Technology, Engineering and Design
Unit 5: The Designed World
Class Notes - Mr. Dion

Big Idea: 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.

Key concepts:

This unit will enable students to learn to apply a design process, to a variety of resources , materials, tools and machines, people, information, energy, capital, and time – to produce products and services in the technologies of energy and power, construction, manufacturing, information and communication, agriculture and transportation, and telemedicine.

Unit Vocabulary:

First Law of Thermodynamics – Energy cannot be created or destroyed, it can be converted from one form to another.
Thermal Energy– or heat, is the vibration and movement of the atoms and molecules within substances.
Radiant energy (light) - is electromagnetic energy that travels in transverse waves
Electrical energy - energy made available by the flow of electric charge through a conductor.
Chemical energy- is energy stored in the bonds of atoms and molecules. Biomass, petroleum, natural gas, and coal are examples of stored chemical energy.
Mechanical energy - energy stored in the movement of objects
Nuclear energy - is energy stored in the nucleus of an atom — the energy that holds the nucleus together.
Energy Flow Diagrams - The flow of energy within any system can be documented using energy flow diagrams. Energy flow diagrams show what is happening to a particular type of energy as it is used or changed in some process or situation. One type of energy flow diagrams are called Sankey Diagrams.
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.
Interchangeable parts - are parts that are identical, meaning to replace the part, you do not have to make a custom piece.
Open System – An open-loop system has no feedback path and requires human intervention.
Closed System – A system that uses feedback from the output to control the input.
Input – Inputs consist of the resources that flow into a technological system. Inputs include: People, Materials, Tools and/or Machines, Energy, Information, Capital, Time.
Process – The process is the systematic sequence of actions that combines resources to produce an output. Processes can be categorized into:

- Problem Solving: process that works through problem identification to select a final solution.

- Production: process that involves the creation of the product or structure.
- Management: controlling and managing the inputs and other processes involved in the system.

Output – The output is the end result, which can have either a positive or negative impact. Outputs can take the following forms:

- Unexpected Desired
- Expected Desired
- Unexpected Undesired
- Expected Undesired

Feedback - Feedback is information used to monitor or control a system. The feedback loop allows the system to make necessary adjustments during operation.

Non verbal communication - Communication can take place without the use of words. Technological knowledge and processes are often communicated by using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

Agriculture - includes a combination of businesses that use a wide array of products and systems to produce, process, and distribute food, fiber, fuel, chemical, and other useful products.

USDA - The United States Department of Agriculture (USDA) oversees the rules and regulations related to agriculture and includes the Food Safety and Inspection Service Department which helps monitor the safety of food for the public.

Telemedicine - is the use of medical information exchanged from one site to another via electronic communications to improve patients' health status.

Lesson 1: Energy and Power

Big Idea: Advancements in the processing and controlling of energy resources have been an enabling factor in the development of technology.

Key Concepts:

1. The first law of thermodynamics - Energy cannot be created or destroyed, it can be converted from one form to another.
2. The major forms of energy are:
    a. Thermal - or heat, is the vibration and movement of the atoms and molecules within substances
    b. Radiant (light) - is electromagnetic energy that travels in transverse waves.
    c. Electrical - is electromagnetic energy that travels in transverse waves.
    d. Mechanical - energy stored in the movement of objects.
    e. Chemical - is energy stored in the bonds of atoms and molecules. Biomass, petroleum, natural gas, and coal are examples of stored chemical energy.
    f. Nuclear - is energy stored in the nucleus of an atom — the energy that holds the nucleus together.

