KNOWLEDGE ORGANISER

KS3 DESIGN AND TECHNOLOGY

YEAR 9 LAMP PROJECT

Learning Objectives

- To learn about electronic and mechanical systems.
- To learn about design strategies.
- To develop drawing and visual communication skills.

WHAT WILL YOU BE DOING THIS PROJECT?

As the main project this year is to design and make a desk lamp, we will focus on topics that relate to this. Therefore, we will learn about electronic and mechanical systems, and design strategies. Once these topics have been covered we will focus on developing our drawing skills and the ability to produce high quality 3D freehand sketches.

Key words

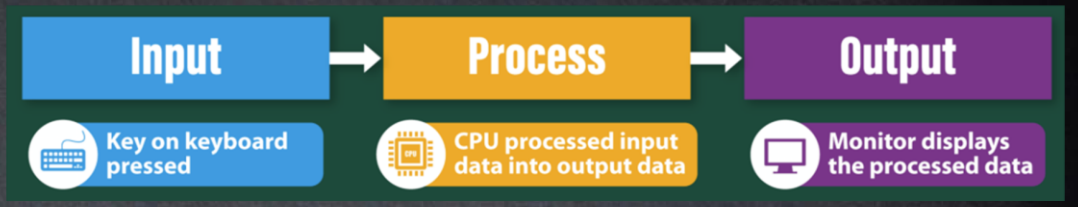
Printed circuit board an electronic circuit in which certain components and the connections between them are formed by etching a metallic coating or by electrodeposition on one or both sides of a thin insulating board.
Light dependent resistor electronic components that are used to detect light & change the operation of a circuit dependent upon the light levels.
Thermistor is a resistance thermometer, or a resistor whose resistance is dependent on temperature.
Microcontroller a microcontroller is a compact integrated circuit designed to govern a specific operation in an embedded system.
Mechanical advantage Some levers operate with mechanical advantage. This means that the lever can overcome a large load with relatively little effort.
Motion the action or process of moving or being moved.
Linear is a one-dimensional motion along a straight line.
Oscillating can be termed as the repeated motion in which an object repeats the same movement over and over.
Rotary moving around a fixed axis or about a fixed axis of revolution or motion with respect to a fixed axis of rotation is a special case of rotational motion.
Reciprocating motion is a repetitive up-and-down or back-and-forth linear motion.
Biomimicry is a practice that learns from and mimics the strategies found in nature to solve human design challenges.

Electronic Systems

- A system is a collection of parts that work together to do a particular function.
- Electronic systems are made up of components that are connected to form a circuit.

Input – process - output

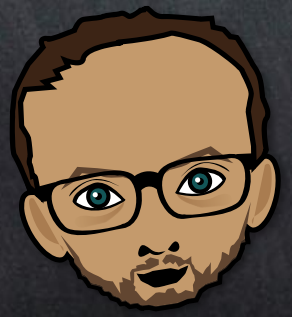
- A system can be broken down into three blocks; input, process and output.
- A signal (such as electricity, movement or light) passes from one block to the next.

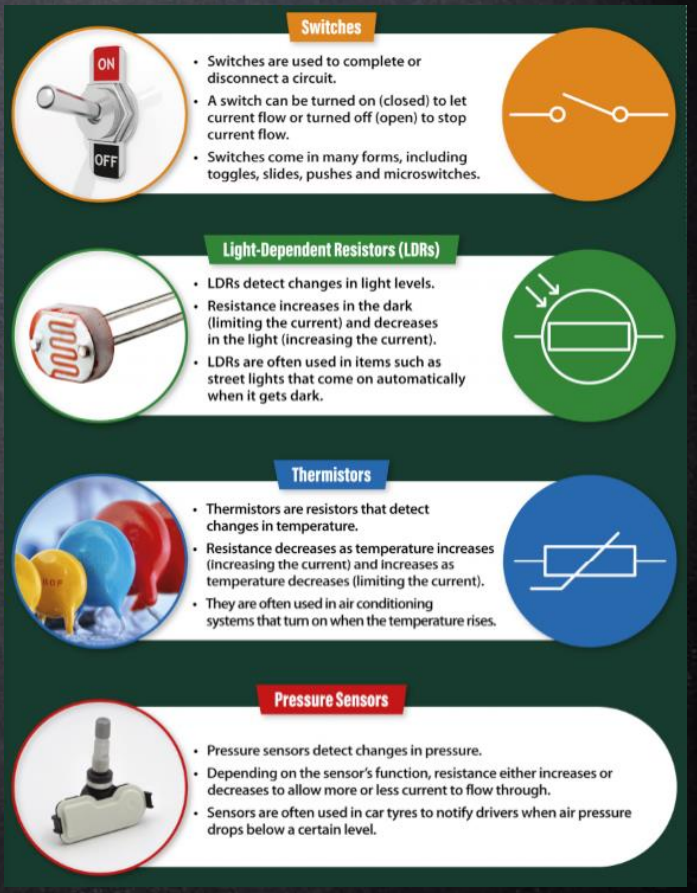


Input Devices

Input devices are electrical or mechanical sensors that use signals from the environment, such as light levels, temperature and pressure, and convert them into signals that can be passed into processing devices and components. Examples of input devices include:

- **Switches**
- **Light dependent resistors**
- **Thermistors**
- **Pressure Sensors**





Process devices

Process devices handle information received and turn outputs on and/or off.

