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1.1 Machining

The machining characteristics of Perspex® are similar to those of soft brass or hard aluminium, but there are two important differences:-

1. Perspex® will soften if heated above 80°C. Considerable heat can be generated by machining, causing stress, so it is therefore very important that heat build-up is kept to a minimum. The use of coolants during machining is recommended to assist in lubrication, removing swarf and to maintain a cool stress-free machining temperature.

2. Perspex® is a brittle material. It is therefore important that only light machining cuts are taken and feed rates are kept slow. Various coolants can be used including water and water/air mists, soluble oils and compressed air. Soluble oils must be oil-in-water emulsions and must not contain solvents which may cause stress cracking.

When machining, drilling or cutting Perspex®, the heat build-up can generate stress in the final work piece which can induce "stress-cracking", a phenomenon common to many plastics materials when stressed. The risk of crazing can be reduced or eliminated by the simple process of heat annealing and it is strongly recommended that all machined or worked components made from Perspex® are annealed. Please see section 1.5 for full details of the annealing process.

1.1.1 Cutting Tools

To achieve a good finish on Perspex®, all cutting tools must be kept sharp. Most hand tools designed for use with wood and soft metals are suitable for use with Perspex® except laminate cutters, guillotines and blanking dies. If necessary, these tools can be used with Perspex® provided the sheet is heated to at least 50°C. Most power tools can be used and HSS tools bits are suitable to achieve a good cut finish.

For lengthy runs, tungsten carbide tipped blades and tool bits are recommended for long life. For accurate work, especially where a high degree of finish is required, diamond-tipped tools are particularly suitable for machining Perspex®.

1.1.2 Sawing

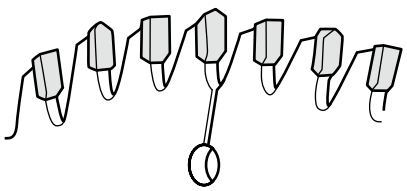
For small jobs, Perspex® may be cut with fine-toothed hand saws such as fret saws and hack saws. The work must be securely fixed and only light pressure applied. Powered saws with blades having alternative teeth bevelled, as for aluminium, are particularly recommended for sawing Perspex® as are band saws, jigsaws and fret saws. The recommended conditions for sawing Perspex® are given in Table 2.

Figure 1 gives details of the recommended type of TCT circular saw blade suitable for cutting Perspex® sheets.

Table 2 Conditions for sawing Perspex®

Saw Type	Optimum Blade Speed (approx)	Optimum Saw Pitch Sheet Thickness	Teeth/cm	Recommendation
Bandsaw	1500m/min	Up to 3mm 3-13mm Over 13mm	6-8 4-5 1.5-2	Keep saw guides as close together as possible to prevent blade twisting
Circular saw (carbide tipped)	3000m/min	All thicknesses	0.8-1.6	See Figure 1
Jigsaw fretsaw	Non critical	Up to 6mm	5-6	Allow blade to stop before withdrawing from saw cut

Fig. 1a



Typical diameter: 200 - 250mm
Width: 2 - 3mm

Fig. 1b

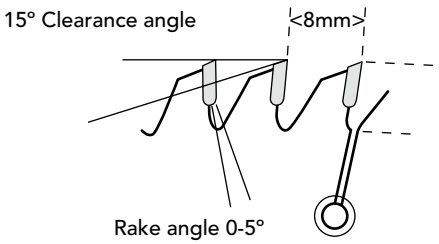
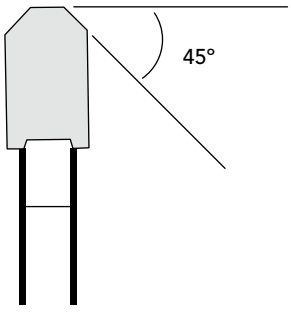


Fig. 1c



Bevelled tooth

Figure 1 A tungsten carbide tipped saw blade suitable for cutting Perspex®

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1.1.3 Scribe – Breaking

Perspex® up to 4mm thick may be conveniently cut in a straight line by deeply scribing one surface several times with a sharp metal scriber, clamping the sheet with the scribed line uppermost and pressing sharply down over the edge of a bench. See Figures 2 and 2a for details of scribe-breaking.

