

Exploring Design and Technology

for Key Stage 3

Paul Anderson
Jacqui Howells

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How to use this book

Find out more

Links are provided to online resources where you can find out more information on a subject.

Knowledge check

Questions for each topic test your knowledge and understanding and help your teacher to monitor your progress. Extension questions allow you to take your understanding of a topic a step further.

Exploring Design and Technology for Key Stage 3

Exploded views

Exploded views show how all the parts of a product are related to each other. The parts are drawn slightly separated from each other and suspended in space. This helps the designer to understand how all the parts will fit together to make the completed product.



▲ An isometric and exploded view of a sweet dispenser

Modelling

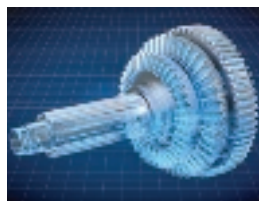
Physical models

Physical models are models made from real materials, such as card or polystyrene blocks. They allow the designer to see what an idea would look like in three dimensions. They also allow errors and problems with the design to be spotted before it is made using more expensive materials.

Physical models can also be produced using rapid prototyping or 3D-printing equipment (see Section 4.1). This allows models of very complicated products to be produced much more quickly than if made by hand.

Virtual models

Models can also be produced using computer-aided design (CAD) software. These are called **virtual models**. The main advantage of this type of modelling is that no materials or equipment are needed, other than a computer and the software. The CAD software is usually very accurate and produces realistic-looking results. Changes to the design can be made quickly and easily.



▲ A virtual model of a component

1.9 Communicating design ideas

Knowledge check

- 1 Explain the differences between a freehand sketch and a formal drawing.
- 2 Name two types of orthographic projection.
- 3 Explain the difference between one- and two-point perspective drawings.
- 4 Describe the purpose of exploded views.
- 5 Describe an example of a mathematical model.

Extension

- 6 Discuss the advantages and disadvantages of virtual modelling.

Find out more

Information and notes about sketching and drawing: www.bbc.co.uk/bitesize/guides/z6jkw6f/revision/3

An example of the use of third angle orthographic projection: www.technologystudent.com/designpro/ortho2.htm

A video tutorial showing how to draw a hallway using one-point perspective: www.youtube.com/watch?v=0ICyLN612cY

In practice

Produce an annotated 3D sketch, third angle orthographic drawing and exploded view of a smartphone.

Mathematical models

Mathematical models use equations to model products and systems. For example, the effect of one force on a bridge can be worked out using an equation. A simple model might be produced on a spreadsheet; more complex models, where many forces are involved and many calculations are required, are often carried out using CAD software. You will learn more about the forces involved in Section 2.1.

Communicating systems

Systems can be communicated using block diagrams and circuit diagrams, known as schematics. Block diagrams show an overview of the system in terms of its inputs, processes and outputs. Schematics use circuit symbols to show how all of the components are joined together.

More information on systems can be found in Section 3.1.

Key words

exploded view - where parts of a product are drawn slightly separated from each other and suspended in space to show how they are related to each other.

physical model - a model of a design made using real materials.

virtual model - a model of a design produced using CAD software.

mathematical model - a model produced using mathematical equations.

Activity

- 1 Draw a range of different 3D shapes using isometric projection.
- 2 Sketch a range of ideas for a toy that helps to improve a child's numeracy skills. Use CAD to produce a virtual model and orthographic drawing of your design.
- 3 Draw your school's corridor using one-point perspective.

Key words

Important terminology and concepts are clearly explained for each topic.

Activity

Short individual or group activities help you to apply your understanding of each topic.

In practice

Suggested practical activities help you to put your knowledge and understanding into practice and build your designing and making skills.

