



Phone Pod Manufacturing Process

The following process has been designed to provide a route through manufacturing the Phone Pod by dividing the assembly into a number of discrete sub-assemblies. This provides opportunity for pupils to make decisions regarding aesthetics, function, scale and finish to enable a variety of individual product outcomes.

It is suggested that teachers demonstrate these processes as focused practical tasks, dependent on the organisation of resources available in each school. Pupils are then able to develop the necessary skills to design and manufacture their individual product.

Assembly task A: Pod Casing

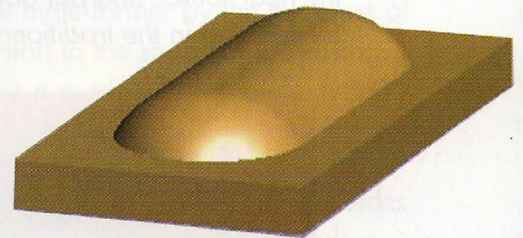
Various heat forming processes can be used to manufacture the Phone Pod casing. The following section will describe these processes separately to enable decisions to be made on the manufacture of individual Phone Pods.

School resources differ considerably and it is recommended that development work is undertaken prior to the delivery of this project. Use test pieces of materials on the vacuum forming machine and oven to determine the appropriate temperatures, timing and techniques required to achieve the desired results. Refer to the chart in the appendices for approximate timings and temperatures for the thermoforming of materials.

Vacuum Forming

The following materials are suitable to vacuum form the casing:

- 3mm expanded foam PVC (foamex) sheet
- 3mm/6mm plastazote sheet
- 2mm neoprene EVA foam sheet
- 2mm high impact polystyrene (vacuum forming) sheet.



Working drawings are provided in the appendices as a guide to manufacture exemplar vacuum forming moulds.

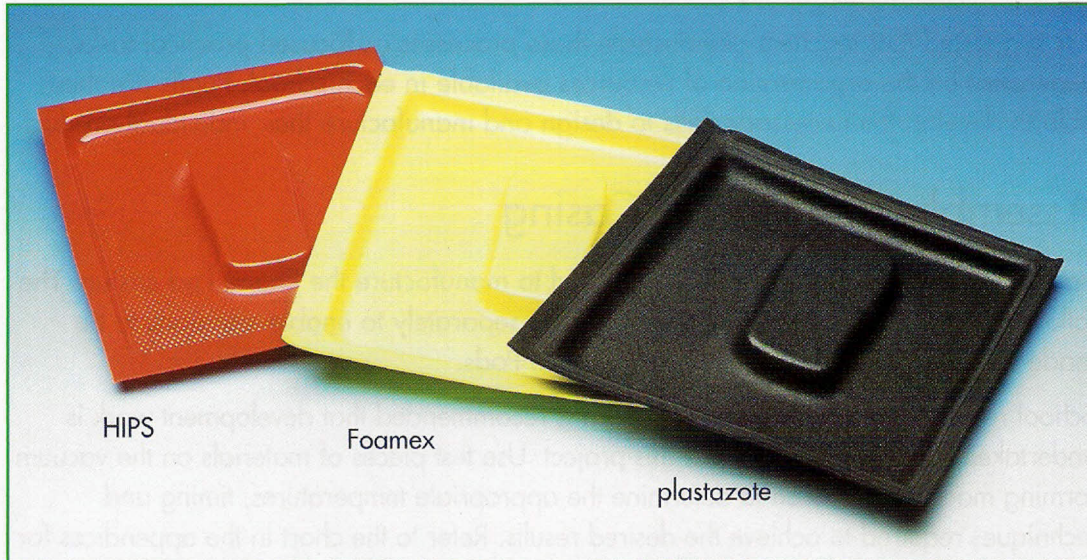


It is possible to use a mobile phone as the former when vacuum forming neoprene or plastazote. It is recommended that a scrap phone should be used with batteries removed. Vacuum form over the phone in the normal way and leave enough material to enable closure and fastening.

