PRO 204 – Modeling Prototyping

WATER SOLUBLE FILLERS

Fillers

Fillers have an important function in modelmaking. They fill in gaps that exist when two parts are joined together and can therefore be used to create a seamless part from separate elements. Fillers are used to create certain features such as inside fillets. They are also used to fill scratches or to repair mistakes. Fillers need to be sanded smooth to the substrate. The filler should always be softer than the substrate. If the filler is harder then it is impossible to achieve a good finish, since the substrate will sand instead of the filler. They are either water- or organic solvent-soluble. Wear dust masks, and vacuum dust particles frequently with a fine-particle filter or use a dust-collection system.

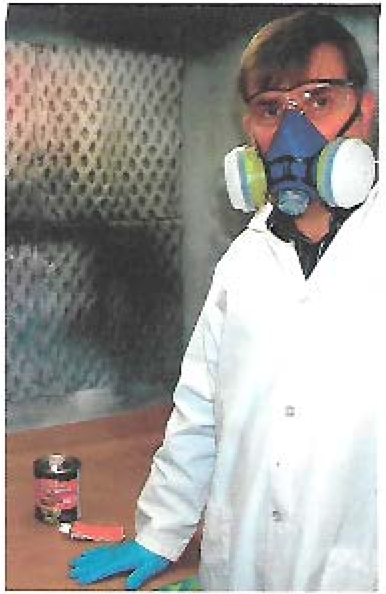
Solvent-Based Fillers

Automotive fillers and spot putties are generally used to fill and repair dents and scratches in cars. They have long been used in modelmaking because they set quickly, feather well and are easy to sand. The downside is that they contain organic solvents that pose health risks. They should only be used with very good ventilation (outside or in a paint booth). Body filler is generally used to build up volume or to create a seamless joint between two parts. It consists of a filler material that is mixed thoroughly with a hardener. It will set in approximately 20 minutes, after which it can be sanded smooth. The spot filler is generally applied on top of the body filler in order to smooth the surface and fill minor surface imperfections. This material dries by solvent evaporation, after which it can be sanded. Limit your exposure to dust when sanding (see above).

Typical Modelmaking Fillers

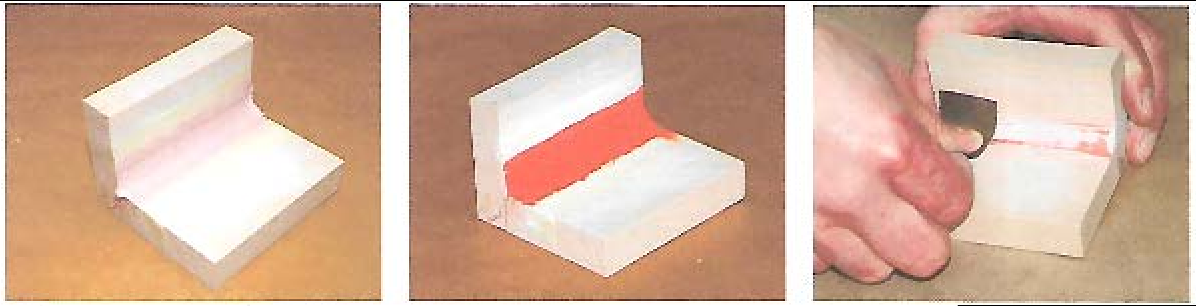
Type of Filler	Typical Modelmaking Applications	Benefits	Precautions*
Automotive Body Filler	Thick fill areas and volume. Adheres to most materials. Do not use with Styrofoam.	Quick cure time. Feathers well.	Solvents are flammable and pose health risk. Use only in well-ventilated area. Wear gloves.
Automotive Spot Filler	Thick fill areas and volume. Adheres to most materials. Can be sculpted.	Sands very smooth.	Solvents are flammable and pose health risk. Use only in well-ventilated area. Wear gloves.
Apoxie® Sculpt (Water-Soluble)	Paper, cardboard, polystyrene foam, foamboard, wood.	More environmental than body filler. Water clean-up.	Takes a long time to dry. Use only in well-ventilated area. Wear gloves.
Polyfilla (Water-Soluble)	Fine scratch and finishing. Adheres to most materials. Use with Styrofoam.	Water clean-up.	Wet-sand if possible. Limit exposure to dust. Wear gloves.
Wood Filler (Water-Soluble Varieties)	Mostly for wood, test on other substrates.	Similar to polyfilla but harder. Water clean-up.	Wet-sand if possible. Limit exposure to dust. Wear gloves.

