

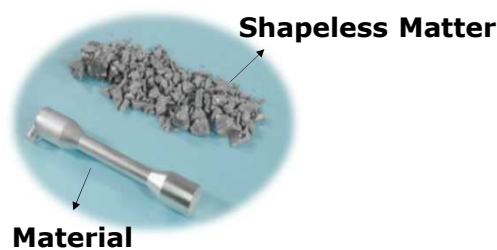
INTRODUCTION AND OVERVIEW TO MANUFACTURING

Chapter Contents

- What Is Manufacturing?
- Materials in Manufacturing
- Manufacturing Processes
- Production Systems
- Trends in Manufacturing

Material Manufacturing

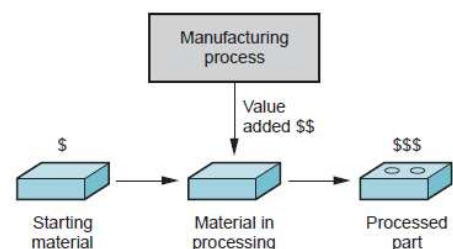
- What is material?
- Manufacturing is the application of physical and/or chemical processes to alter the geometry, properties, and/or appearance of a given starting material to make parts or products; manufacturing also includes assembly of multiple parts to make products.



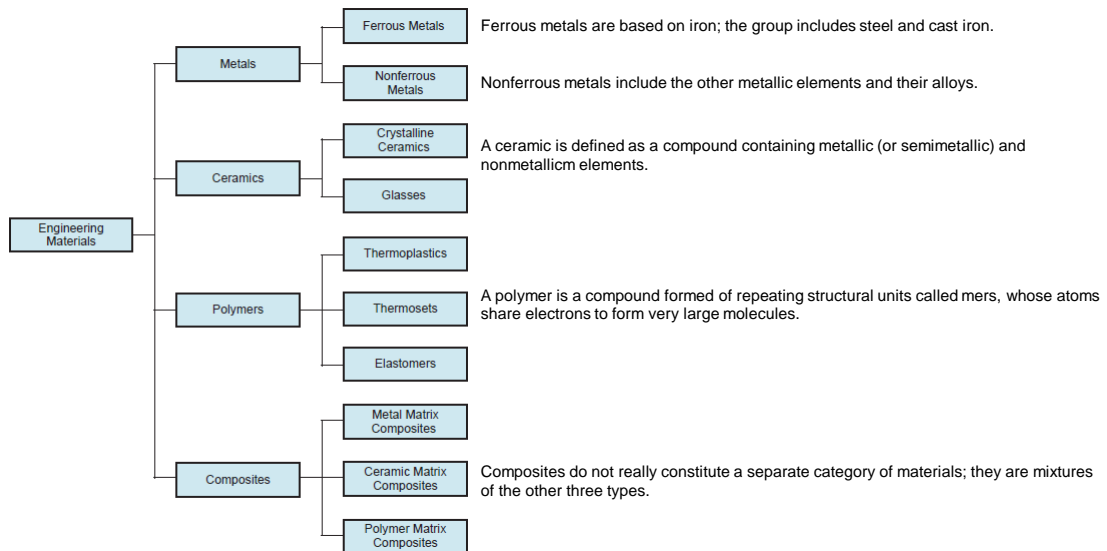
Manufacturing Defined

- Economically, manufacturing is the transformation of materials into items of greater value by means of one or more processing and/or assembly operations.
- The key point is that manufacturing adds value to the material by changing its shape or properties, or by combining it with other materials that have been similarly altered.
- The material has been made more valuable through the manufacturing operations performed on it.

When iron ore is converted into steel, value is added. When sand is transformed into glass, value is added. When petroleum is refined into plastic, value is added. And when plastic is molded into the complex geometry of a patio chair, it is made even more valuable.