Contents

How to use this book

xx

1 Designing and making principles

- 1.1 Contexts: informing possible outcomes xx
- 1.2 Identifying client and user needs: collecting primary and secondary data xx
- 1.3 Writing a design brief and producing a design specification xx
- 1.4 Carrying out investigations to identify problems and needs xx
- 1.5 Environmental, social and economic challenges that influence designing and making xx
- 1.6 Energy xx
- 1.7 The work of past and present designers xx
- 1.8 Design strategies xx
- 1.9 Communicating design ideas xx
- 1.10 Developing prototypes xx
- 1.11 Testing and evaluating ideas and products xx
- 1.12 Working safely xx

2 Using and working with materials

- 2.1 Material properties xx
- 2.2 Selecting materials xx
- 2.3 Paper and board xx
- 2.4 Timbers xx
- 2.5 Metals xx
- 2.6 Polymers xx
- 2.7 Textiles xx

3 Electronic and mechanical systems

3.1	Systems thinking	xx
3.2	Electronic systems	xx
3.3	Programmable components	xx
3.4	Mechanical devices	xx

4 New developments in technology

4.1	New and emerging technologies	xx
4.2	New materials	xx

Glossary	xx
-----------------	-----------

Index	xx
--------------	-----------

Picture credits	xx
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1.9

There are many different ways to communicate design ideas. This is because each type of drawing and model communicates different information, or is shown to a different group of people.

Freehand sketching

Freehand sketches are a great way to quickly get first ideas down on paper. These can be a designer's ideas for their own use or the first thoughts of other people. These sketches don't follow any formal drawing rules or require the use of any special equipment. They can be produced in either 2D or 3D.

Ideally, 3D sketches should be annotated. This means that they are labelled with notes to give useful information about the design, for example what is good and bad about the design, how it could be made and how well it would meet the needs of the user.



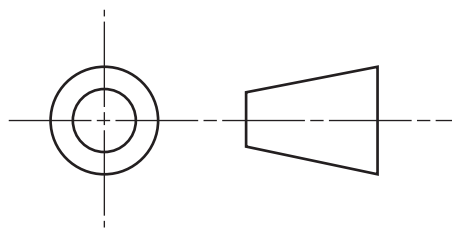
▲ 3Dsketches with annotations

Working drawings

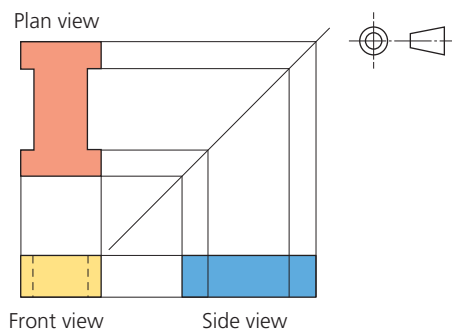
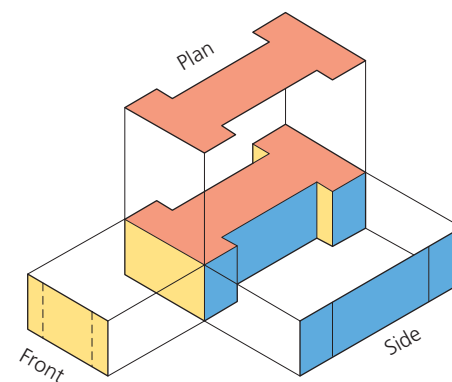
Working drawings are a type of formal drawing. Formal drawings are different from freehand sketches as they must follow certain rules, known as **conventions**. They are used to communicate the sizes of parts and products, for example so that machine operators know what size to make the products.

Working drawings use **orthographic projection**, which is a way to draw 3D objects in 2D. This is achieved by drawing the product from three different viewing points – these are called the front, plan and side views.

The two main types of orthographic projection are first angle and third angle. Most designers in the UK use third angle orthographic projection. For these, the front view is drawn below the plan view, with the side view to its right. Orthographic drawings can be produced by hand or by using computer-aided design (CAD) software.



