Humans Innovating Technology Series

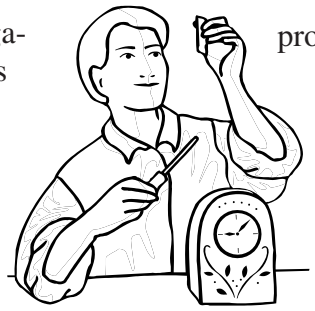
Manufacturing Processes

Introduction

Almost every product we use was produced using some type of manufacturing process. Most of the food we eat is processed. We watch television on a set that was manufactured. Likewise, the vehicle we drive is the product of processing actions. The books and magazines we read and the CDs that bring us music were all manufactured.

Manufacturing processes can be divided into three stages. The first stage involves locating and extracting materials. This may be a forester cruising a forest to select mature trees or geologists seeking rock formations that may contain petroleum or minerals.

Once the material (natural) resource is found, it must be removed from the earth and transported to a processing mill. Trees are felled and crops are harvested. Ores are obtained using open-pit or shaft mines. Liquid and gaseous resources, such as natural gas and petroleum, are extracted through wells.



The second stage of manufacturing processing is called primary processing. It involves changing the material resources into industrial materials or standard stock. These are the materials that are used to make final products. Typical primary processing activities are smelting iron ore with coke and limestone to make steel, grinding grain to produce flour, processing natural gas to make plastics, and fusing silica sand with other additives to make glass.

The result of primary processing is a material

Technological Literacy Standard #19

Students will develop an understanding of and be able to select and use manufacturing technologies.

Benchmarks

Grades 6-8 Manufacturing processes include designing, engineering, making, and servicing.

Grades 9-12 Interchangeable parts increase efficiency.

Servicing products keeps products in operating condition.

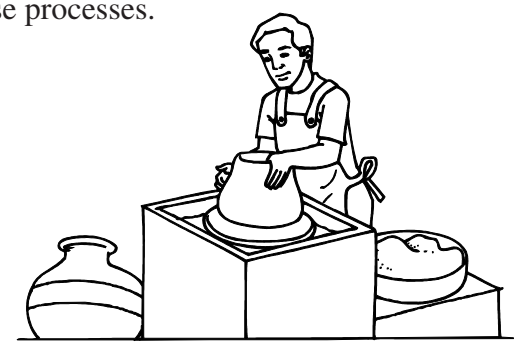
that has value to other manufacturers but not to consumers. Sheets of steel, boards of lumber, or containers of polyethylene pellets are of little use to the end consumer. These materials need to be further processed into consumable goods.

The last stage of manufacturing is called secondary processing. It converts industrial materials into products. The processes are done in factories that employ people and machines to change the size, shape, or finish of material, parts, and assemblies.

There are six classes of secondary processes used to produce produces. These processes are:

- Casting and molding: processes that cause molten or liquid materials to enter a mold where it solidifies before being extracted. Making an ice cube is a simple example of casting.
- Forming: processes that cause a material to take the shape of a die using an external force. Forming aluminum foil over a pie is a simple forming process.
- Separating: processes that give a material size and shape by removing excess material. Cutting hair or a lawn are examples of simple separating processes.
- Conditioning: processes that change material properties using heat, pressure, or chemical action. Baking cookies is an example of a conditioning process.
- Assembling: processes that are used to temporarily or permanently fasten or bond pieces together. Sewing a dress is an example of an assembly process.
- Finishing: processes that protect or beautify a surface by converting the surface or applying a coating. Painting a lawnchair is an example of a finishing process.

In this activity, the students will design and engineer a candle holder and then produce it using a number of different manufacturing processes. During the activity they will identify and describe the several material processes they use and list the basic characteristics of each of these processes.



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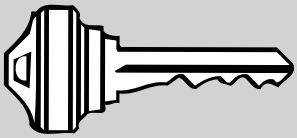


Key Terms

Manufacturing	Making a product by changing the shape, size, or composition of materials.	**Separating**	Processes that give a material size and shape by removing excess material.
Processes	A series of actions that lead to a goal.	**Conditioning**	Processes that change material properties using heat, pressure, or chemical action.
Casting and molding	Processes that cause molten material to enter a mold where it solidifies before being extracted.	**Assembling**	Processes that are used to temporarily or permanently fasten or bond pieces together.
Forming	Processes that cause a material to take the shape of a die using an external force.	**Finishing**	Processes that protect or beautify a surface by converting the surface or applying a coating.

Connections to Other Subjects

Science: Simple machines, forces used in manufacturing processes, geological surveying.

Mathematics: Measuring distances for layout work.

Language arts: Communicating technical information.

