Mock-ups, models and prototypes

A vital part of the design process is the testing and refinement of ideas and presentation of them to the client. Designers have to communicate their ideas clearly. Usually, this is done with sketches and two-dimensional and three-dimensional drawings. However, models can convey ideas more accurately than even the best drawings. A good model will show the form and size, the surface finish, texture and colour, and especially, in the case of moving models, how the object to be produced works.

At an early stage of a design:

- Quick rough **mock-ups** are made to convey to the client what is being proposed. (A mock-up is defined as 'a simple construction or device to explore, explain and test design ideas'.)
- Problems of fit and function can be resolved.

Mock-ups are used to test a design before continuing with the design process. They visualise an idea, giving an impression of possible solutions. Cheap recycled materials like cardboard, lids, ping-pong balls, and plastic may be used.

Models are defined as scaled replicas of design solutions.

Static models have no moving parts. These are sometimes called *block models* and are made out of any material that can be made to imitate the solution. Sometimes only half models are made, as in the case of many yachts (half models accurately convey the lines since yacht bodies are symmetrical). Materials used for all models may be totally unrelated to the materials to be used for the finished product, but perfectly suitable for photographs, advertisements and evaluations.

Working models have moving parts. The purpose of a working model is to test how various parts will fit together and how the design will function.

Prototypes are exactly the same as the finished product, identical in every way except they are fabricated by hand. In industry, a prototype is used to test a product before expensive tools are made to mass-produce it.

Computer modelling

Computer modelling is used extensively in industry, planning, films, animation, hospitals and many industries. Schools are now being offered 2-D and 3-D software packages like *Pro/DESKTOP*, *SolidWorks*, and *VectorWorks*, which enable a concept to be drawn and then refined on the computer, turning it this way and that, rendering it to simulate its appearance in a number of different materials, modifying it and creating orthographic drawings, parts lists, **detail drawings** and sections. The scale may be changed to view even the very smallest components. Computer models require no physical materials, so are much cheaper than other models.

Surface developments can readily be produced from a pictorial and areas calculated. Models can be placed in a virtual landscape for viewing. The major disadvantage is that they cannot actually be handled and that there is a rather steep learning curve involved in using computer programs.

Materials for modelling

A wide variety of materials are used for making models, varying from soft, easily-worked materials to harder ones that are more difficult to cut and shape. The softer the material, the easier it is to work but the more difficult it is to get accuracy or a 'professional finish' to the model.

Softer materials, such as card, foam plastic and wood are very useful for making mock-ups where the surface finish is not important; harder materials like acrylic and metal are better for scaled models.

Cardboard comes in a series of colours and thicknesses. Its easy to cut and bend, can be drawn or printed on and comes in a range of textures. Corrugated cardboard is useful for strengthening.

Foamed plastics are of different types.

• Expanded polystyrene comes in sheets and blocks. It is coarse-grained and tends to crumble, so it is hard to achieve a good surface finish. A hot wire or knife will cut it, and the surface can be filled with Plaster of Paris. (Video shops typically advertise on a type of sandwich board, which is ideal for gluing in layers to make site models.) Polystyrene sheet is often used for vacuum-forming techniques.

• Styrofoam has a very fine structure making it more suitable than expanded polystyrene. It can be cut with a hot wire, knife or saw.

Wood can be easily shaped, glued, jointed and painted. **MDF** (medium density fibreboard) is cheap and easily worked. Balsa is a very light wood from Ecuador, which can be bought in thin sheets and joined with glue; balsa is very good for making models of furniture.

Acrylic is a flat rigid plastic with a high surface finish. It can be cut, laminated, bent and bonded with special glue. It can also be worked on the lathe and milling machines.

Plasticine can be softened by warming and may be reused. It is possible to get an excellent finish on plasticine.

Plaster of Paris can be poured into a Plasticine mould, and when set, worked with knives or potters' tools.

Other materials often found in models are: wire, string, metal foil, adhesive backed copper, wax, clay, papier maché, cork, **welding** rods, split pins, fasteners, steel wool, sponge, twigs, sandpaper, wood shavings, sawdust, sand, floc, eggshells and dyed lichen.

Papier maché models are made by sticking strips of glue-soaked newspaper over a frame made from wire, crumpled newspaper or cardboard boxes. Overlap and build up the strips until the desired form is reached. A firmer finish can be obtained by plastering over the papier maché once it has dried.
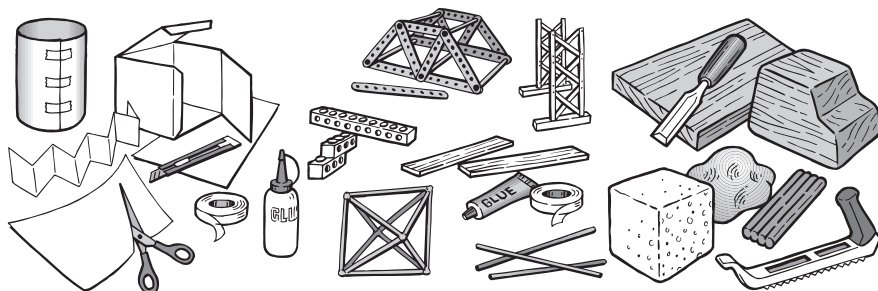


Materials used for modelling

Techniques for constructing models

Expanded polystyrene models

- Work from pictorial and orthographic views.
- Cut out a block of the correct size.
- Sketch the plan on the top of the block and the elevation on the side.
- Gradually cut away excess material, using a hot wire cutter, a craft knife or a saw.
- Use a cardboard template to check curves.
- Fill the surface with plaster or *Polyfilla*.
- Paint and draw on details such as switches.

