

PODS

Once in a while a process or material emerges that energises and changes the way we think about designing and making. The rigid foam PVC sheet (Foamex) in this feature is one such material. As a true thermoplastic it can be formed by using an almost long forgotten process of press forming using 'plug and yoke' moulds. This is a truly exciting material that gives outstanding results at low cost and is an ideal opportunity for teachers and students to rethink their ideas about product design and enclosures and electronic product cases. The process and material combine to provide a rigid, strong and attractive finished product.



The Sheffield Hallam University team originally derived the project as a 'funky' mobile phone holder as one of the acclaimed Millennium Schools projects. We quickly realised the much greater potential for the material and the process. Most sheet thermoplastics have a relatively narrow thermal window in which, once heated the material can be formed.

High Impact Polystyrene and Acrylic sheets commonly used in school demonstrate the difficulties of this by having just a few seconds to form. Once heated to around 140°C the Foamex remains plastic for anything up to 30 seconds providing a decent handling time for students and pupils. School resources differ considerably from one to another and while some may have a suitable temperature controlled oven others may only have the use of the heater canopy on a vacuum forming machine. We have also had great success in using a small domestic desktop oven and achieved equally good results.



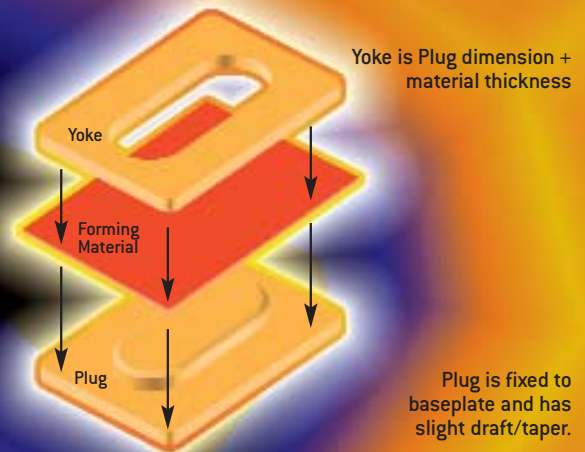
Mould Design

This requires a little careful planning to realise quality moulded parts. The larger the mould the greater the force needed. Using registration pins / pegs helps line up the plug and yoke. RADIUSING the plug top edge and ensuring the plug-body to yoke clearance is just greater than the sheet material used. This means that for 3mm Foamex a 3mm routed gap is ideal after light abrading with glasspaper. Moulds do not need a bottom plate although it helps alignment and stops the foamex picking up dust and unwanted textures off a worktop.

Moulds manufactured from MDF are ideal and will not need to be tapered as with vacuum forming moulds. The style of moulds should be kept relatively simple keeping radiuses large and no sharp directional changes.

The Foamex or other sheet material needs pre-cutting to size to suit the moulds and can even be scored and snapped using a handheld ceramic tile cutter. The material is produced by the manufacturers as a continuous sheet off a roller and as such it 'remembers' or has plastic memory of the stress concentrations during manufacture.

To that end it is important to place the material the correct way up in a preheated oven or it will tend to curl up on itself. The 'top' side of the sheet material has a peel-able protective film and has the same texture both sides so only remove the film shortly before using it.



Using the accompanying time and temperature table allow the material to soak in the oven at the preset temperature and do try some trial pieces first.

THERMOFORMING

Times and Temperatures for the thermoforming of plastics

Vacuum Forming	Temperature of Vacuum Former	Approx. Time (seconds)	Notes
3mm Plastazote	It is recommended that test pieces are used to practice on individual machines using the timings as a guide.	20	Check plastazote after 2 seconds then every 3-5 seconds when forming.
6mm Plastazote		40	
2mm Neoprene		40	
3mm Foamex		180	
1.5mm Vacuum Forming HIPS		180	
Press Forming	Temperature of Oven °C		
3mm Foamex	140	30	If plastic becomes mis-shapen during forming process, return to oven and reheat until plastic returns to its original state.
2mm Neoprene	140	30	
3mm Plastazote	140	90	
6mm Plastazote	140	60	

Shaping and Joining

What makes this process so modern and also radical is the way pupils can interpret the cut and joining lines and reshape the remaining lip or flange to suit their needs.



Joining the parts in really interesting ways is important too, so coloured shock cords, beads, plastic rivets, snap fasteners, cable ties and polymorph all have an influence on the functionality and appearance of products and lend a 'machine aesthetic' quality to projects as well. The PODs featured in the gallery were produced from just three basic moulds. More importantly speed and almost instant results start to appear in just one or two lessons.

A wide variation in design is possible even from a limited number of moulds and basic hand tools are ideal, including coping saws and files. The bright colours and tactile nature of the material and the organic shapes and applications possible also give this project and process real cross gender appeal.



Adhesives like fasteners for this material are almost limitless, ranging from Tensol cements, PVA, Spraymount and Polystyrene cement through to double sided sticky pads. The use of acrylic paints to decorate a surface or attaching holographic foils to the surface of the PVC liberates the design potential even further. Using other elegant self finished materials like anodised aluminium lends a further perceived value to artifacts using this material. Many of the gallery projects featured also used a vacuum former to 'pull in' a soft plastazote or neoprene inner skin into the shell. Other work also benefited from using the TEP injection moulding kit to make small feet, fixtures, buttons and toggles.

Volume work in class could benefit from a simple preset egg timer to ensure consistency for pupils rather than let them rely on guessing and constant checking. Always encourage handling the material using riggers gloves or appropriate gauntlets although the residual heat in the material does not cause burns.



Make sure that the mould halves are ready on a flat surface close to the oven and then with the plug at the bottom drape the sheet over it and lightly but firmly push over the yoke. Only hand pressure is required and needs to be maintained until the material has cooled to leave a moulded shape with a large rim or flange. Using the yoke underneath is not ideal as again the soft sheet can pick up dust and texture off the worksurface. Gentle warming with a hot air gun will remove light scars and imperfections as the plastic memory restores its shape.

Pupils who don't get it right first time can simply return the material to the oven and do it again! Unused sheet should be stored vertically where possible so dust and grit does not get trapped between layers. Drilling and machining with a shallow angle bit / helix angle is best to avoid local damage to shapes and it drills readily in large diameters with Forstner bits. Small diameters are easily punched or created with taper reamers. Edges can be eased with wet and dry paper to finish. Not surprisingly this same process works with acrylics and foams. Acrylics require more pressure when moulding and of course have only a small thermal window and need care as they are hygroscopic and degrade when overheated quickly. Other foams like Neoprenes and Plastazote need working quickly as they retain heat only briefly, being thinner and having mainly air cavities that have little specific heat capacity.

Press forming the sheet material:



The material is placed in a pre-heated oven. Follow the temperature charts below to judge approximately when the material has reached its desired plasticity. When ready the material needs to be taken quickly from the oven using gloves and draped over the male former.



The female former is then located over the male former and force applied to sandwich the two formers together. Hold the formers in position until the material cools enough to keep its shape.



Release the plastic from the male former and repeat the process the second side of the Pod casing.