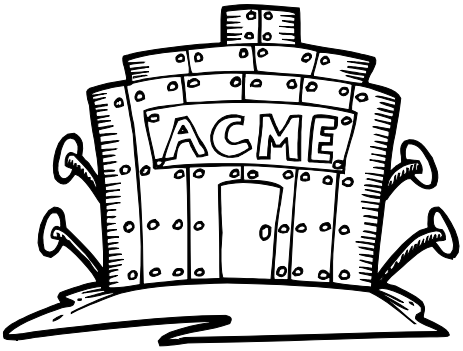
Social Studies: How tools and manufacturing processes have developed over time, effects of manufacturing on a society.

Engineering: How product use information is communicated to customers.

Content Overview

Manufacturing involves a number of different types of processes including designing, engineering, producing, and servicing processes. Each of these help move the product from an idea to a useful item for consumer use.

Designing involves the process that changes "ideas in the mind" to "ideas on paper." Engineering is the act of specifying products and production systems. Producing is a series of processes used to change materials into products. Servicing is the group of processes used to keep products in working order.



The major focus of this HITS unit is on examining the processes that change industrial materials (standard stock) into products. This set of processes is often called secondary processes. They include:

- Casting and molding processes
- Forming processes
- Separating processes
- Conditioning processes
- Assembling processes
- Finishing processes

Casting and molding produce parts that have a desired size and shape by introducing a material into an existing mold cavity. The material may be a liquid or may be made molten by heating it, (metals and plastics) or suspending it in a liquid (clay slip). The material is then introduced into the mold by gravity (pouring) or with force (injecting). Once in the mold, the material is solidified by cooling, drying, or chemical action (catalyst). The casting (cast part) is then extracted by opening or destroying the mold.

Forming processes change the size and shape but not the volume of the material by forcing the material over, between, into a forming device. Forming processes use a forming force and a forming device. The force may be generated by a hammer, press, or rolling machine. The forming device may be a die with a shaved cavity, a mold with an external shape, or a set of smooth or shaped rolls. Forming may be done either hot or cold.

Separating processes size and shape material by removing unwanted material. This is done by action called either machining or shearing. Machining removes the material in the form of chips or molten globs (flame cutting) while shearing fractures the unwanted material from the part. Both processes use a cutting element (tool, burning gases, electric spark, etc.). They include mechanisms to develop cutting motion (causing a cut to form) and feed motion (bringing new material into the cut).

Look at a product near you. What manufacturing processes were used to make it? How would the product have been made a hundred years ago? Could it have even been made then?

Conditioning processes change the properties of a material by altering its internal structure. These processes use heat, mechanical force, or chemical action to change the hardness, corrosion resistance, strength, or other property of a material. These processes include firing ceramics, heat treating metals, and tempering glass.

Assembling processes permanently or temporarily join parts together. These processes may use fusion, adhesion, fasteners, or joints to create the assembly. The process includes processes such as welding, brazing, soldering, riveting, bolting, seaming, and gluing.

Finishing processes coat or convert the surface of a material or product to protect or beautify it. All finishing processes include a finishing agent and a method of application. The agents are either organic (paints, varnishes, etc.) or inorganic (metallic or ceramic) coatings. They are applied by methods such as brushing, dipping, spraying, roll coating, flooding, electroplating, and vacuum metalizing.

Evidence of Attainment

The students will show that they have attained understanding of and ability to use manufacturing processes and technologies by:

- Describing designing, engineering, making, and servicing as manufacturing actions.
- Listing and describing the three stages of manufacturing.
- Giving examples of processes used in each stage of manufacturing.
- Listing and describing the six families of secondary manufacturing processes.
- Using appropriate manufacturing processes to make a product.

Problem/Challenge/Scenario

This unit is based on the manufacturing processes that are used to change industrial goods into finished products. The students will complete the final design and engineering for a candle holder then use casting, separating, assembling, and finishing processes to complete the product. They will conclude the activity by developing an information card to accompany the product.

Context

The context for this activity is one of the areas of technology listed in *Standards for Technological Literacy*: manufacturing technologies.

Resources

Print

Wright, R. T. (2000). *Manufacturing Systems*. Tinley Park, IL: Goodheart-Willcox. ISBN: 1-56637-584-3.

Wright, R. T. . (2000) *Technology.* Tinley Park, IL: Goodheart-Willcox. ISBN: 1-56637-50-0.