* Also read each manufacturer's specific safety and use precautions and instructions as well as SDS. Always wear dust mask and eye protection when sanding any filler. Always wear rubber gloves when handling any uncured fillers.



Mix solvent-based fillers in a well-ventilated area, a spray booth, outside or under a fume hood.

Automotive body filler is mixed according to the manufacturer's instructions. It is important to achieve a uniform colour consistency to ensure that mixing has been thorough.



In making this inside corner, first body filler was used to build up the radius (left) and then a final . layer of spot filler was used on top (middle) and sanded smooth (right).

Water-Soluble Fillers

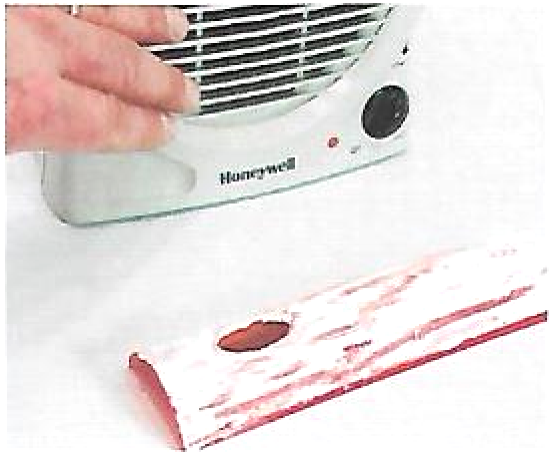
Water-based products are increasingly sought after, thanks to the easier clean-up and so as to avoid solvents. These materials should still be treated with caution, especially when sanding, as many fillers contain silica.

Household Polyfilla

Household polyfilla (or spackle) is found in hardware and DIY shops, as it has been developed as a general paint preparation material. Polyfilla is used to fill scratches and blemishes, and for filling smaller voids. Look for high-quality, non-shrinking pre-mixed varieties as shown on the left. These products can also be used to fill and finish 3D printer parts (see Chapter 18 on paint and finishing, page 159). Polyfilla does not have any structural strength, so it is only useful for cosmetic filling. Apply in thin layers and ideally place in front of a fan to allow it to dry rapidly.

General household polyfilla can be used as a substitute for automotive spot fillers, and does not have the same hazardous solvents. The lack of these solvents also allows polyfilla to be used on polystyrene foam, which would otherwise melt.

Pre-mixed water-based household polyfilla is a useful modelmaking filler and avoids solvents.



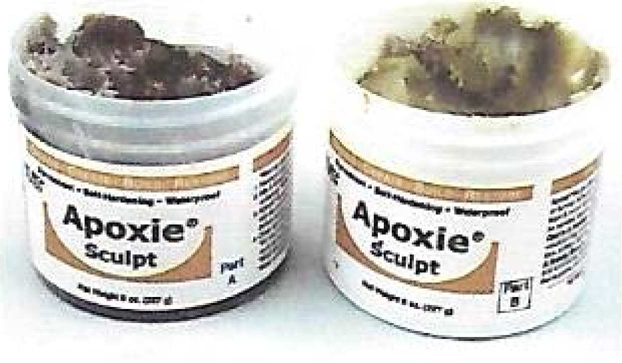
Water-Based Wood Filler

Water-based wood fillers are becoming more commonplace. They have been designed to fill larger cracks and voids. They can be used on other materials than just wood, but make sure to check compatibility on a piece of scrap material first. Drying time varies based on thickness. These are used just like polyfilla, but are more structural. They are also harder to sand.