Materials in Manufacturing



Materials in Manufacturing

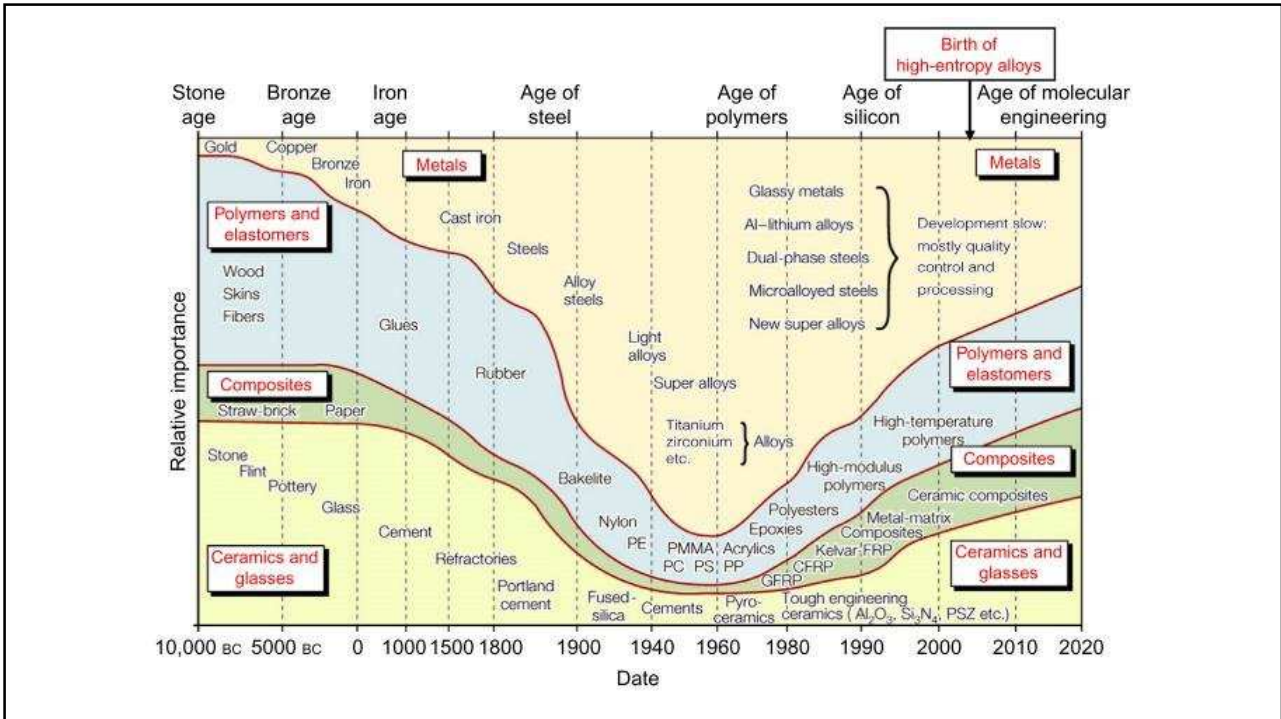
- **Metals** used in manufacturing are usually alloys, which are composed of two or more elements, with at least one being a metallic element.
- Metals and alloys can be divided into two basic groups: (1) ferrous and (2) nonferrous.
 - **Ferrous Metals** - Ferrous metals are based on iron; the group includes steel and cast iron. These metals constitute the most important group commercially, more than three fourths of the metal tonnage throughout the world. Pure iron has limited commercial use, but when alloyed with carbon, iron has more uses and greater commercial value than any other metal. Alloys of iron and carbon form steel and cast iron.
 - What is steel?
 - What is cast iron?

