Designing and Making Principles

Design Context
= Where there are problems that need a solution the Design Context looks at where, how, when, by who a product will be used

The **design context** may be based on:
- Location (e.g. home)
- Social need (e.g. safety)
- Environmental issues (e.g. sustainability – using **natural resources** in a responsible way)

Good examples of **design context**:
- Support for people with physical or learning disabilities
- Encouraging healthier lifestyles

natural resources = natural products that people can make use of (e.g. metal ores, wood, oil)

Design Brief
= A short way of explaining what you intend to design, who it's for and its purpose

A good **design brief** should include:
- Context
- Client
- Problem to be solved
- Identify design constraints

Constraints = things that control or limit what you can do

Client
= The person that the product is being designed for

Client profile includes:
- Age
- Where they live
- Job
- Car
- Holiday
- Hobbies and interests
- Any disabilities

Design Specification
= A document that lists all the needs and wants that the design solution must meet

Design specification to include when designing a product:
- Aesthetics – how it looks
- Cost
- Customer – what they need/want
- Environment
- Safety
- Size
- Function - how it works
- Materials and manufacturing

Manufacturing Specification
= The information needed to make a product

Areas to include:
- Scale of production – how many will be made
- List of all materials and parts
- Sizes
- Step-by-step instructions
- Testing
- Drawings
- Health and safety

manufacturing = making products (normally on a large scale)

Social Challenges
= The positive and negative effects that a product can have on people

For example:
Everyone now has the ability to play music from a phone, but music that is played too loud could damage the user's hearing.

The designer has to consider both the wants of the user and how the designer will affect other people.

Economic Challenges
= How money is made, organized and used in a society

For example:
If a product sells well, the company producing it can open new factories, creating more jobs and paying more workers. The more profit a company makes.

economic = understanding how money is made and used

Environmental Challenges
= The impact/effect that a product will have on the environment

Products can affect the environment:
- Materials use up natural resources
- Processes use energy
- Product is powered
- Disposed of (thrown away) when no longer needed

The 6Rs of Sustainability:
Refuse, Rethink, Reduce, Reuse, Recycle and Repair.

sustainability = using natural resources responsibly

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Energy
= The power from something (e.g. electricity) that can do work, such as movement or heat

The most common type of **energy** used is electricity.

Sources of **energy**:
- **Fossil fuels** – fuels taken from the Earth (e.g. coal, oil and gas)
- **Nuclear power** - creates power using a nuclear fission reaction
- **Renewable energy sources** – wind, hydroelectricity and solar are used to produce electricity

Designer
= Someone who produces designs and ideas for new products

Sometimes **designers** work on their own, but often they work as part of a team.

Past and present **designers**
- **Jonathan Ive** – iMac, iPod and iPhone working for Apple
- **James Dyson** – first bagless vacuum cleaner working for his own company
- **Coco Chanel** – French fashion designer of luxury clothes
- **Iris Van Herpen** – 3d printing of fashion garments

Design Ideas

Each type of drawing and model communicates different information.

- **Freehand sketching** – quick first ideas down on paper
- **Working drawings** – formal drawing using conventions. 2d and 3d views with sizes
- **Isometric projection** – drawing produced at 30 degrees in 3d
- **Perspective drawings** – drawing using 1 or 2 points showing objects becoming smaller as they get further away
- **Exploded views** – shows all parts slightly separated from each other to help understand how parts fit together

Design Strategies
= Different approaches to designing a product

Sometimes designers work on their own, but often they work as part of a team.

- **Iterative design** – making a model of the design, testing and evaluating repeatedly until the design meets all the need of the client
- **User-centred design** – user is considered at the end of each design stage
- **Inclusive design** – product is designed for all ages, gender and physical ability
- **System thinking** – starts by identifying the input, processes and outputs of a product or system.

Prototypes
= One-off product made to evaluate a design idea

Prototypes are full-sized first versions or smaller examples of a product. Made so a design can be tested and improved before it is produced in larger numbers.

Prototypes can be made using:
- Hand tools / Machine tools
- Computer aided design
- 3d printing
- Breadboards for electronic systems

Testing and evaluating
Testing and evaluating is done to make sure that a product does its job in the way it was intended.

Testing is to check that the product meets the design specification.

Two different types of **testing**:
- **Visual testing** = the way it looks
- **User testing** = does it work

Evaluation = How well does the product:
- meet the needs of the client
- meet the criteria in the design specification

Personal protective equipment (PPE)
= Equipment that provides a barrier between the person wearing it and a potential hazard

Types of **PPE** used in the workshop:
- Safety glasses/goggles used to protect eyes from dust and other flying debris
- Apron used to protect clothing and skin from dust, paint, etc.
- Ear protectors used to protect ears from damage caused by loud and noisy equipment

Working Safely

General safety rules:
- Follow all instructions in the workshop
- Wear an apron and remove any loose clothing or jewellery.
- Tie back long hair
- Always walk – never run
- Keep working area clean and tidy
- Only one person to use the machines

Using and working with materials

Material properties
= How a material will perform and what it can do

Mechanical properties of a material that show **strength** are:
- **Tension** – pulled in different directions
- **Compression** – squeezing and pressing.
- **Shear** – pushing in opposite directions.
- **Torsion** – twisting in different directions.