Two-Part Epoxy-Based Putties

Epoxy-based putties have the advantage of holding their shape, so that they can be sculpted without flowing. A water-soluble variety named Apoxie® Sculpt adheres to acrylic, polystyrene, wood, polyurethane and metal surfaces. It can be softened in warm water before use. Knead the two parts together and place in a warm cup of water for a few minutes. These putties can be sanded and worked with other tools after 12–24 hours, but the long drying period requires some extra planning and time. Wear rubber gloves when handling uncured two-part materials. Also use adequate ventilation when mixing.

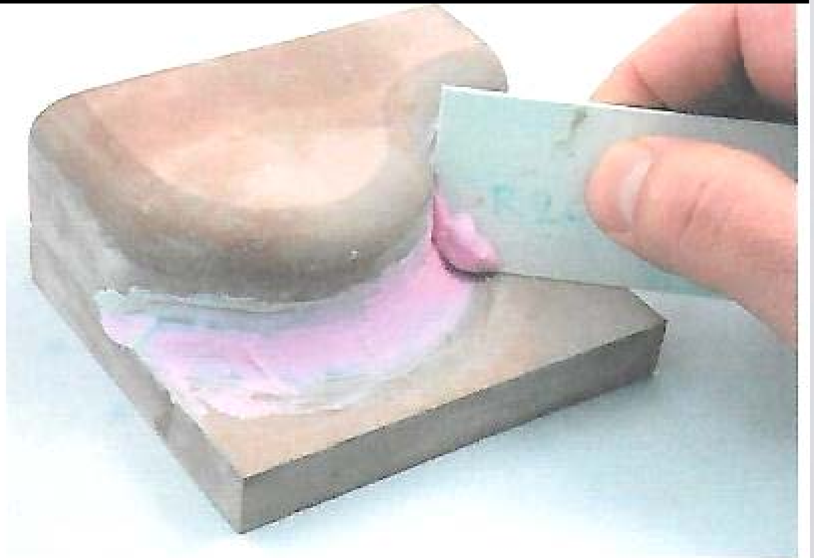
This type of filler has the benefit of also being able to be used as a sculptural medium since it holds its own shape.



Apoxie® Sculpt water-based epoxy two-part putty is structural and adheres to many substrates.

Part A and Part B are kneaded together by braiding and folding until colour is consistent.

Step C The Apoxie® Sculpt is left to harden overnight and then sanded [illegible]