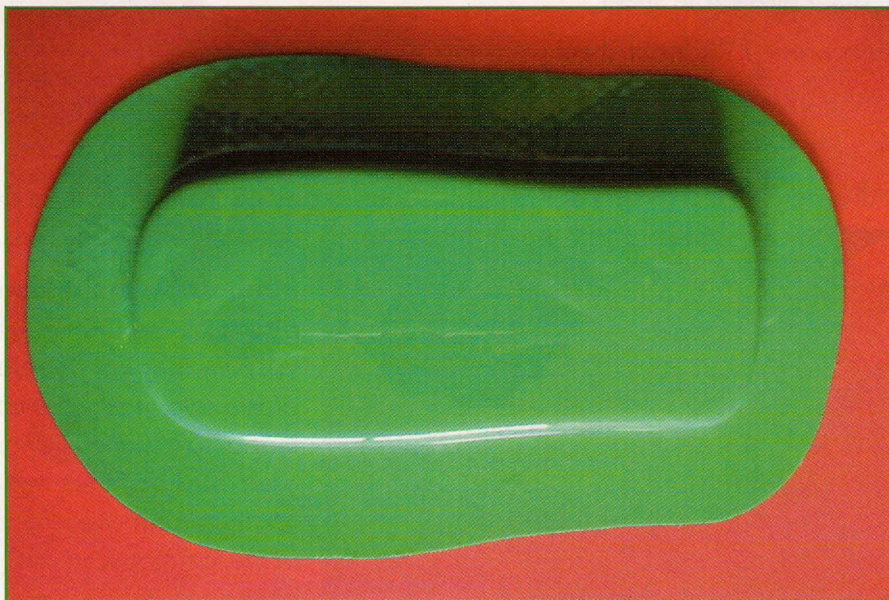




Manufacture the mould from 12mm MDF or other suitable material. Consider the sides of the mould. They should be tapered slightly and have no undercuts. Make sure the mould is sanded to a smooth finish. Moulds should be sealed and to enable quick release parting powder can be used. The use of pull screws and air holes in the appropriate places will also ensure a successful vacuum forming. Vacuum form two halves.



Note: Care needs to be taken when vacuum forming plastazote. Constant checking of the state of the material is required as plastazote will rise in a matter of seconds and may become too close to the heating elements of the vacuum former. Remove the heat source and pat down gently with hands and continue to heat until ready for forming in the traditional manner.



Cut vacuum formed sheet leaving approximately 30mm on all sides of formed plastic.