Materials in Manufacturing

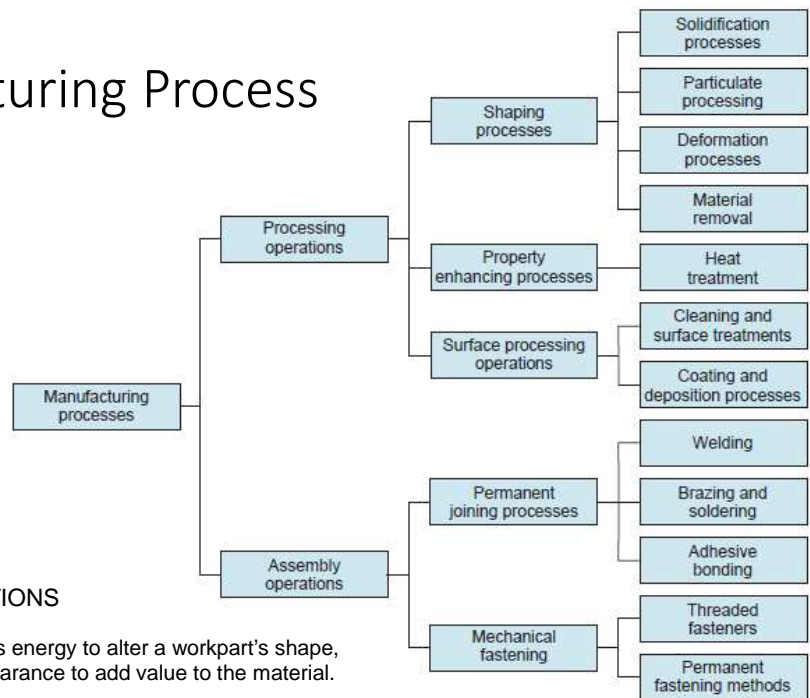
- A **ceramic** is defined as a compound containing metallic (or semimetallic) and nonmetallic elements. Typical nonmetallic elements are oxygen, nitrogen, and carbon. Ceramics include a variety of traditional and modern materials.
 - Traditional ceramics, some of which have been used for thousands of years, include: clay (abundantly available, consisting of fine particles of hydrous aluminum silicates and other minerals used in making brick, tile, and pottery); silica (the basis for nearly all glass products); and alumina and silicon carbide (two abrasive materials used in grinding).
 - Modern ceramics include some of the preceding materials, such as alumina, whose properties are enhanced in various ways through modern processing methods.
 - Newer ceramics include: carbides—metal carbides such as tungsten carbide and titanium carbide, which are widely used as cutting tool materials; and nitrides—metal and semimetal nitrides such as titanium nitride and boron nitride, used as cutting tools and grinding abrasives

Materials in Manufacturing

- A **polymer** is a compound formed of repeating structural units called mers, whose atoms share electrons to form very large molecules.
 - Polymers usually consist of carbon plus one or more other elements, such as hydrogen, nitrogen, oxygen, and chlorine. Polymers are divided into three categories: (1) thermoplastic polymers, (2) thermosetting polymers, and (3) elastomers.
- **Composites** do not really constitute a separate category of materials; they are mixtures of the other three types. A composite is a material consisting of two or more phases that are processed separately and then bonded together to achieve properties superior to those of its constituents.
 - The term phase refers to a homogeneous mass of material, such as an aggregation of grains of identical unit cell structure in a solid metal. The usual structure of a composite consists of particles or fibers of one phase mixed in a second phase, called the matrix.