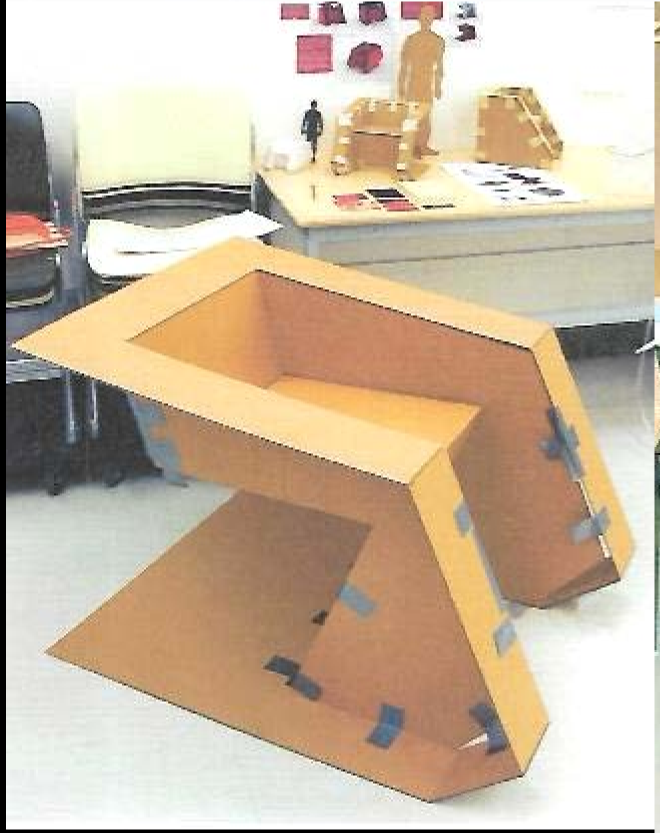


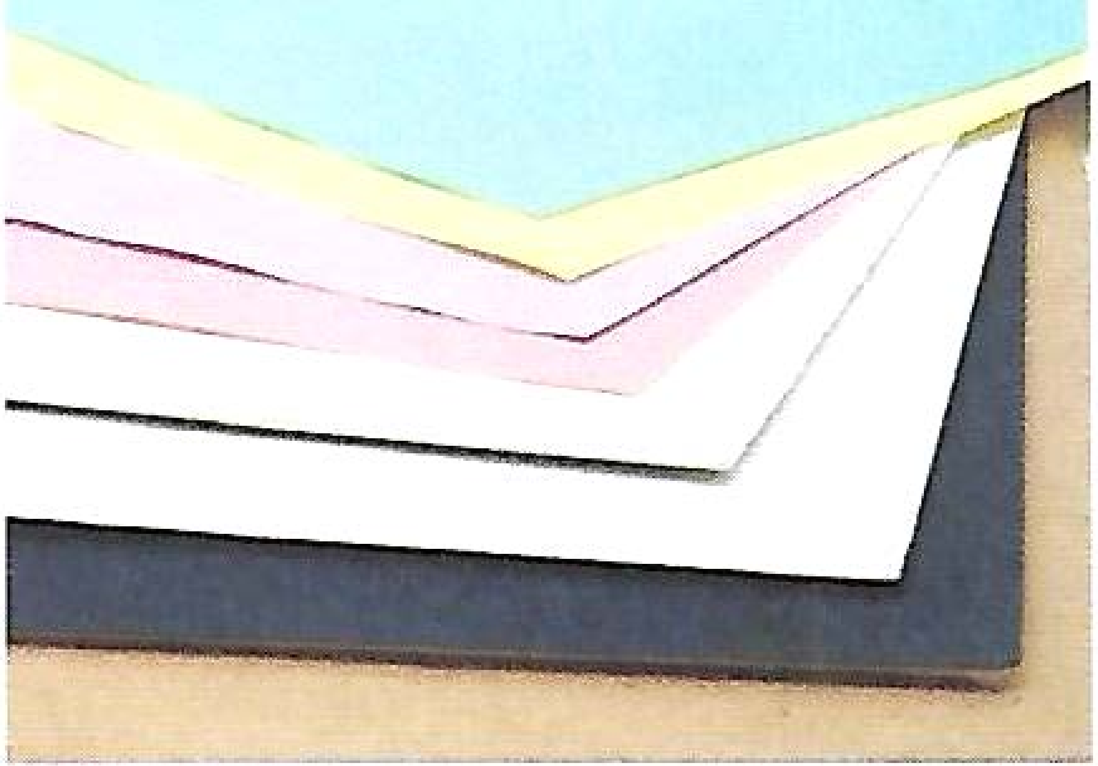
Step D Quick-drying polyfilla is used for final finishing. The DryDex® brand of polyfilla contains a colourant so that it starts pink and hardens to a white colour.

Step F The final shape should feel smooth and is then ready for priming. Half [illegible] has been painted to show what the form will look like. A few coats

— Read Chapter 5 on health and safety
— Use sharp blades and dispose of in a sharps container
— Use a steel rule as a guide and cut on a cutting mat

Paper comes in many forms and is categorized as sheet, cardboard or corrugated cardboard. It is a renewable, environmentally friendly, easy-to-work-with material. Since paper requires few tools it is both accessible and mobile. Its low-tech nature might create the perception that it is suitable mainly for craft projects, but it is actually an extremely flexible set of materials, more limited by skill and imagination than by its properties.