Hardness – resistance to scratching and wear

Toughness – a material will not break when a force is applied

Malleability – the way a material can change shape without breaking

Physical properties of a material
- **Density** – is the mass of the material (per unit volume)
- **Electrical conductivity** – ability of electricity to pass through the material
- **Absorbency** – ability of the material to draw in moisture

Selecting materials
= The success of a product depends on the selection of the right materials

Material selection needs to look at:
- **Functionality** – how a product works
- **Aesthetics** – how it looks
- **Availability** – how you buy it in the shops
- **Cost**
- **Environmental factors** – carbon footprint
- **Social and cultural factors** – latest trends

Paper and boards
= Materials that mainly come from trees.

Paper and boards are made by chopping down trees and turning the chips into **pulp**

Stages of making **paper and boards** are
- **Timber** – cutting down trees
- **De-barking** – taking off the outside texture
- **Chipping** – cutting into small pieces
- **Mechanical pulping process** – mixing and cutting by adding water
- **Chemical pulping process** – adding different chemicals to break down the wood
- **Hydrapulper** – mixing and cutting recycled paper by adding water
- **Refining** – used to change the fibres
- **Screening and cleaning**
- **Paper-making machine**

Weight of the paper and boards is measured in **gms** grams per square metre

Polymers
= Plastic materials that are mostly made from oil.

Types of **polymers**:
- **Thermoplastic polymer** can be recycled

Example PET used for drinks bottles.
- **Thermosetting polymer** cannot be reshaped

Example Polyester resin used for car bodies

Synthetic = man-made using chemical processes. Typically, made from crude oil by drilling underground or under the sea.

Metals
= Materials that are made from metal ores, which are dug from quarries or mines.

Most **metals** are not used as pure elements. They are normally a mixture of two or more metals called an alloy.

Two main types of **metals:**
- **Ferrous metals** – contain iron.

Examples Cast iron.
- **Non-ferrous metals** – do not contain iron.

Examples Aluminium.

Timbers
= Material that comes from trees

Types of **timber** include:
- **Hardwoods** – from deciduous trees that can take up to 100 years to grow. Examples are: Oak , Beech.
- **Softwoods**– from coniferous trees that take between 25 and 30 years to grow. Example: Pine.
- **Manufactured board** – made by gluing particles or pieces of wood together

Textiles
= Fabric materials that are made from fibres.

Fibres - very fine, hair-like structures that are spun or twisted into **yarns**.

Natural fibres come from plants and animals.
Examples Cotton and wool.

Synthetic fibres come from oil, coal or petrochemicals.
Examples Polyester and Acrylic.

There are two main methods for making textile fabrics: **Weaving and knitting**.

System thinking
= A group of parts that work together to carry out a function.

The three blocks of the simplest system are:

- **Input block** – signal from outside (e.g. switch or a sensor).
- **Process block** – receives the signal from the input, determines what the system will do.
- **Output block** – is turned on and off by the process block (e.g. light, movement and sound).

New and emerging technologies
= Items that are being developed continually.

Technology is the use of knowledge to achieve a practical outcome.

Examples of these are:

- **Automation** – computer technology to operate equipment.
- **Computer-aided design (CAD)** – software to draw, model and simulate the performance of products.
- **Computer-aided manufacture (CAM)** – the use of software to control machines tools.
- **3d printing** – making a product model from a polymer from many layers.

Electronic systems
= Made up of a wide range of components.

These components are called:

- **Input devices** – usually a sensor or a switch
- **Output devices** - transforms the electrical signals (Lamp, buzzer, motor).
- **Passive components** – not an input or output devise, or a power supply (Resistor, diode, capacitor).

Circuit diagrams – each component is drawn as a simple symbol.

New materials
= Materials that have improved properties or combinations of properties that were not previously possible.

Examples of these are:

- **Graphene** – harder than diamond, about 300 times stronger than steel and conducts electricity better than copper.
- **Composites** – made up of two or more different materials.
- **Smart materials** – property that can change depending upon its environment. E.G. light and heat.
- **Interactive textiles** – conductive fibres and threads made from carbon steel and silver to connect a circuit.

Programmable components
= A component that can be programmed to do different tasks.

For example:

- **Microcontrollers** – work like small computers (computer chip)

Flowcharts and programming - set of instructions that tell the microcontroller what to do. Written on a computer and downloaded into the chip (microcontroller).

Mechanical devices
= A device that can change the amount or direction of force in a system.

The four types of movement are:

- **Linear motion** – moving in straight lines.
- **Rotary motion** – moving in a circle.
- **Reciprocating motion** – moving back and forth in straight lines.
- **Oscillating motion** – swings from side to side.

Types of devices:
Linkages, Gears, Pulley systems, Cam and follower and Rack and pinion.

Electronic and Mechanical Systems
New Developments in Technology