- Electronic processes can be carried out by many components, but in recent years they are more frequently performed by microcontrollers.
- Microcontrollers can be found in many products such as engine control systems, remote controls, office machines, medical devices, and toys; most electronic products contain one.

Process Devices

Process devices process the electronic signals received from an input to determine an output action.

Most processes in electronic systems are carried out by **integrated circuits (ICs)** that can perform multiple tasks, thus reducing the number of components needed in a circuit.

Microcontrollers

A **microcontroller** is a type of IC that is programmed to perform specific tasks in a wide variety of electronic devices. It contains memory, programmable input/output peripherals and a processor all on one chip – it is essentially a tiny computer.

Microcontrollers are adaptable and can be programmed to perform different tasks. The program is then stored in the microcontroller's memory.

Programs are written in a special programming language. Alternatively, a flowchart can be used and then translated by special software into coded commands for the microcontroller. Common programming languages include embedded C, Python, BASIC and Scratch.

Microcontrollers are often used as **timers** and **counters** in embedded systems to measure elapsed time or to count or time external events.

Timers

Timers are often used to add a time delay. They do this by creating a pulse of voltage after a certain period of time to trigger an output. An example includes a microwave timer.

Counters

Counters count the number of pulses of voltage created by an input device and display this as an output. An example includes a pedometer, which counts each step a person takes.

Output devices

Output devices send out information, heat, light, sound or mechanical movement to the environment the system is operating in.

Output Devices

Output devices transfer electrical energy into a response depending on the device's function.

Buzzers

- Buzzers use electrical energy to create sound energy.
- Most use a piezo transducer, which converts electrical current into mechanical movement, to create sound.

Example: car alarm

Speakers

- Speakers use electrical energy to create sound energy.

Example: speakers on a mobile phone

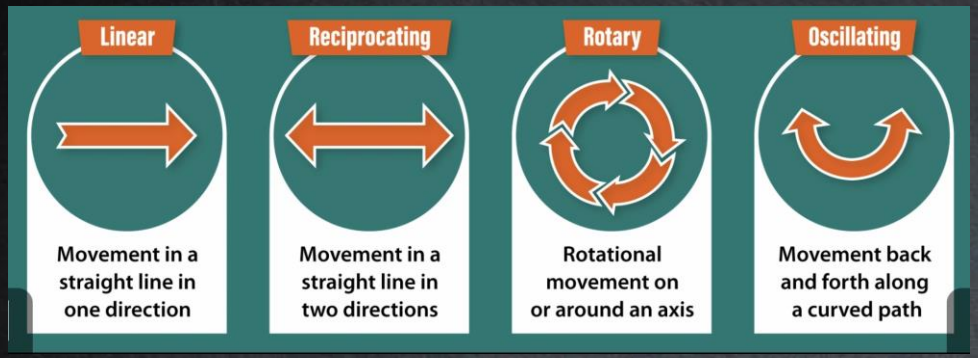
Lamps

- Lamps convert electrical energy into light energy.

Example: house lights

Mechanical systems Movement/motion

All mechanical systems have mechanisms which transform an input motion and force into an output one. They're designed so that you can gain a mechanical advantage from using them. This often involves changing the magnitude (size) and direction of the forces applied.

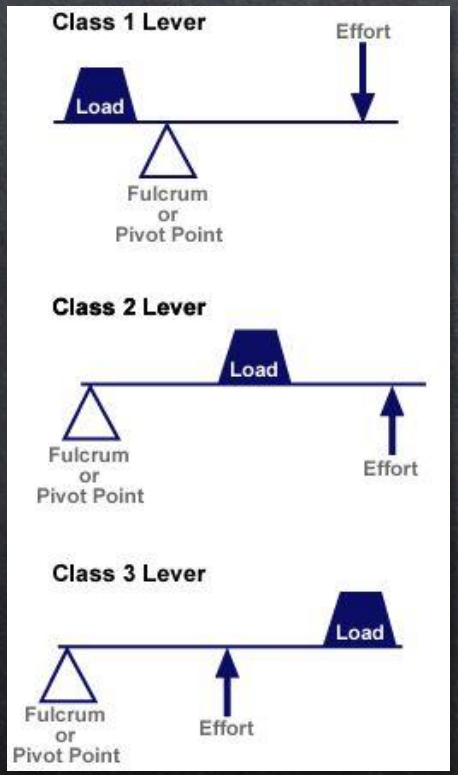


Levers

Levers move and lift loads by rotating about stationary points called fixed pivots.