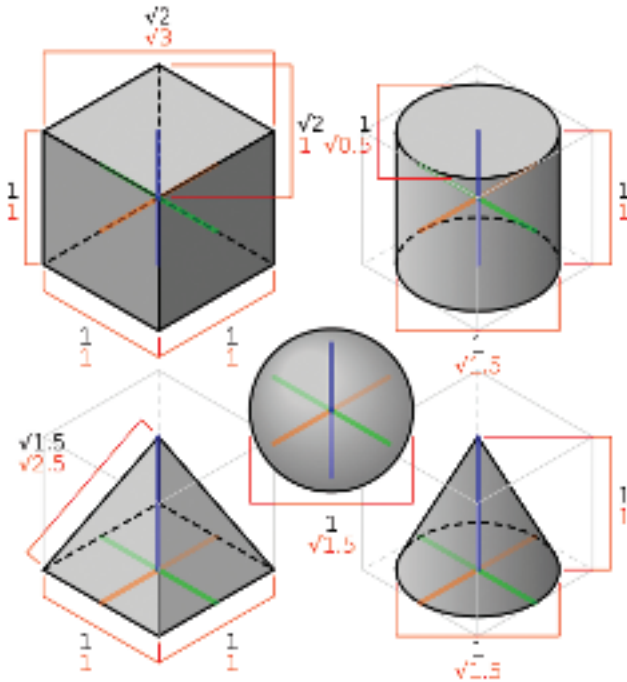
▲ Symbol used for third angle orthographic projection



▲ An example of third angle orthographic projection

Isometric projections

Isometric projection is a method for drawing an object in 3D. It is useful when presenting design ideas to users and clients. Each of the sides is drawn at a 30° angle.

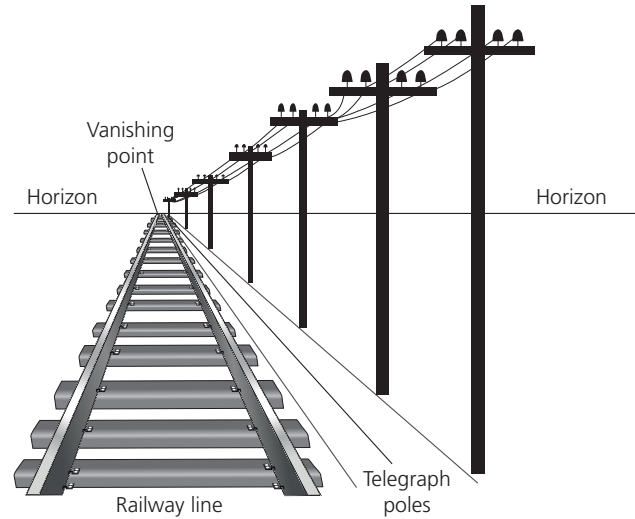


▲ Different shapes drawn in isometric projection

Perspective drawings

There are two main types of **perspective drawing** – one-point and two-point. Both types show objects becoming smaller as they get further away.

With one-point perspective, the objects are shown heading towards a single vanishing point on a horizon line. With two-point perspective, there are two vanishing points, one on each side of the horizon line. Two-point perspective drawings are harder to draw, but they look more realistic.



▲ A drawing using one-point perspective



▲ A drawing using two-point perspective

Key words

drawing conventions – rules that a formal drawing must follow.

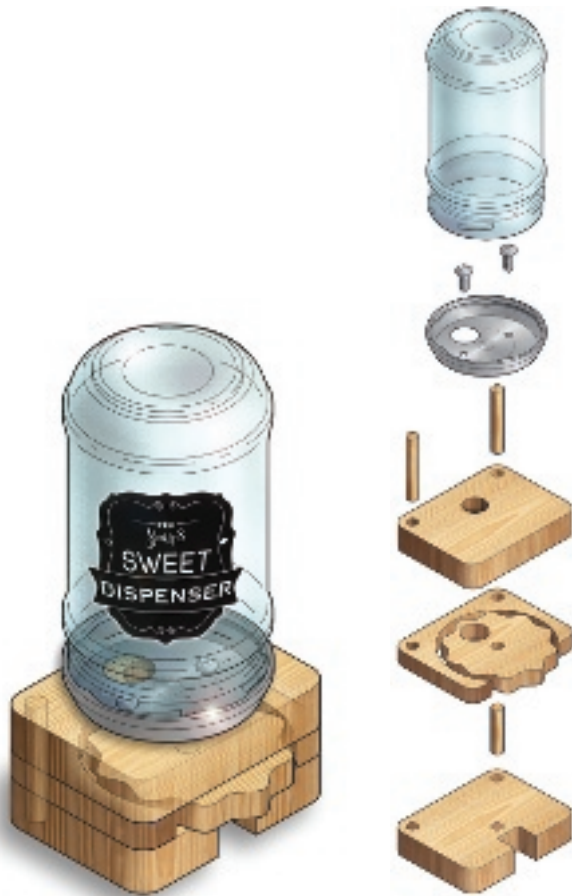
orthographic projection – a way of showing a 3D object in 2D by drawing it from its front, plan and side views.

