly same part again and again. Many people instead of just one produce each garment.

Tailors could not compete with the speed of mass production and the low prices of mass-produced products. They, like many other crafts people, were replaced by the factory system of manufacture.

Manufacturing Industrial Products

Have you ever visited a lumberyard? Most lumberyards are stacked with piles of lumber in many sizes and shapes. Under a covered area in the yard, you might find sacks of cement, rolls of insulation, and piles of roofing shingles. These are all examples of industrial materials.

Industrial materials are created by primary manufacturing. ***Primary manufacturing*** is the conversion of raw materials into industrial materials. Industrial materials later undergo ***secondary manufacturing***, which changes them into finished products. Most factories produce either industrial materials through primary manufacturing or finished products through secondary manufacturing.

If you were to construct a picnic table, you might make it with redwood lumber. The redwood you purchased from the lumberyard would be an example of an industrial material that has undergone primary manufacturing. The raw material (tree) has been manufactured into board lum-

ber. You then begin secondary manufacturing to change the lumber into the table as you cut, assemble, sand, and apply a finish.

Primary Manufacturing Processes

All raw materials must be processed or changed into more useful forms before they can be made into finished products. This is the goal of primary manufacturing. Primary manufacturing involves three processes: obtaining the material, refining the material, and creating industrial materials.

Obtaining Raw Materials

Materials are gathered by mining, drilling, or harvesting. Materials that are mined are dug from the earth. Coal, iron ore, and copper are mined materials.

Liquids and gases can be collected by drilling. Large drilling rigs cut holes deep into the ground and pump out materials such as oil and natural gas.

Harvesting is the method used to gather renewable resources. For example, trees are harvested by cutting forested areas.

Refining Materials

Raw materials are very rarely used in their raw form. Primary manufacturing processes are used to refine them (clean them up).

Logs harvested from trees must have their branches and bark removed. Minerals that have been mined must have soil, rocks, and other impurities removed. Refining gets the materials ready for manufacturing.

Manufacturing Industrial Materials

Many different processes are used to manufacture refined materials into metal, wood, ceramic, plastic, and composite industrial materials.

Steel, for example, is manufactured into sheets, plates, and bars. Logs are cut into boards and veneers of various-but standard-shapes and sizes. Silicates are combined into cement. Industrial materials are manufactured into standard sizes and shapes to insure that consumers will be able to purchase identical materials each time a job requires them.

Early Manufacturing History[1]

The first American iron ore was found in 1585 on an island off the North Carolina coast. It was too inaccessible to mine, but iron ore that could be mined was found in Virginia in

[1] From John H. Lienhard's *Iron in America, No. 22*

1607. When colonists sent a shipload to England, they found it just wasn't efficient to ship un-smelted ore that far. A company finally set up an American iron-smelting operation near Richmond in 1622, and then Indians massacred the whole group just before it went into production.

So the first American iron was finally produced in 1644 on the Saugus River just north of Boston -- 24 years after the Pilgrims landed, and 59 years after the first iron ore was located. This operation lasted until the 1670s, when it was forced out of business by a labor shortage.

The Saugus Iron Works was an integrated facility involving a dam to provide waterpower for forging, a furnace for smelting, a trip-hammer forge, and a rolling/slitting mill. It produced two forms of iron. One was cast iron, which was directly poured into molds to shape whatever product was needed, or cast into "pigs." A pig was a lump of cast iron that could be re-melted and cast later, but which was more often made into the second form of iron, which was wrought iron.

Wrought iron was made by re-melting the pig to reduce the amount of carbon in it and then forging it to refine its grain structure. This took a lot of power, but it yielded a very strong metal.

Now, what do you suppose was the primary product of the Saugus Works? What do people need when they're building cities out of the wilderness? They need nails, and lots of them. A great deal of the wrought iron was milled out into thin strips, which were then slit into small square rods. These were sold to individual householders who cut them into short lengths and used small dies to form points and heads on them.