Paper comes in a variety of colours and thicknesses and can be worked without complicated tools.

Cantilevered Plywood Chair by Nicholas Kleemola, Carleton University, Ottawa (above). The small cardstock models in the background explored design solutions, whereas a full-scale cardboard prototype verified proportions and scale (left).

Paper is also often the starting point for examining textiles, since it behaves in much the same way and allows us to create patterns. Chapter 20's discussion of soft goods products covers this in detail (see page 170).

Munich-based product designer Konstantin Grcic uses paper extensively to envision and sketch his ideas in three-dimensional space. He speaks passionately about how important it is to explore ideas in 1:1 scale in terms of both proportion and structure. Most studios do not have the facilities for making intricate and detailed models in final materials. This approach therefore makes use of a simple material to save time and to work any issues out as far as possible.

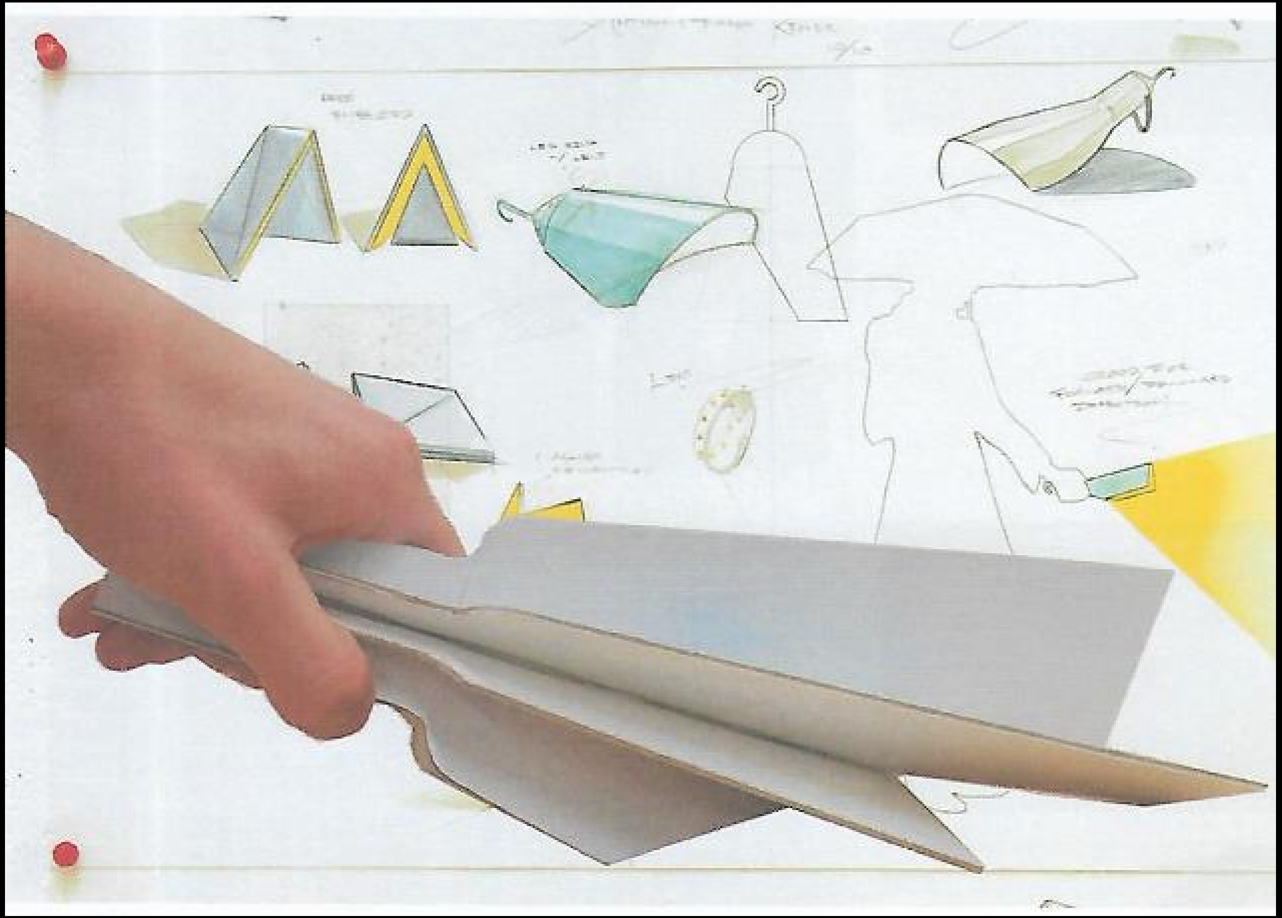
Digital 2D printing is a starting point of most prototyping, as will be shown in the next chapter on foamboard (pages 95–103). Even when the prototype is to be built in other materials it will often start with a printed template in paper. The computer is used to create layouts that are both accurately and instantly printed in colour. In interaction design, paper prototyping is used primarily to perform usability testing prior to developing computer code for interactive displays, so that the designers can try to predict the behaviour of the user.