isometric projection – a method for drawing an object in 3D, where each of the sides is drawn at a 30° angle.

perspective drawing – a method of showing how objects become smaller as they get further away.

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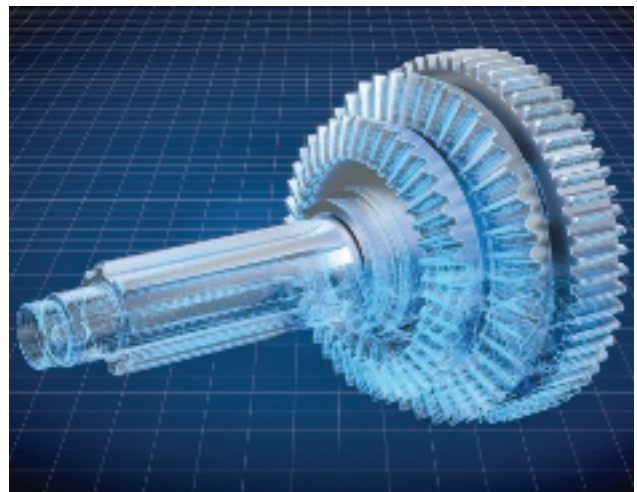
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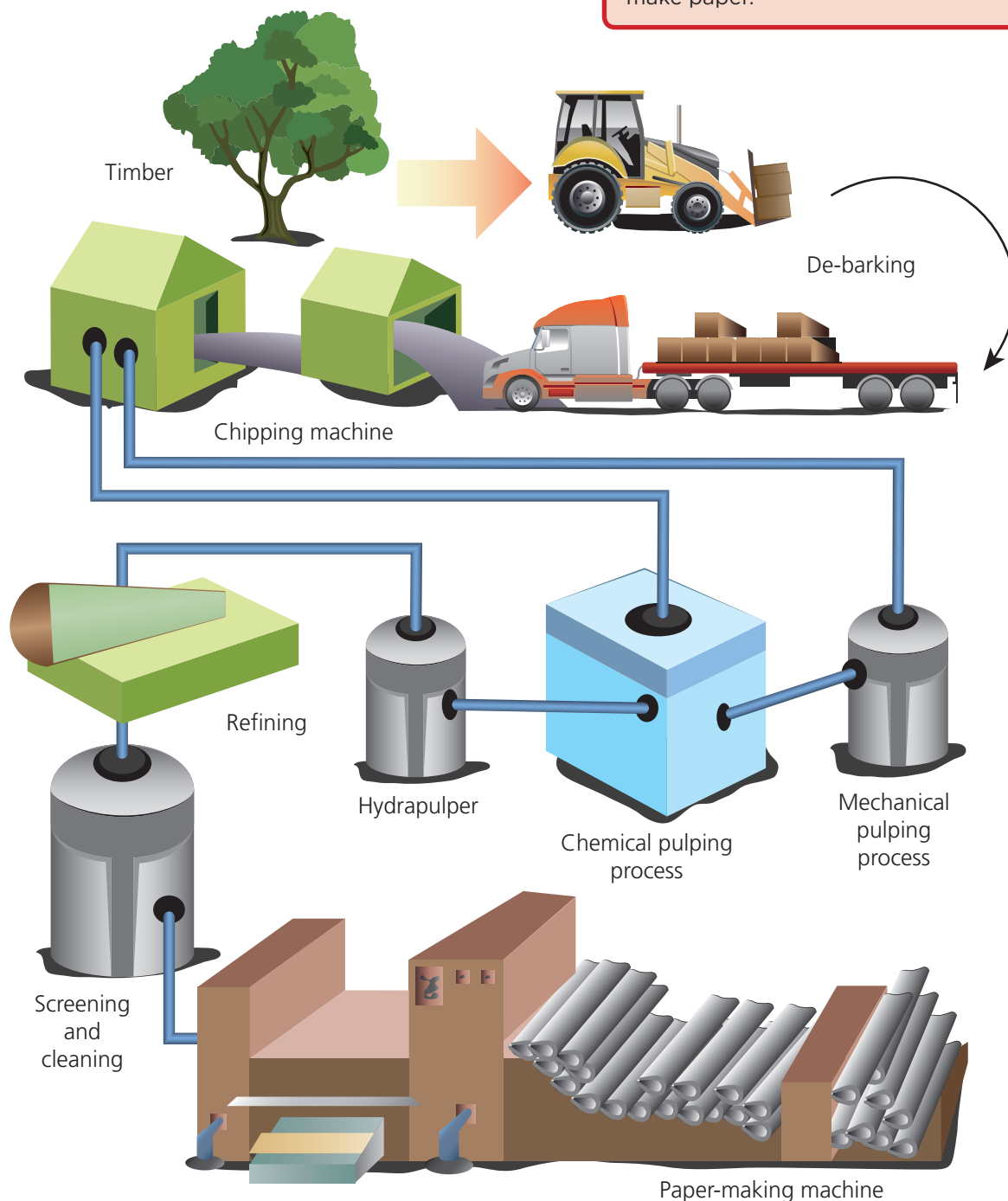
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2.3 Paper and board