Fig. 2

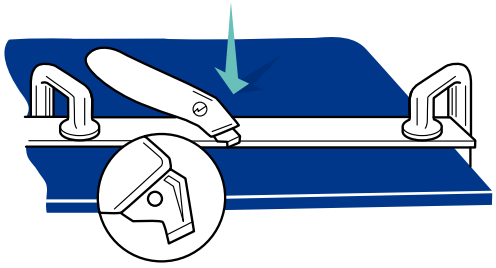

Figure 2 A Scribe-breaking Perspex® suitable for cutting Perspex®

Fig. 2a

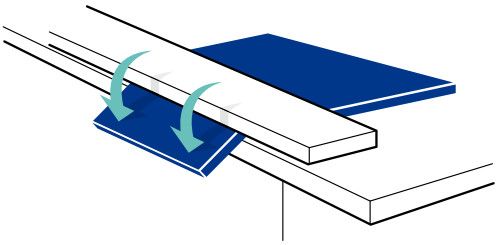

Figure 2a Breaking along the scribline

1.1.4 Laser Cutting

Perspex® may be laser cut (see Figure 3) and very complex and intricate shapes may be cut out using this type of equipment. Thicknesses up to 25mm can be cut although some experimentation will be necessary to achieve the optimum quality of edge finish above 12mm. Some stress can be generated around the edge of laser cut Perspex® and it is important that the laser beam is accurately focussed. If cementing or surface decorating up to a laser cut edge it may be found necessary to carry out a short annealing cycle (see later) to reduce the risk of fine crazing along the edge. It may be found preferable to remove the top masking film to improve the edge polishing effect from the laser.

NB: When laser cutting Perspex®, as with all other materials, it is very important to provide adequate ventilation at the cutting head to remove any traces of unpleasant combustion vapour. Expert advice should be sought from the machine manufacturers if in any doubt. Before laser cutting Perspex®, please read the safety notes on flammability and combustion products on page 26.

1.1.5 Laser Engraving

Perspex® is easy to engrave using pantographs or CNC engraving machines. Laser engraving can also be carried out to give remarkable fine detail on Perspex®. The use of coolants is generally unnecessary for mechanical engraving other than the use of a compressed air jet directed on to the cutting head to remove swarf and cool the cutter. Filling is best carried out using one of the usual setting waxes. Paints can be used but it is most important to use those paints intended for use with acrylic sheet and known to be compatible. When intending to engrave Perspex® and fill with paint, especially for outdoor use, annealing of the engraved sections before filling is strongly recommended to prevent subsequent crazing.

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1.1.6 Drilling

Standard woodworking twist drills can be used for all normal drilling work with Perspex®. It is advisable to re-grind twist drills to give a zero rake; Figure 3 demonstrates the preferred cutting angles

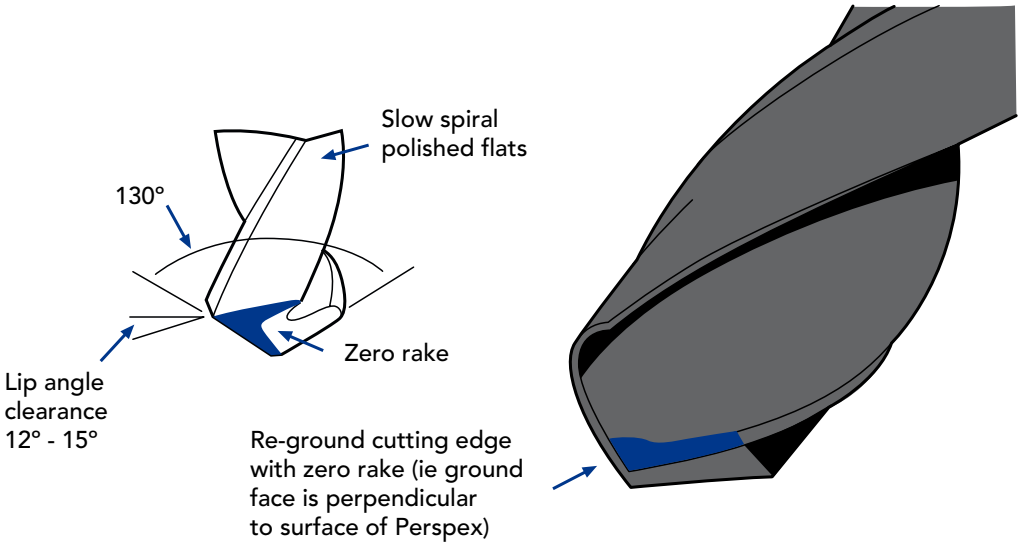

Figure 3 A standard drill (130°) with cutting edges re-ground for use with Perspex®

Wherever possible, the work should be supported by a back stop made from either scrap Perspex® or hardwood to prevent splintering the exit hole. Under no circumstances should a centre punch be used before drilling Perspex®. A small pilot hole should be drilled first to locate the drill.

