Manufacturing

5.2.1A
Unit 5, Lesson 2
Explanation
The designed world is the product of a design process, which provides ways to turn resources - materials, tools and machines, people, information, energy, capital, and time - into products and services.
The Lesson Big Idea

Manufacturing technologies produce quality goods at low prices, and apply the properties of materials to ensure the desired function of a product.
Material Properties

- The physical properties of the material are a basic reason for selecting the material.
- The performance of a product requires various behaviors and types of properties.
- Example, a material could have particularly desirable electrical conductivity properties and perform poorly in maximum strength.
Material Properties

- Often a compromise/trade-off among the needed properties must be made
- To be consistent with the processing selected
- And the structural state desired or possible.
Categories of Materials

- Materials can be categorized as the following:
  - Metals
  - Ceramics
  - Plastics
  - Semiconductors
  - Composites
Metals

- Materials that are normally combinations of metallic elements.
- Elements, when combined, have electrons that are non-localized,
- As a consequence, have generic types of properties.
Metals

- Metals are good conductors of heat and electricity.
- Quite strong, but malleable
- Lustrous look when polished.
- Examples: copper, aluminum, titanium
Ceramics

- Compounds between metallic and nonmetallic elements
- Include such compounds as oxides, nitrides, and carbides.
- They are insulating and resistant to high temperatures and harsh environments.
- Examples: clay, tungsten carbide, alumina, glass
Plastics & Polymers

- Organic compounds based upon carbon and hydrogen.
- Very large molecular structures.
- Low density, not stable at high temperatures.
- Two types:
  - Thermoset (can be melted and shaped once)
  - Thermoplastic (can be melted and reshaped)
- Examples: nylon, polystyrene, rubber
Semiconductors

- Electrical properties intermediate between metallic conductors and ceramic insulators.
- Electrical properties are strongly dependent upon small amounts of impurities.
- Examples: silicon, germanium
Composites consist of more than one distinct material type.

Examples: Fiberglass, a combination of glass and a polymer, concrete, plywood
Think about where you are sitting. What types of materials are surrounding you?

Is your computer, laptop, or cell phone made of more than one type of material?
Properties of Materials

- Properties of Materials can be categorized:
  - Mechanical
  - Electrical
  - Magnetic
  - Optical and Dielectric
  - Thermal
Manufacturing

5.2.1B
Unit 5, Lesson 2
Explanation
Mechanical Properties

- **Tensile strength**: measuring of resistance to being pulled apart
- **Fracture toughness**: the ability of a material containing a crack to resist fracture
- **Fatigue strength**: ability of material to resist various kinds of rapidly changing stresses
- **Creep strength**: ability of a metal to withstand a constant weight or force at elevated temperatures
- **Hardness**: property of a material to resist permanent indentation
Electrical Properties

- **Conductivity**: measure of how well a material accommodates the movement of an electric charge
- **Resistivity**: opposition of a material to the flow of electrical current
Magnetic Properties

- **Magnetic susceptibility**: ratio of magnetization ($M$) to *magnetic* field ($H$)
- **Curie temperature**: temperature at which a material will lose magnetism
- **Saturation magnetization**: state reached when an increase in applied external magnetizing field $H$ cannot increase the magnetization of the material further
Thermal Properties

- **Coefficient of thermal expansion:** how much a material will expand for each degree of temperature increase.
- **Heat capacity:** amount of heat required to change a material’s temperature by a given amount.
- **Thermal conductivity:** indicates a material’s ability to conduct heat.
How do we apply the properties of materials?

Engineers use the material properties to select appropriate materials for product production.
Manufacturing Processes

- Primary processes
  - Turn raw materials into standard stock (timber cut into boards)
- Secondary processes
  - Turn standard stock into finish products (boards turned into furniture)
Final manufactured Products can be one of three types:
- Custom
- Batch
- Continuous
Custom Manufacturing

- One of kind item made by a specialist
- Product examples: yacht, clothing, purse
Batch Manufacturing

- Products are made in batches.
- The components of a product are completed at a workstation before they move to the next one.
- Product Examples:
  - bakery items, paints, special edition shoes
Continuous Manufacturing

- Products are made with no interruption to the production line from the input to output.
- Product examples: cars, food products, bricks
Interchangeable Parts

- The invention of interchangeable parts in the 1700s innovated manufacturing.
- Interchangeable parts are parts that are identical, meaning to replace the part, you do not have to make a custom piece. There is already one the same size.
Interchangeable Parts

- The interchangeability of parts increased the effectiveness of all manufacturing processes.
- An example would be a windshield wiper blade that can be used on multiple vehicle models.