Each year, about 12.5 million tonnes of paper and board are used in the UK – that works out at about 0.5 kg per day for each person in the UK, the same weight as a half-litre bottle of water.

Key word

pulp – wood fibres mixed with water, used to make paper.



▲ The paper-making process

How paper and board are made

Paper and board are mainly made from trees. The trees are chopped down and turned into **pulp**, which is wood fibres mixed with water. Chemicals might be added to the pulp to give the colour and properties that are wanted. The water is then squeezed or sucked from the pulp, in order to form the paper or board.

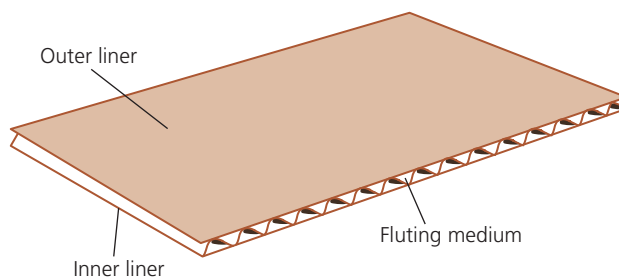
On average, each tree makes about 40 kg of paper or board. To reduce the impact of this on the environment, these trees can be sourced from managed forests – this means that new trees are planted to replace those that are chopped down.

After being used, most paper and board can also be recycled. There are some products, however, such as food packaging, for which recycled paper cannot be used. One reason for this is to avoid the risk of contaminating the food with the chemicals that the paper was in contact with in its previous use. Paper and board can also be burnt to make energy. If they are dumped in landfill, paper and board are biodegradable. This means that they will break down into their constituent parts fairly quickly and should cause very little pollution.

Types of paper and board

Paper and board are used for many different purposes and as a result there are many different types. Some types of paper are also referred to as card. The difference between paper and card is just the thickness (or weight per unit area) of the material.

Almost all of the types of board are solid. The one exception is corrugated cardboard. The fluted layer increases the stiffness of the cardboard without increasing its weight much.