Konstantin Grcic uses paper and cardboard models as a tool to complement CAD and sketching.

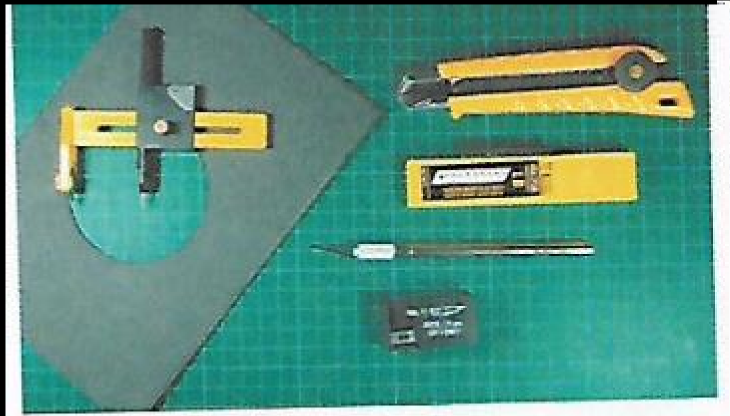
Paper prototypes often precede fabric prototypes when exploring new sewn products and are used in pattern creation.

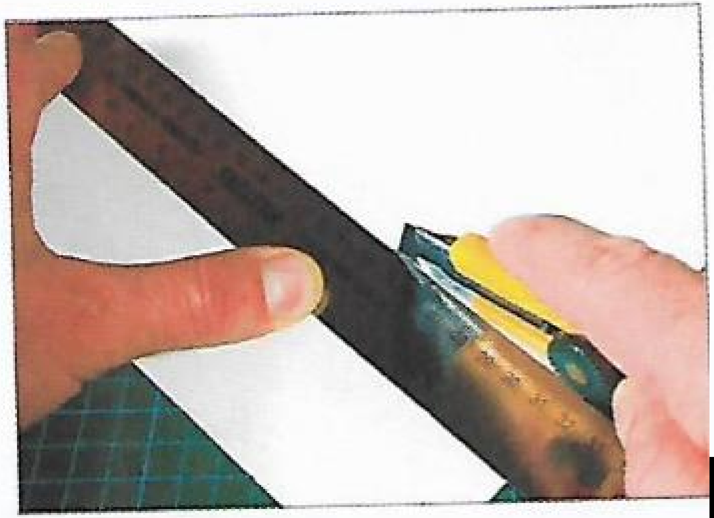
Cross-Sectional Models

To create a surface representation of more complex geometry it is usually easier and more effective to make models from a series of cross sections. Such models approximate the shape as a series of slices and give a good idea of size and proportion.