Web

Society of Manufacturing Engineers is a professional society serving its members and the manufacturing community. *URL:http://www.sme.org/*

Manufacturing Extension Partnership is a list of manufacturing extension centers. *URL:http://www.mep.nist.gov/*

Tools and Supplies

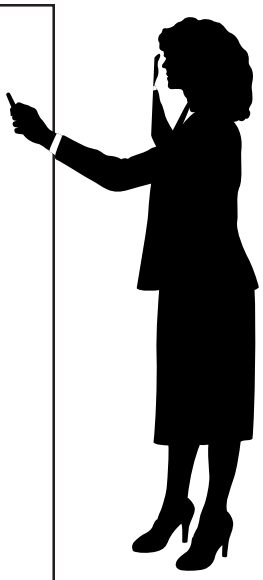
Tools and equipment

Common woodworking tools and machines
Common metalworking tools and machines
Candle molds
Double boiler
Hot plate

Supplies

Candle wax
Candle wick
1/2" thick wood
Sheet aluminum
1/16" thick acrylic
Abrasive paper
Finishing materials
Adhesives

Teacher Preparation



Prepare for this unit by:

1. Developing a presentation or bulletin board showing designing, engineering, making (producing), and servicing as major manufacturing activities.
2. Developing a presentation/discussion on the stages of manufacturing and the six process families included in secondary processing.
3. Reviewing sections of common technology education textbooks dealing with manufacturing and manufacturing processes.
4. Reproducing the handouts in this packet.
5. Gathering the supplies, materials, and tools listed for this activity.

Getting the Students Ready

Prepare the students for the activity by:

1. Describing manufacturing, stages of manufacturing, and major manufacturing processes.
2. Having the students read about manufacturing processes in a technology education textbook.
3. Challenging the students to locate Web sites or "how things work" books that have examples of manufacturing processes.

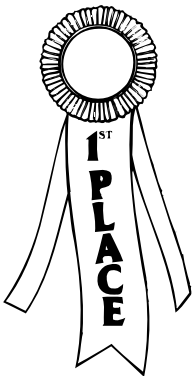
Conducting the Activity

1. Divide the class into groups of three to four students each.
2. Show Transparency #1 which shows the candle holder and the challenge for the students.
3. Have each student in each design team:
   a. Use a *Product Design* form, like the one on page 12, to sketch two possible shapes for the candle holder base.
   b. Present the design to his or her team.
4. Have each team:
   a. Discuss the advantages and disadvantages of each design developed by members of the team.
   b. Select and refine the best design.
5. Have each team assign a part (base, protective member, or candle) to a member of its team. Two members can have the same part if the team has more that three members.

Conducting the Activity (continued)

6. Have each member complete his or her part of a *Process Identification* form, like the one on page 13.
7. Have each team assign one or two members to make the base and one or two members to make the protective member.
8. Have each student:
   a. Make his or her respective part.
   b. Complete the appropriate section on a *Separating Processes* form, like the one on page 14.
   c. Describe the part he or she made and review his or her entries on the *Separating Processes* form with the other members of the team.
9. Repeat steps 7 and 8 with one group finishing the base and the other group casting a candle. The groups should complete their appropriate form on a sheet, like the one shown on page 15.
10. Have each design team assemble the candle holder and complete the *Assembling Processes* form, like the one on the top of page 16.
11. Have each team:
    a. Use brainstorming to determine the information for a consumer information card/sheet. They should enter the information on a *Consumer Service* form, like the one on the bottom of page 16.
    b. Develop a layout for the consumer information on the second page of the *Consumer Service* form, like the one on page 17.