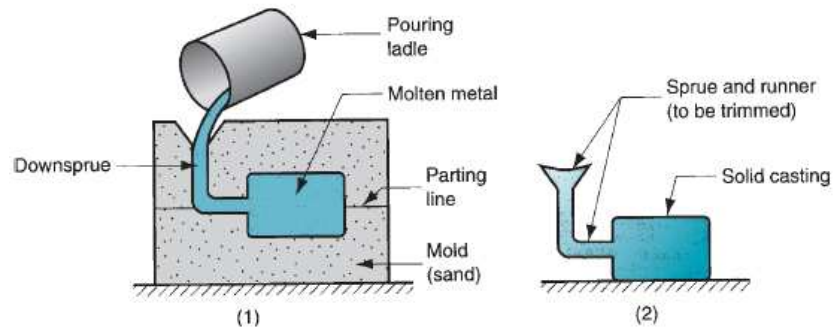


Manufacturing Process

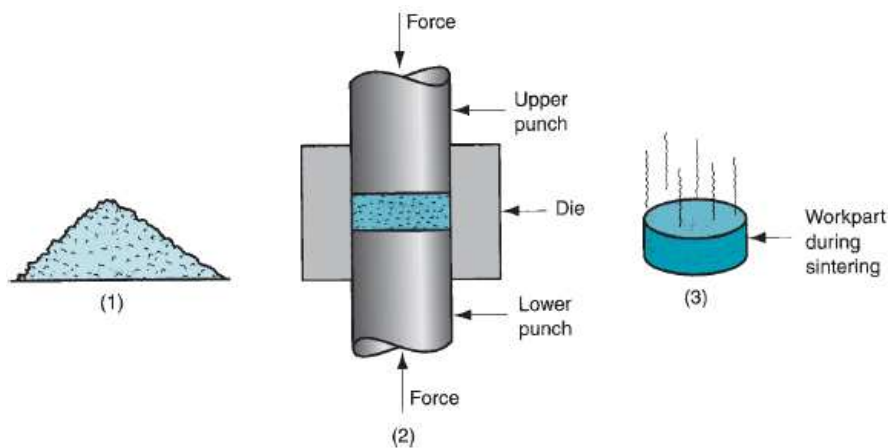


PROCESSING OPERATIONS

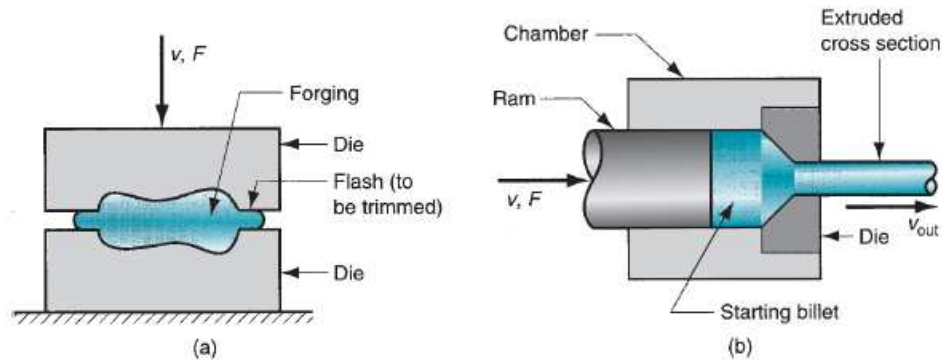
A processing operation uses energy to alter a workpart's shape, physical properties, or appearance to add value to the material.



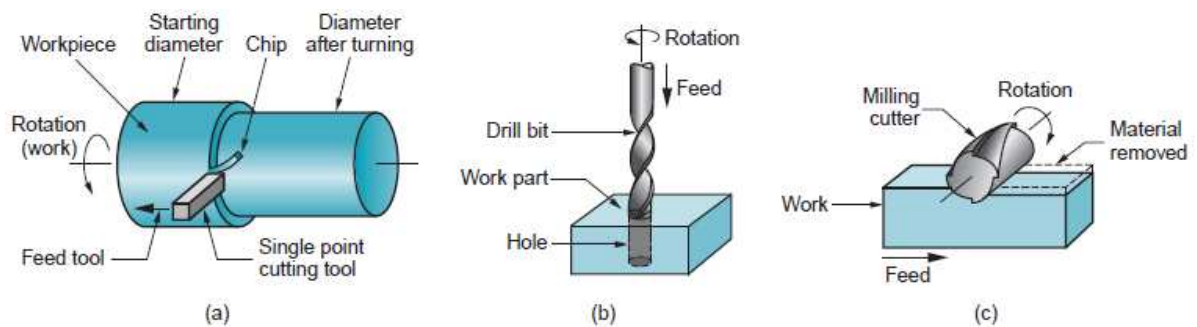
Casting and molding processes start with a work material heated to a fluid or semifluid state. The process consists of: (1) pouring the fluid into a mold cavity and (2) allowing the fluid to solidify, after which the solid part is removed from the mold.



Particulate processing: (1) the starting material is powder; the usual process consists of (2) pressing and (3) sintering.



Some common deformation processes: (a) forging, in which two halves of a die squeeze the workpart, causing it to assume the shape of the die cavity; and (b) extrusion, in which a billet is forced to flow through a die orifice, thus taking the cross-sectional shape of the orifice.



Common machining operations: (a) turning, in which a single-point cutting tool removes metal from a rotating workpiece to reduce its diameter; (b) drilling, in which a rotating drill bit is fed into the work to create a round hole; and (c) milling, in which a workpart is fed past a rotating cutter with multiple edges.

REVIEW QUESTIONS

1. How would you define “material” in terms of metallurgy and materials engineering?
2. How would you define “metallurgy” in terms of metallurgy and materials engineering?
3. How many subgroups of engineering materials are there? Please write them.
4. How would you define metal? What are the features that distinguish it from other materials?
5. How would you define material production?
6. Please explain the importance of the industrial revolution in terms of manufacturing.
7. Why were metals less important to humans than ceramics and polymers in ancient times?
8. Give the definition of steel. Is there a relation between the industrial revolution and steel production? If yes, please explain briefly.
9. How does a shaping process differ from a surface processing operation?
10. What are two subclasses of assembly processes? Provide an example process for each subclass.