Coolants are strongly recommended for any deep drilling into Perspex® and time must be allowed to remove swarf from the drill at regular intervals.

Hole saws may be used for larger holes greater than 12mm diameter but when drilling large holes in thin extruded sheet, especially if it is not possible to support the work, “cone-cut” drills have been found to be particularly suitable.

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1.1.7 Screwing and Tapping
Standard taps and dies may be used for cutting screw threads in Perspex® but wherever possible, coarse threads are preferred as they are less liable to damage. Lubricants are essential, water or soluble oil being preferred. Threads must not be overstressed and it is not advisable to thread Perspex® if frequent dismantling is likely. In such conditions, threaded metal inserts are recommended.

1.1.8 Turning
Perspex® can be turned on conventional metalworking lathes but it is important to keep the work cool by the use of coolants and ensuring that feed rates are slow. Any overheating of the work is likely to lead to localised distortions and a loss of tolerance. Crazing may also occur sometime after.

Correct grinding of the lathe tool is necessary. HSS tool bits are preferred, ground to zero rake at the top and 15-20° front rake. The fine grain texture of HSS tools ensures a better finish than TCT tools but all cutting surfaces must be kept very sharp.

Cutting speeds of 90-150m/min are typical for turning Perspex® but for a first class finish, speeds of 15-30m/min are recommended.

Diamond fly-cutting is particularly recommended where a good polished finish is required after turning.

1.1.9 Spindle Moulding
A spindle moulder is a useful machine for the rapid machining of Perspex®. Cutters designed for woodworking are suitable, two-bladed cutters being preferred. Spindle moulding is carried out dry as swarf is easy to remove.

1.1.10 Routing
Routing is a common machining operation used on Perspex® today. Fixed head, moving head or portable standard woodworking routers are suitable for Perspex® using the same cutter speeds as for wood. Double edged cutters are preferred, ground and honed with a back clearance angle of about 12° or more.

Cutters	Spindle Speed
6 to 12mm diameter or less	ca 24000 RPM
>12	ca 18000 RPM

Routing is usually performed dry but provision must be made to clear all swarf from the work bench and keep the cutter cool. A compressed air jet directed at the work piece usually performs this task.

HSS cutters give better results than TCT cutters although their life will be shorter. Regular sharpening is therefore necessary.

1.1.11 Finishing
Machined surfaces of Perspex®, with the exception of laser cutting which many customers will leave as a finished edge, are usually matt unless diamond cutting tools are used. Machine marks are best removed by scraping with a sharp blade set at 90° or sanding and then the gloss finish restored by polishing.

1.1.11.1 Sanding
Bench mounted or portable sanders may be used - as may belt sanders - to remove machine marks or saw cut marks from the edge of Perspex®.

Sanding should be carried out dry and only very light pressure applied to prevent softening or melting of the surfaces.

After any sanding operation it will be necessary to anneal the work if cementing or surface decoration is intended.

1.1.11.2 Power buffing
Power buffing with rotating calico mops is the traditional polishing technique for Perspex®. Edges must first be scraped or sanded to remove all machine marks then a mild abrasive buffing soap may be applied. Moderate speeds and only very light pressure is needed otherwise overheating will occur.

1.1.11.3 Diamond polishing
Diamond polishing can be used for straight edges and gives excellent results without the rounded edges often produced by buffing. Diamond polishing produces very little stress in the surface.

1.1.11.4 Flame polishing
Flame polishing is ideal for polishing thin edges of Perspex®, because it is fast and effective. A good routered or scraped edge is essential for flame polishing. Specialised equipment is available otherwise a small blowtorch type gas-air flame can be used. The technique requires some practice to achieve the desired level of skill. Only the slightest impingement of the hottest part of the flame is required rapidly passing the jet across the work. Great care must be taken not to ignite the surface and it should be noted that flame polishing can produce highly stressed edges. Annealing of the work piece will be necessary if the flame polished edges are to be cemented or decorated.

Flame polishing can be difficult on certain heavily pigmented colours resulting in a matt finish or discolouration.

1.1.11.5 Hand polishing
Hand polishing is suitable for the restoration of the original gloss finish after minor surface scratching. Deep scratches should first be removed using 600 grade waterproof abrasive paper applied wet with a light circular motion. To avoid optical distortions, the abraded area should be much larger than the damaged surface to “feather” the edges. Final polishing of the matt abraded area can be carried out using proprietary acrylic polishes. Good quality metal polish intended for use on silver plate can be used provided the product has been tested and found to be compatible with Perspex®.