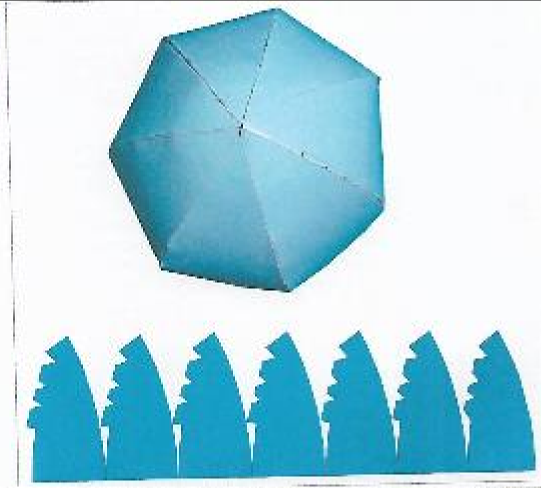


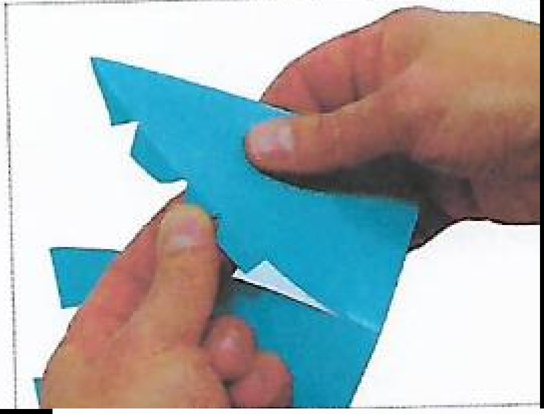
A cross-sectional model of a hand-held light accompanies concept sketches in order to gain a feel for the size and proportions (above). Quick paper models allows numerous formal iterations to be evaluated (left).





Stanley knives and scalpels are essential paper-modelling tools and should be kept sharp with an ample supply of replacement blades. Use a metal ruler and keep fingers away from the path of the cut.



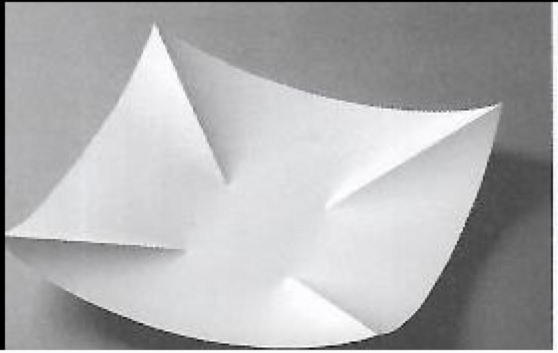


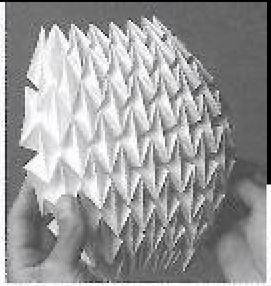
A dome can be approximated by a series of curved elements and overlapping glue tabs.

Working with Paper and Board

In terms of creating three-dimensional forms the qualities of paper need to be understood. Paper can be cut, folded or twisted. It can be curved in one direction, which is suitable for geometric forms, such as cylinders and blocks. On the other hand, curvature in two directions would require the material to stretch. It is therefore not easy to create more complex forms such as spheres or organic forms in paper. A spherical shape can be approximated by a series of curved planes, as shown above.

Paper sheet can be cut with scissors or with a scalpel on a cutting mat. The self-healing cutting mat both guides the blade better and provides protection for underlying surfaces. Thick cardboard and corrugated cardboard are often cut with a Stanley knife. Always use extreme caution when handling these sharp instruments. A sharp blade is better than a dull blade as it will do the job with less force. Cardboard is never cut with one pass: usually three passes are necessary so as to cut the material accurately, cleanly and safely. Extra blades should be kept, and come in special containers that are also designed for safer sharps disposal. For straight cuts always use a metal ruler as a guide and make sure that fingers are not in the path of the cut.