▲ Corrugated cardboard



▲ Pulp ready for the paper-making process

Processes used to make products from paper and board

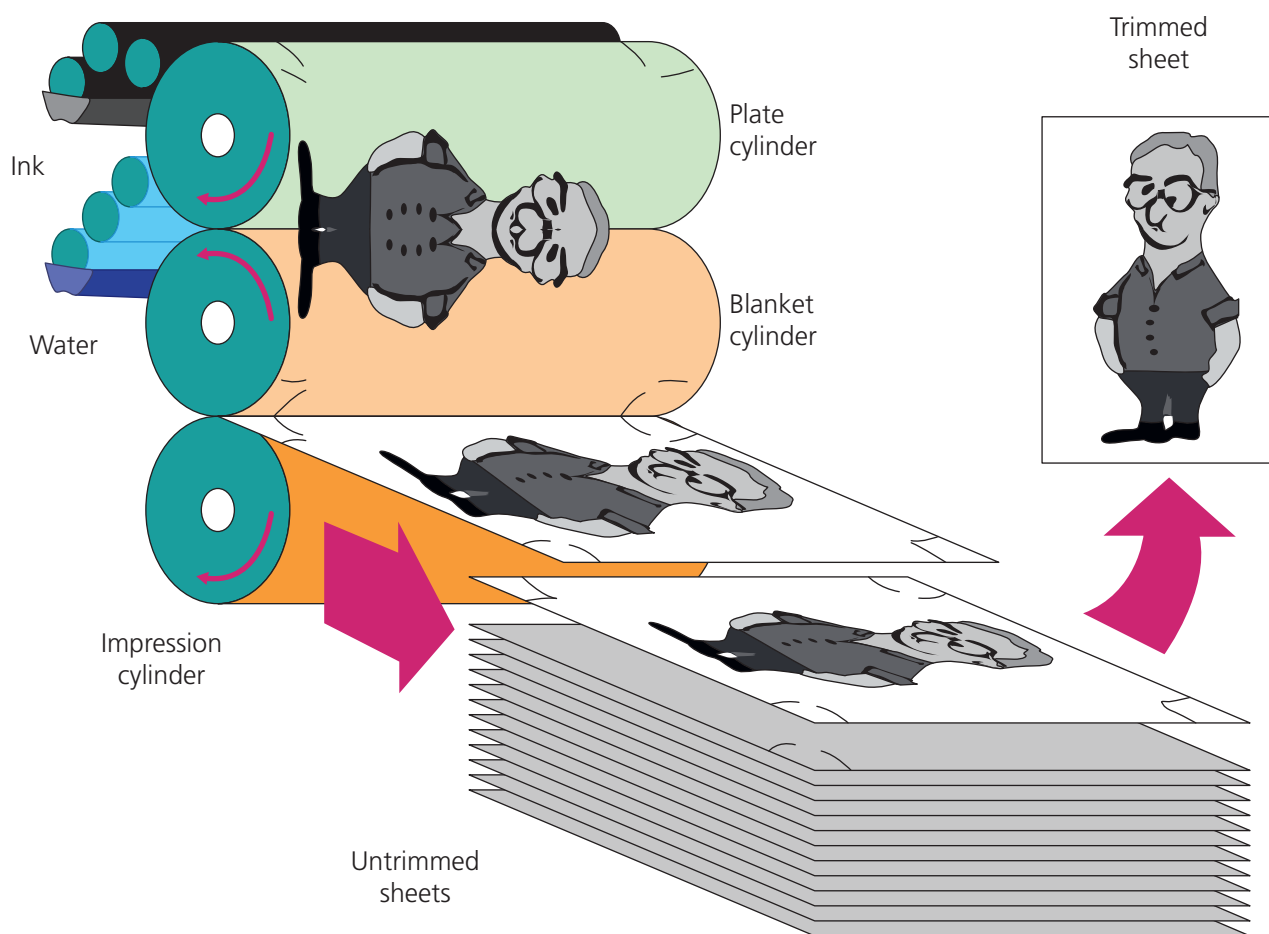
Printing

Printing is used to apply designs to paper or board. A laser printer or inkjet printer might be used to print one product or a few products with the same design.