Cardboard models

- Cylinders, cones, pyramids and prisms can be made from flat sheet after a surface development has been drawn.
- Draw the plan and elevation first to get the measurements.
- Draw the surface development.
- Use a cutting mat and a craft knife with a metal ruler.
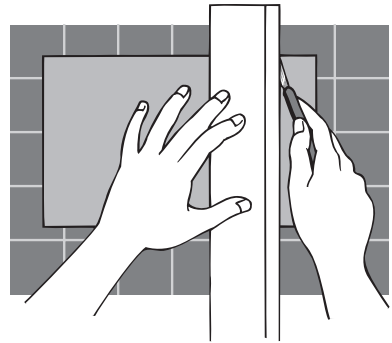
Cutting card on a cutting mat

- Score the card before bending.
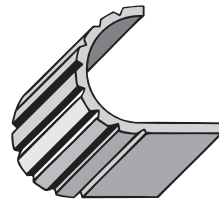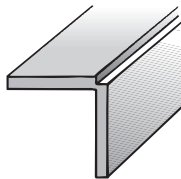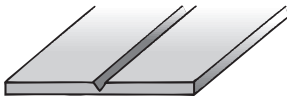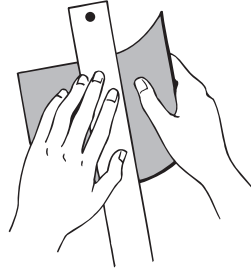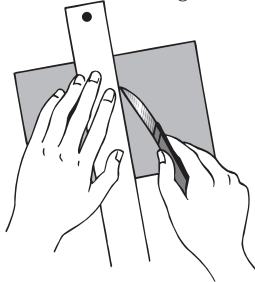
Scoring and bending card

- Make sure there are flaps for gluing.
- Cut out any windows.
- Add the graphics.
- Assemble with *PVA* and hold with tape or paperclips until set.

Wood models

• Cut out the shapes oversize.
• Laminate by gluing and clamping.
• When dry, shape with a bandsaw, plane or rasp.
• Drill holes.
• Sand.

Acrylic models

• Accurately draw each part and mark out the acrylic.
• Laminate if necessary, using acrylic cement. (Be very careful – the cement can cause cancer.)
• Cut out parts on a bandsaw.
• Sand to the line on the disc sander.
• Drill holes.
• Smooth edges with a metal rule or file.
• Cut reinforcing strips for joins.
• Cement the reinforcing strips in.
• Sand the fillets and rounds.

Texture

Small areas can be modelled with paper, sandpaper or card stuck on with double-sided tape and then a primer applied over the surface.

Fillers

• Plaster of Paris, although soft and easily damaged, is useful for filling large areas and coarse grain.
• Polyester-based filler is a two-part mix used in the panelbeating trade. It can be used thick and dries in about 15 minutes.
• Epoxy fillers are two-part and take longer to harden than polyester. They can be used thick but may run.
• Cellulose putty hardens through evaporation, so thin coats are necessary.

Painting

Primers seal a surface and will fill minor blemishes. To get a good finish, rub down after each coat and use two or three thin coats.

Car spray paint used over the appropriate primer gives a very high gloss, dries fast and can be used to re-coat in 10–15 minutes. It can dissolve expanded polystyrene, so a water-based primer must first be applied.

Enamels give a good finish, but take a long time to dry. They can successfully be used over polystyrene.

Acrylics are water-based and take about two hours to dry.

Thin coats of paint coats are preferable to thick ones. Spraying gives a better finish. Suspend the model and read the instructions on the aerosol can to find the optimum distance for spraying. If the can is held too close, *orange peeling* may occur; too far away and the paint will start to dry too much as it passes through the air.

For a very high gloss finish, *Brasso* may be used to polish a painted surface.

Masking areas is difficult, as sometimes the mask drags some paint off. It is best to paint parts separately and then to assemble.

Lettering

Photocopy lettering onto OHP (overhead projector) sheet and stick it on to the model. If relief is wanted, use card. *Letraset* ('stick-on' lettering) or computer-generated text can also be used.

Glues

- Contact eg *Ados*   no good for expanded polystyrene but good for most other materials.
- *PVA*   good for paper, wood and expanded polystyrene.
- *Tensol*   used for rigid polystyrene and acrylic.
- *Bostik* and *UHU*   paper.
- *Araldite*   good for aluminium and wood.
- Glue gun   for mock-ups, messy finish.

Present the model in its context by supplying a background or by photographing it being used – eg if it's a scale model to a scale of 1 : 20, find a picture of someone drawn to a scale of 1 : 20 to simulate holding the model or standing beside it.