3. Non renewable resources include fossil fuels such as coal, oil, and natural gas. These nonrenewable resources are forms of chemical energy created from natural occurring elements. Fossil fuels provide around 66% of the world's electrical power and meet 95% of the world's total energy demands. Oil and Coal power plants produce harmful environmental emissions.
4. Nuclear power is also considered a non renewable energy resource. Nuclear power is generated using uranium and produces around 11% of the world's energy needs. The heat required to produce steam, which turns the turbine is created using a process called fission, where atoms split and release energy in the form of heat.
5. Renewable energy resources include water, solar and wind. Hydroelectric power plants take advantage of the downward flow of water to turn the blades of a turbine. Wind works similarly, the wind blows and turns the blades of the turbine. Solar power plants generate electricity by converting the radiant energy from sunlight to electrical using specific materials within the solar panel.
6. Power systems must have these three things:
    a. Source of energy
    b. Process
    c. Load
7. Energy Flow Diagrams - The flow of energy within any system can be documented using energy flow diagrams. Energy flow diagrams show what is happening to a particular type of energy as it is used or changed in some process or situation. One type of energy flow diagrams are called Sankey Diagrams.

Lesson 2: Manufacturing

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

Key Concepts:

1. 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.
2. Materials can be categorized as the following:
    a. Metals - Metals are good conductors of heat and electricity. Quite strong, but malleable. Lustrous look when polished.
    b. Ceramics - 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

c. Plastics - Organic compounds based upon carbon and hydrogen. Very large molecular structures. Low density, not stable at high temperatures. Two types:
    i. Thermoset (can be melted and shaped once)
    ii. Thermoplastic (can be melted and reshaped)
d. Semiconductors - Electrical properties intermediate between metallic conductors and ceramic insulators. Electrical properties are strongly dependent upon small amounts of impurities. Example: silicon germanium.
e. Composites - Composites consist of more than one distinct material type. Examples: Fiberglass, a combination of glass and a polymer, concrete, plywood

3. Properties of Materials can be categorized:
    a. Mechanical –
        i. Tensile strength: measuring of resistance to being pulled apart
        ii. Fracture toughness: the ability of a material containing a crack to resist fracture
        iii. Fatigue strength: ability of material to resist various kinds of rapidly changing stresses
        iv. Creep strength: ability of a metal to withstand a constant weight or force at elevated temperatures
        v. Hardness: property of a material to resist permanent indentation
    b. Electrical –
        i. Conductivity: measure of how well a material accommodates the movement of an electric charge
        ii. Resistivity: opposition of a material to the flow of electrical current
    c. Magnetic –
        i. Magnetic susceptibility : ratio of magnetization (M) to magnetic field (H)
        ii. Curie temperature : temperature at which a material will lose magnetism
        iii. Saturation magnetization: state reached when an increase in applied external magnetizing field H cannot increase the magnetization of the material further
    d. Optical and Dielectric -
    e. Thermal –
        i. Coefficient of thermal expansion: how much a material will expand for each degree of temperature increase
        ii. Heat capacity: amount of heat required to change a material's temperature by a given amount
        iii. Thermal conductivity: indicates a material's ability to conduct heat.
4. The are two types of manufacturing processes:
    a. Primary processes - Turn raw materials into standard stock (timber cut into boards)

    b. Secondary processes - Turn standard stock into finish products (boards turned into furniture)
5. Final manufactured Products can be one of three types:
    a. Custom - One of kind item made by a specialist. Product examples: yacht, clothing, purse
    b. Batch - 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
    c. Continuous - Products are made with no interruption to the production line from the input to output. Product examples: cars, food products, bricks
6. 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. The interchangeability of parts increased the effectiveness of all manufacturing processes.

Lesson 3: Construction

Big Idea: Construction is the systematic process of erecting structures to meet human needs and desires using specific processes related to available resources.

Key Concepts:

1. Steps in the construction process –
    a. Preparing the site
    b. Setting foundations
    c. Building the framework
    d. Enclosing the structure
    e. Installing utilities
    f. Finishing the exterior
2. Construction processes and procedures are:
    a. Based on: Mathematical calculations and Scale drawings
    b. Based on: Scientific principles (Can you name others?)
        i. Electrical; high/low voltage service, Ohm's Law
        ii. Plumbing; volume, rates of water flow
        iii. HVAC; heating and cooling by convection & conduction
    c. Also based on availability of resources
        i. Material; wood, adobe, timber frame, stone,
        ii. People; one person to a large crew

iii. Equipment; hand tools to large mechanical equipment

Lesson 4: Information and Communication

Big Idea: Information and communication systems greatly impact our quality of life.

