Section Three — Knowledge Organiser

If you've ever found yourself wondering how to select a material, what processes go into obtaining it, and how to make sure a product is up to scratch, you're in luck. The key info is summarised here — read on...

Selecting Materials

Weigh up the factors before choosing a material. E.g.

Functionality

- Properties suitable for use of product?
- Easy to work with?

Availability

Easy/cheap to source and buy in the right form?

Social Factors

- Positive impact on lives of producers?
- Impacts on society: health and welfare?

Cultural Factors

Appropriate for culture of target market?

Culture covers religion, beliefs, laws, language, food, dress, art and traditions.

Cost of Materials

- Selling price of product?
- How much material? Bulk buying?
- Mass production?

Aesthetics

- Colour, finishes, texture, feel?
- Will it appeal to target market?

Environmental Factors

- Sustainable/biodegradable?
- Recyclable or re-usable?
- Renewable or non-renewable?
- Damaging to ecosystems?

Ethical Factors

- Fair to workers?
- Animal cruelty?

Forces and Stresses

Forces — cause materials to break or change shape, measured in newtons (N)

Stress — force per unit area, measured in N/m^2

Forces

Tension stretches, pulls objects apart. E.g. suspension bridge cables are under tension.

Compression squashes, shortens objects. E.g. chair legs supporting a person sitting experience compression.

Shear forces cause parts of objects to slide past each other. Cutting uses shear forces. **Bending** is a type of shear force.

Torsion twists objects by rotating parts in opposite ways. E.g. ship propeller shafts experience torsion (engine pushes one way, water pushes back other way).

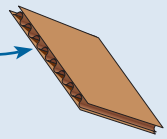
Enhancing Materials

Lamination — layers added to form composite. Increased strength and rigidity.

Interfacings — fabric sewn/stuck onto inside. Improved strength, rigidity, functionality, aesthetics.

Webbing — fabric woven to give high tensile strength (resistance to tension).

Bending — reinforces, stiffens.



Folding — bending to form a fold. Material more flexible along fold.

Scales of Production

One-Off Production

Bespoke products — every item different, meeting customer needs, e.g. custom-made dresses.

Skilled workers needed, labour-intensive, expensive, time-consuming.

Batch Production

Specific quantities (batches) made, process by process on whole batch, e.g. printed circuit boards.

Quicker, more consistent than one at a time. Needs flexible workers. Down time between batches wasteful.

Mass Production

Thousands made — for mass-market products. Broken into simple tasks on assembly line.

Can use expensive equipment and CAD/CAM. Recruitment easy, robots often used.

Continuous Production

Constantly running, making massive amounts of one thing, e.g. aluminium foil.

Almost fully automated, few workers. Expensive equipment but low cost per item.

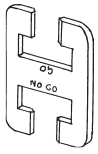
Quality Control

Quality checks are made at every stage of production.

Checking products meet a high enough standard — only a sample is tested.

Tolerance — acceptable margin of error.

Limit gauges check components are within tolerance, e.g. go/no go fixtures.



Colour registration marks check printing plates aligned.

Repeated prints checked by eye against sample print.

Consistency in Manufacturing

- Depth stop — long rod lets you drill to exact depth.
- Laser cutters — cut accurately and precisely, to a small tolerance. Machine must be programmed correctly.
- Photo-etching (for printed circuit boards) — removes unwanted copper from circuit board. Consistent exposure time keeps quality consistent.

Production of Materials

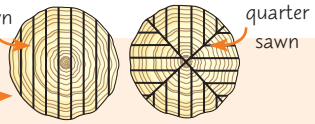
Paper and Board

trees cut down → bark stripped → wood chipped and pulped → pulp washed and bleached → pressed, dried and cut to size

Pulping — converts wood to cellulose fibres. Can be mechanical (grinding with machines) or chemical (other parts of wood dissolved).

Paper can also be made from other plants, e.g. grasses.

Wood and Timber



Trees felled, bark removed and cut into planks: →

Wood is seasoned (dried) by air-drying or kiln-drying. Makes wood stronger and less likely to rot.

Wood also processed into manufactured timbers:

- **MDF** — cellulose fibres glued together.
- **Chipboard** — wood chips, shavings, sawdust glued together.
- **Plywood** — thin layers peeled from softened wood, cut and dried. Layers stacked and glued, with grain of each layer at 90° to the one above.

Each of these are heated, pressed and dried.

Metals

Ore — rock containing metal that can be extracted.

Metal extracted from ore by:

Furnace — ore crushed and heated with other materials. Metal separates and is removed. E.g. iron from haematite.

Electrolysis — extracted using electricity. E.g. aluminium from bauxite.

Refining — removing impurities from extracted metals. Refined, molten metal usually cast — poured into moulds and cooled to solidify in certain shape.

Fibres

Natural fibres — naturally occurring fibres.

Wool: sheep sheared → fleece cleaned and scoured → fibres combed with wire rollers (carding)

Cotton: cotton plant seed pods harvested → fibres cleaned and seeds removed → carding

Silk: cocoon of silkworm harvested → hard cocoon gum softened → silk fibre filament unwound (reeling)

- **Regenerated fibres** — made from natural material, chemically processed into fibres. E.g. viscose.
- **Synthetic fibres** — made from polymers. E.g. polyester, nylon.

polymers melted, forced through tiny holes → cooled to form long filaments

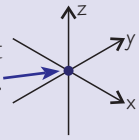
Fibres made into yarn, yarn made into fabric.

Production Aids

Reference points and coordinates

Reference point — point from which all measurements are made. Helps control accuracy and reduce measurement errors. Essential for CAM machines.

If using x,y,z coordinates, reference point usually the datum — coordinate (0, 0, 0).



Templates

Template — object drawn or cut around to produce shape identical to template. Quicker, easier and more accurate that measuring every time.

Strong and hard-wearing, so can be used repeatedly without wear or damage.

Can check against template for quality control.

Patterns

CAM cutting machines use CAD patterns, and follow coordinates of pattern's outline.

Textile patterns — templates of different pieces of product. Made from e.g. tissue paper, pinned to fabric and cut around.

Casting patterns — exact replica used to make mould of object you want to form. Made of resin/wood/metal.

Jigs

Jig — device that guides tools working on material, or keeps material positioned correctly.

Speed up and simplify production.

Plastics

Plastics made by polymerisation — small molecules (monomers) joined into long chains (polymers).

Get monomers by fractional distillation (heat crude oil to split into different chemical fractions) and cracking (heat fractions to break into smaller molecules).

Material Production & The Environment

Deforestation — large areas of forest cut down for wood for timber, paper and board. Destroys habitat.

Oil drilling — for plastics and synthetic fibres. Can disrupt habitats. Can release toxic chemicals into air. Leaks of oil or waste materials harm wildlife.

Mining — for metals. Habitats destroyed. Energy from fossil fuels, releases pollution and greenhouse gases. Chemicals can leak into waterways.

Farming — for natural fibres. Artificial fertilisers/pesticides pollute waterways and harm wildlife. Habitats cleared for crops.

Revision is like quality control for your knowledge...

It's not enough to know how to select materials — you need to know how they are obtained and processed.