Summary:

- Production system activities include manufacturing and construction.
- All technological systems are dependent on each other.
- Today’s manufacturing is a result of changes in how products are produced.
- Primary manufacturing produces industrial materials.
- Secondary manufacturing produces finished products.


Water wheels running at the Saugus Iron Works.

- Primary manufacturing processes include gathering materials, refining materials, and manufacturing industrial products.

Questions for Discussion:

1. Describe how a hospital is dependent on transportation, communication and production systems.

   Answers will vary. Point out that hospitals depend on ambulances to transport patients who are very ill or injured; the staff in the hospital depends on communication to relate results of lab tests to doctors; production systems are responsible for the equipment and machines that are used to treat patients.

2. Make a list of ten manufactured materials that are used in house construction.

   Answers will vary. Examples include bricks, plywood, shingles, concrete, plumbing fixtures, and electrical fixtures.

3. Before craftspeople, how did families obtain everyday products they needed?

   Answers will vary. Point out that before craftspeople became skilled in single trades, individual families had to produce the products they needed.

4. Describe how the factory system affected the work of the blacksmith.

   Answers will vary. Remind students that the factory system could produce many of the same products the blacksmith produced, but the factory system could produce them faster and cheaper. Many blacksmiths went out of business.

5. Make a list of the many industrial materials used in the manufacture of automobiles.

   Answers will vary. Students may list plastics, seat covers, springs, car bodies, steering wheels, axles, tires, windows, windshields, windshield wipers, headlights, and so on.

6. Describe how the materials used to make applesauce are harvested, refined, and produced.

   Answers will vary. Remind students that the apples must be picked from the trees and the bad apples discarded. The remaining apples must be washed, chopped, and processed into applesauce. The applesauce is placed in containers that are labeled and shipped to stores to be sold.

Assessment:

Have students complete the Technology Engineering / Manufacturing Questions sheet.

References:

1. Hacker, Michael, Barden, Robert, (2003), *Living With Technology*, Delmar Publications Inc., New York
2. Lienhard, John H., *Iron in America, No. 22*, downloaded July 2005 from the web at: http://www.uh.edu/engines/epi22.htm
3. McGruder, Robert, (1999), *Curriculum Brief; Manufacturing Technology*, International Technology Education Association, Reston, VA

Answers to technology engineering / manufacturing questions:

1. What are the two activities performed by production systems?

   Construction and manufacturing

2. How are manufacturing and construction different from each other?

   Manufactured items are usually produced in a factory and transported to their final destination. Construction usually takes place on the site.

3. Describe how manufacturing and construction systems are interdependent?

   Manufacturing provides many of the products used in construction. Construction is the process that is used to build the factories in which manufacturing takes place.

4. Describe the factory system of production?

   The factory system uses mass production techniques such as assembly lines to produce many products at a time

5. What impact did the factory system have of craftspeople?

   The factory system put many craftspeople out of business because it could produce more products faster than skilled craftspeople could, and it could sell them for less.

6. List four primary manufactured products and describe how they are used in secondary manufacturing.

   Lumber, concrete, sheet metal, and glass are examples of primary manufactured products. Lumber can be used in homes, furniture, boats, and other products. Concrete is used primarily in construction. Sheet metal is used for automobiles and other products. Glass is used to make windows for cars, homes, and other products.

7. What are three methods used to gather raw materials?

   Mining, drilling, and harvesting.

8. What is the goal of refining materials?

   Materials are refined to get them ready for manufacturing.

9. Wood is processed into many different shapes and sizes. How do people know what to buy?

   Answers will vary. The wood is processed into standard shapes and sizes. Builders are familiar with these and know which ones to use for specific purposes.

10. List three shapes in which steel products can be purchased.

    Sheets, plates, and bars.

Name: _____ **Class:** _____

Technology Engineering / Manufacturing Questions

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