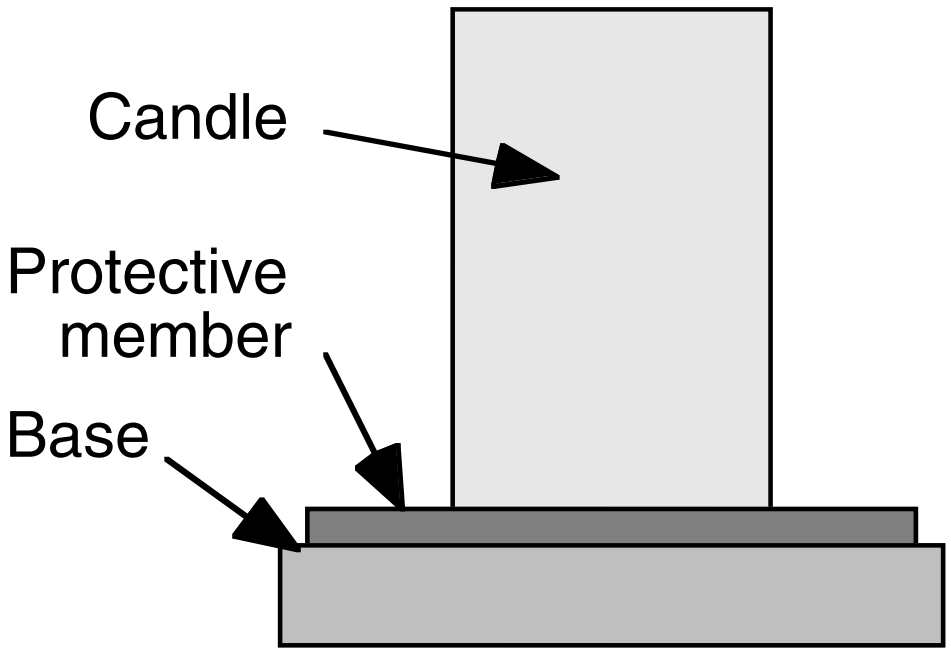
Assessing Students



Students' ability to understand and use manufacturing technologies and processes use can be evaluated in a number of ways, including the methods listed below:

1. Ask the students to describe the stages of manufacturing including locating and extracting natural resources, primary processing, and secondary processing.
2. Have the students give examples of processes used in each stage of manufacturing.
3. Have the students describe the characteristics of each secondary manufacturing process used in making their product.
4. Administer an objective-type test to determine their knowledge of manufacturing processes.

The Challenge



- ✔ Develop a design for a candle holder.
- ✔ Manufacture the holder in keeping with the design
- ✔ Identify and describe the processes used to make the product.

Manufacturing Processes

Learning Activity

Context

Manufacturing Technology

Introduction

Manufacturing processes make many of the products you use every day. They are all the actions people take to change the form of materials to make them more useful.

Challenge

Identify and describe the manufacturing processes you use in making a simple product.

Goals

By the time you finish this activity you should be able to:

- ✔ Describe manufacturing processes as the action taken to design, engineer, make, and service a product.
- ✔ List the three phases of manufacturing processes that a material goes through in becoming a product.
- ✔ Describe the ways materials are located and extracted from the natural world.
- ✔ List and explain the types of primary manufacturing processes.
- ✔ Describe the six types of secondary manufacturing processes.
- ✔ Explain the role of servicing in manufacturing.

Tasks

Your tasks

- ✔ Join a manufacturing team for this challenge.
- ✔ Work with the team to develop a design for a candle holder or other similar product using the *Product Design* form in this packet.
- ✔ Identify and engineer the processes to be used in making the product using the *Process Identification* form in this packet.
- ✔ Work as a team to:
  - ▲ Cut out the parts needed to make the product.
  - ▲ Analyze each process using a copy of the *Separating Process Analysis* form in this packet.
  - ▲ Apply finish to the parts.
  - ▲ Analyze the finishing processes using a copy of the *Finishing Process Analysis* form in this packet.
  - ▲ Cast the candle for the candle holder set.
  - ▲ Analyze the casting processes using a copy of the *Casting Process Analysis* form in this packet.
  - ▲ Assemble the product.
  - ▲ Analyze the assembling processes using a copy of the *Assembling Process Analysis* form in this packet.
- ✔ Develop a sheet/card that provides servicing and use instruction for the product using the *Customer Service* form included in this packet.
- ✔ Present your product and customer information to the class.

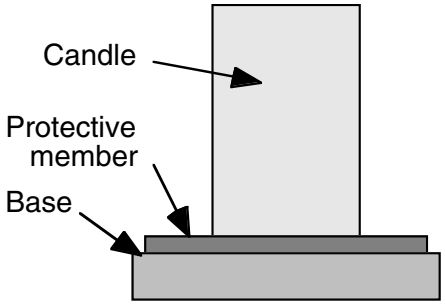
Optional tasks

- ✔ Prepare a layout for a print or electronic advertisement for the product.
- ✔ Prepare a layout and prototype of a package for the product.
- ✔ Design a point-of-purchase display for the product.

Product Design

Complete the following steps in developing a design for a candle holder:

- ✔ Sketch two possible shapes for the candle holder base.
- ✔ The holder should have a base and a protective member as shown at the right.
- ✔ Present your designs to your group.
- ✔ Discuss the advantages and disadvantages of each design developed by members of your team.
- ✔ Help your team select one design to manufacture.



Design # 1

Advantages:

Disadvantages:

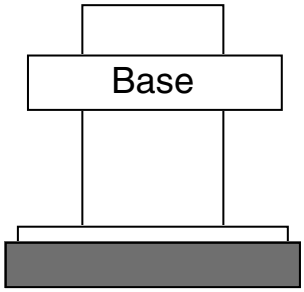
Design #2

Advantages:

Disadvantages:

Process Identification

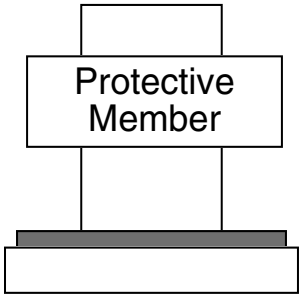
Complete a description for each of the three parts of your candle set.