There are three main types of lever that you need to know about.

- **First order levers** have a pivot in the middle
- **Second order levers** have the load in the middle
- **Third order levers** have the effort in the middle



Gears

Gears are toothed wheels attached to shafts. They're used to transmit power and rotational motion around mechanical systems.

Gear Trains

Gear trains consist of two or more interlocking gears that transmit **torque** (the turning force that causes rotation) and rotary motion.

- The teeth on the gears interlock to prevent slipping.
- The input gear is the **driver gear**.
- The output gear is the **driven gear**.
- If the **driver gear** rotates **clockwise**, the **driven gear** rotates **anticlockwise** and **vice versa**.

In this example, the driver gear is rotating clockwise. Therefore, the driven gear is rotating anticlockwise.

Changing Direction

The direction of rotation of the driven gear can be changed by adding an **idler gear**. The idler gear changes the direction of rotation so that both the driver gear and driven gear are moving in the same direction.

The size of the idler gear does not matter: it transfers the movement, without altering the speed of the gears.

Changing Speed

Gears can be used to make the output speed faster or slower than the input speed by using different-sized gears.

Creating a Faster Output Speed

To make the output speed faster, the input gear must be larger than the output gear.

Creating a Slower Output Speed

To make the output speed slower, the input gear must be smaller than the output gear.

Calculating Gear Ratios

The larger gear always equals 1. The smaller gear is calculated by dividing the number of teeth on the larger gear by the number of teeth on the smaller gear.

In the example above:

Driver	Gear Ratio	Driven
= 1	1 : 2	= 40 ÷ 20 = 2

1 turn of the driver gear = 2 turns of the driven gear

In the example above:

Driver	Gear Ratio	Driven
= 30 ÷ 10 = 3	3 : 1	= 1

3 turns of the driver gear = 1 turn of the driven gear

Design Strategies

Designing can be a very complex process and there are several different ways of doing it:

- The **systems** approach
- The **user-centred design** approach
- The **iterative design** approach

Systems approach	This means breaking down the design process into a number of different stages and doing each in turn. For example, writing the design specification, coming up with ideas, developing your ideas etc.
User-centred design	In this strategy the wants and needs of the user are prioritised and their thoughts are given lost of attention at every stage of the design process.
Iterative design	This is the design strategy GCSE students use to make their prototypes during their NEA. It is centred around a constant process of evaluation and improvement.

Don't get stuck on a bad idea

When you're designing a product it's easy to get stuck on a particular idea. For example it may be an idea that is similar to an existing product, or a design that you've thought of before. This is called design fixation. It can stop you from thinking creatively and coming up with an innovative design idea.

How to avoid design fixation

Following a design strategy will encourage you to look at your design in a critical way and make improvements where necessary.

Geometry

Looking at shapes and mathematical pattern as a starting point. This method is often used by designers.

Biomimicry

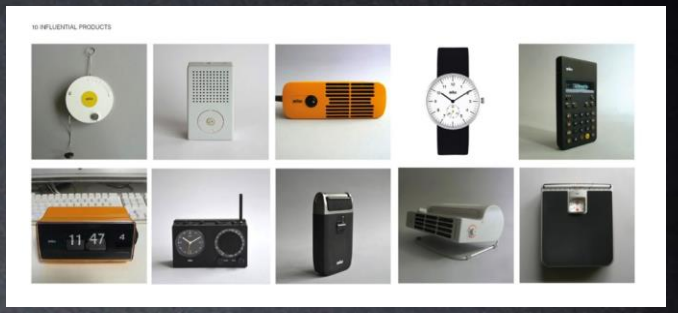
Designing form natural forms, looking at nature for inspiration

Cultural influences

Taking into consideration (or taking inspiration from) the values, beliefs, customs, behaviours and needs of groups of people and societies.

Geometry

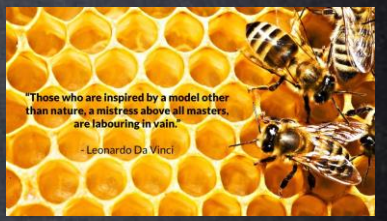
Designers often look towards geometric patterns and shapes as a starting point for design. This can be seen in many examples in surface patterns, especially in textile but is frequently used in three-dimensional product design. Braun is well known for this method of inspiration, taking the most basic shapes and transforming them into seemingly simple and effective products.



Biomimicry

Designing from natural forms

Biomimicry is an innovative approach to design that strives to copy nature's time-tested patterns and structures. The idea is that nature has already solved many of the problems we encounter, and that plants, animals, and even micro-organisms are naturally proficient engineers.



Cultural influences

Over the last 100 years it has become easier to travel, easier to connect through the media and the internet, and so we have become much more aware of the vast wealth of design around the world.

We have also learnt how important it is for society to invest in products that help developing countries to be sufficient and live more comfortably and safely.