Key Concepts:

1. Information and Communication systems follow the systems model and require inputs, processes, outputs and feedback. Example: Text messaging
    a. Inputs: a phone, a person operating the phone, cell phone service, etc.
    b. Process: transmitting the message using phone, landlines and/or satellite, phone
    c. Output: message sent
    d. Feedback: undeliverable message or confirmation of message sent
2. Information and communication systems can be further broken down into the following system components:
    a. Source - Person typing the message
    b. Encoder - CPU used to translate the keyboard strokes to programming language.
    c. Transmitter - Wireless connection, modem, phone line
    d. Receiver - router on other computer
    e. Decoder - CPU used to translate binary code to software application
    f. Storage - Inbox, hard drive, server
    g. Retrieval - Software application which pulls up email, such as Outlook, gmail, etc.
    h. Destination - Other person reads the email.
    i. Feedback – Other person responds.
3. Non verbal communication - Communication can take place without the use of words. Technological knowledge and processes are often communicated by using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

Lesson 5: Agriculture and Transportation

Big Idea: Transportation plays a vital role in the operation of agricultural industries which includes a combination of businesses that use a wide array of products and systems to produce, process, and distribute food, fiber, fuel, chemical, and other useful products.

Key Concepts:

1. Agriculture includes a combination of businesses that use a wide array of products and systems to produce, process, and distribute food, fiber, fuel, chemical, and other useful products.
2. Similar to manufacturing, there are companies and farmers who specialize in primary harvesting (taking the natural element from the earth) and other companies and farmers who specialize in transforming the natural element into something for consumers and/or manufacturers of products.
3. The United States Department of Agriculture (USDA) oversees the rules and regulations related to agriculture and includes the Food Safety and Inspection Service Department which helps monitor the safety of food for the public.
4. Transportation plays a vital role in the operation of other technologies, such as manufacturing, construction, communication, health and safety, and agriculture.
5. Transportation systems include intermodal means of transportation, which means air, water, land and space vehicles.
6. Transportation systems include the moving of goods and people. Without transportation technologies, agriculture products would be incapable of moving from the natural occurring element location to consumers.
7. Conveyors are used in a variety of industries, but specifically utilized in agriculture to move products in and out of storage facilities.
8. A combine is used to harvest crops. The crop is cut and directed into a rotating chamber with a series of beaters rotating in opposite directions. The crop is dislodged, falls to the bottom, and separated from debris by sieves. The grain is transferred to a hopped for transfer and the debris falls out the rear.

Lesson 6: Telemedicine

Big Idea: Telemedicine reflects the convergence of technological advances in a number of fields, including medicine, telecommunications, virtual presence, computer engineering, informatics, artificial intelligence, robotics, materials science, and perceptual psychology.

Key Concepts:

1. Telemedicine is the use of medical information exchanged from one site to another via electronic communications to improve patients' health status.
2. Videoconferencing, transmission of still images, e-health including patient portals, remote monitoring of vital signs, continuing medical education and nursing call centers are all considered part of telemedicine and telehealth.
3. Examples of telemedicine:
    a. Doctors sending out x-rays to be reviewed by specialists outside of the hospital
    b. People in remote areas using communication systems, including webcams, to speak with doctors in another region regarding their health concerns
    c. The monitoring of health data, such as cholesterol levels, in a database for access by doctors and patients.
    d. Medical related images and simulations available to education patients and assist in the implementation of patient treatment plans.
    e. Phone networks created for in home caregivers to contact doctors and specialists for treatment decisions.
4. Technologies of Telemedicine:
    a. Wireless and broadband
    b. Satellites
    c. Databases
    d. Fiber optics
    e. Mobile communication devices
    f. Video and Audio transmitting devices
    g. Electrocardiogram
    h. Network Security systems