What processes need to be completed to make this part?

What materials will be used to make the part?

What tools are needed?



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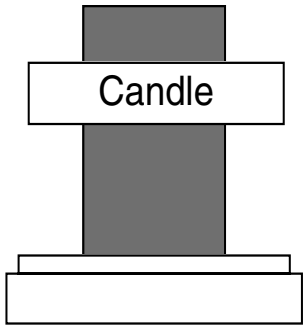
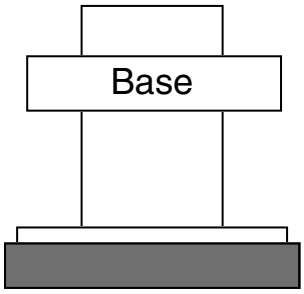


What processes need to be completed to make this part?

What materials will be used to make the part?

What tools are needed?

Separating Processes



What type of separating process was used?

❑ Chip removal ❑ Shearing

What tool or machine was used? _____

What type of cutting tool was used? _____

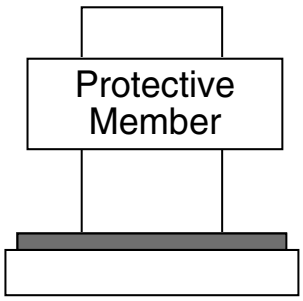
Sketch the tooth shape for the tool:

How was the cutting motion produced? _____

_____

How was the feed motion produced? _____

_____



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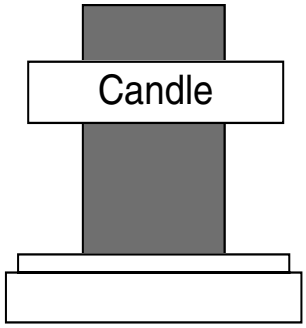
_____

How was the feed motion produced? _____

_____

Casting Processes



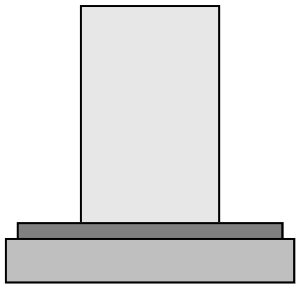
What materials will be used to make the part?_____

What tools are needed?

What steps will you use in making the product?

What problems were encountered while completing the casting process?

Finishing Processes



What type of finishing material was used?

❑ Inorganic coating ❑ Organic coating

What was its name? _____

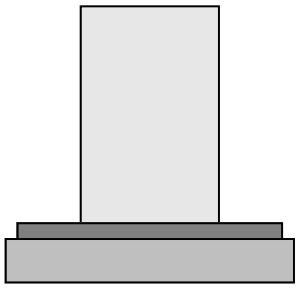
How was it applied? _____

What was the drying time? _____

How did the finish look when applied?

What problems were encountered while finishing the product?

Assembling Processes



What type of assembly was used?

❑ Bonding ❑ Mechanical fastening

How was it done? _____

What problems were encountered while assembling the product?

Consumer Service

What general information about the company and product should be included?

What product use information should be included with the product?

What product care information should be included?

What customer safety information should be included with the product?

Consumer Service

On this grid, develop a layout for the information card or flyer that will be included with the product.

Assessment Rubrics - Writing an Owner's Manual

Company Information

0	1	2	3	4	5
No information included	Only company name given		Company name and address given		Company name and a logo given

Product Information

0	1	2	3	4	5
No information included	Limited product information given		Average product information given		Complete product information given

Set-up Information

0	1	2	3	4	5
No information listed	Incomplete explanation given		Fairly complete explanation but unclear explanation given		Complete and clear explanation given

Service and Maintenance Information

0	1	2	3	4	5
No information given	Incomplete explanation given		Fairly complete but unclear explanation given		Complete and clear explanation given

Operating Information

0	1	2	3	4	5
No procedure given	Incomplete procedure given		Fairly complete but unclear procedure given		Complete and clear procedure given

Repair Information

0	1	2	3	4	5
No information given	Incomplete directions given		Fairly complete but unclear directions given		Complete and clear directions given

Service Required

0	1	2	3	4	5
No information given	Incomplete explanation given		Fairly complete but unclear explanation given		Complete and clear explanation given

Guarantee Information

0	1	2	3	4	5
No information given	Incomplete information given		Fairly complete but unclear informataion given		Complete and clear information given