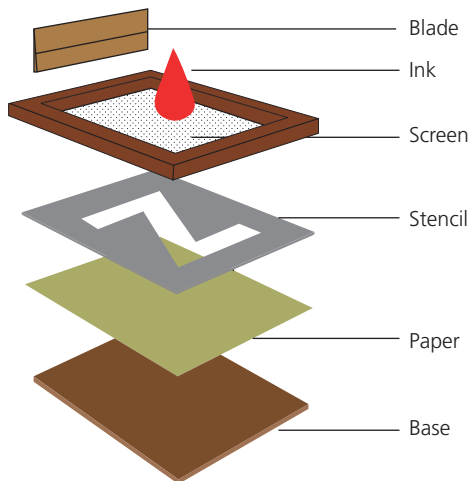
To produce a small number of identical prints, screen printing might be used. A stencil of the required design is cut out and stuck to a screen. Ink is squeezed through the screen, and the stencil

acts as a mask that only allows ink to contact the paper or board in the shape that is wanted. A different stencil is needed for each colour in the design. Screen printing uses relatively low-cost equipment but is time-consuming.

Some products, such as magazines, need to be printed in large quantities. For these, offset lithography may be used. This uses a printing plate with an image marked on it. This transfers the inked image on to a rubber blanket cylinder, which in turn presses the image on to the paper or board as it is fed through. This process is expensive to set up but can very quickly print many products.



▲ Offset lithography printing



▲ Screen printing

Cutting

Tools used for cutting paper and board include scissors, craft knives, compass cutters and guillotines.

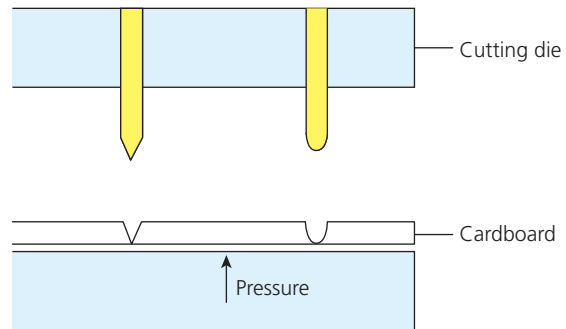


▲ Compass cutters can be used to cut paper and board



▲ Cutting paper using a guillotine

When a large quantity of products needs to be cut, die cutting may be used. This uses metal blades that can cut a complicated shape in a single operation. Creases and folds can also be marked during die cutting by using a blunt blade.



▲ Die cutting

Folding

When making only a few paper products, folds and creases can be marked out by scoring with scissors. A graphics ruler can be used to ensure that the fold is straight. When a large quantity of paper products needs to be folded, machines will use metal plates to fold them at the required places.



▲ Paper-folding machine

Joining

Paper and board products are often attached together using adhesives, such as polyvinyl acetate (PVA). For example, most textbooks are glued together. Paper and board can also be attached together in the following ways:

- Using paper clips.
- Using split pins: These are pushed into holes in the paper or card, then their legs are separated and bent back behind the material to hold it in place. They allow for movement and are often used in pop-up models and books.
- Using staples: These are small U-shaped pieces of metal. When a force is applied by a stapler, the legs of the staple bend inwards, securing the material. They are often used to secure the pages of magazines together.

Finishing processes

Laminating involves adding layers of material. For example, paper can be enclosed between two layers of polymer, using heat. This can protect the paper from moisture. Takeaway food containers are laminated products, made from card with layers of aluminium foil and clear polymer.

Embossing involves pushing paper or board against a mould to create a raised design or pattern. This is used to make features stand out from the background, for example on greetings cards or wallpaper.

Key words



laminating – adding layers of material, such as encapsulating paper in polymer.

embossing – using pressure to create a raised design on a sheet of material.



▲ Embossing to create a pattern on wallpaper

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