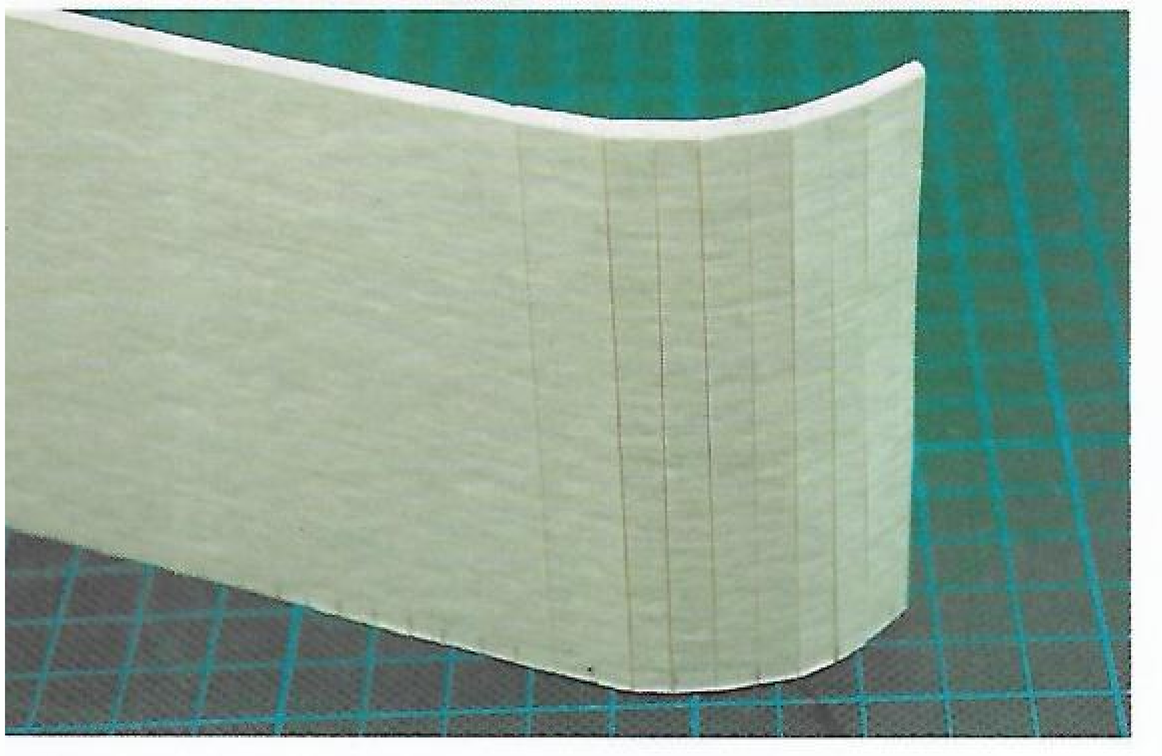
Paper folds from Paul Jackson's book *Folding Techniques for Designers*

Paper folds from Paul Jackson's book *Folding Techniques for Designers.*

Paper folds can be used to explore the behaviour of sheet materials. More eloquent folding that builds on the techniques of origami can be used to explore three-dimensional form and collapsibility. Design educator Paul Jackson demonstrates these folding techniques in his book *Folding Techniques for Designers*.

Simple folds can be used for hinges and flaps. Board materials can also be folded with a metal ruler, and will bend more easily if the material has first been scored. Large curved surfaces are easily created by folding at regular intervals. Corrugated cardboard has flutes running in one direction and it is easier to create folds along these flutes.

When you need to join sheets together, tape is a quick option. It can also be used to hold sheets together while glue is drying. Rubber cement is an old-fashioned alternative to glue sticks but contains solvents and requires good ventilation, especially in a classroom setting when many people are using it at the same time. White-glue or hot-glue sticks create more structural joints with paperboard. White glue tends to result in cleaner work, but takes more time to dry. Tape or pins can be used to hold the work together while the white glue sets. Please refer to the Adhesives and Filler chapter for more detailed information (see page 79).



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