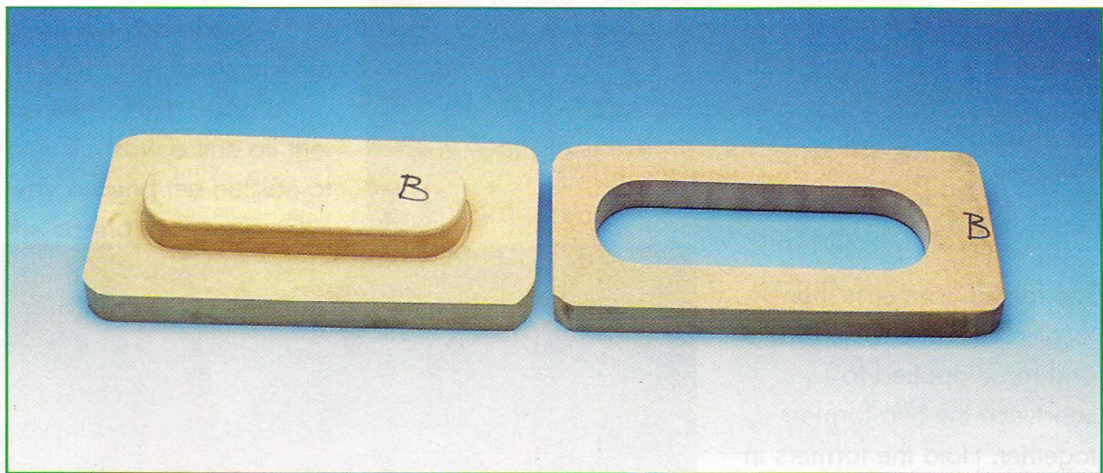


Press forming the casing

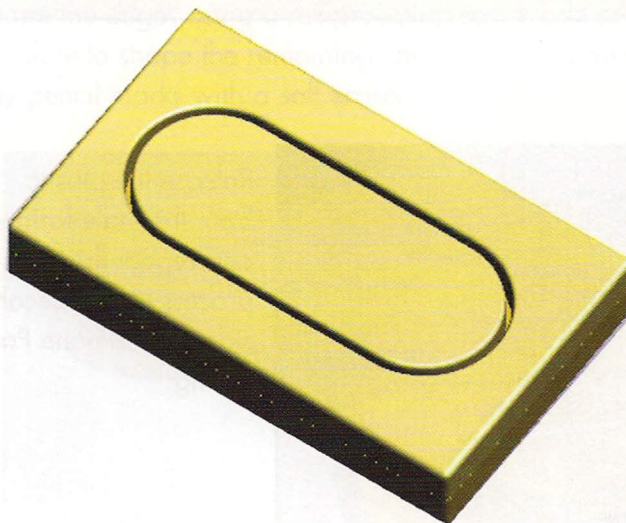
The following materials are suitable for press forming the casing:

- 3mm expanded foam PVC (foamex) sheet size to suit vacuum forming machine
- 3mm/6mm plastazote sheet
- 2mm neoprene EVA foam sheet (smooth/corrugated)
- 2mm High Impact Polystyrene sheet

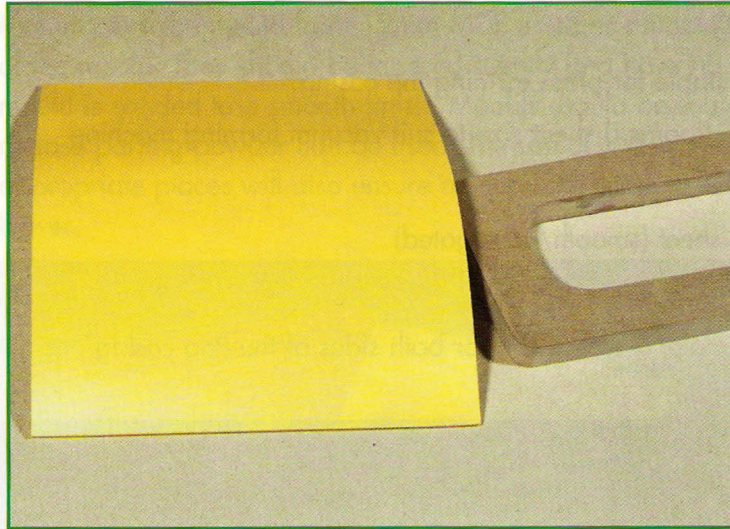
Two formers, a male and a female, are required for both sides of the Pod casing.



Press formers should be simple and manufactured from wood or other suitable material. The female former needs to be larger than the male former by the thickness of material used for the casing. This is to avoid any distortion to the shape of the casing. The working drawings in the appendices can be used as a guide when manufacturing.

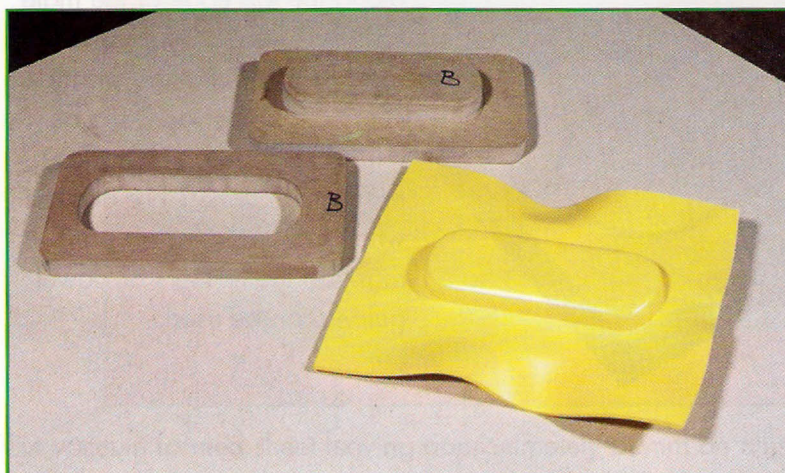
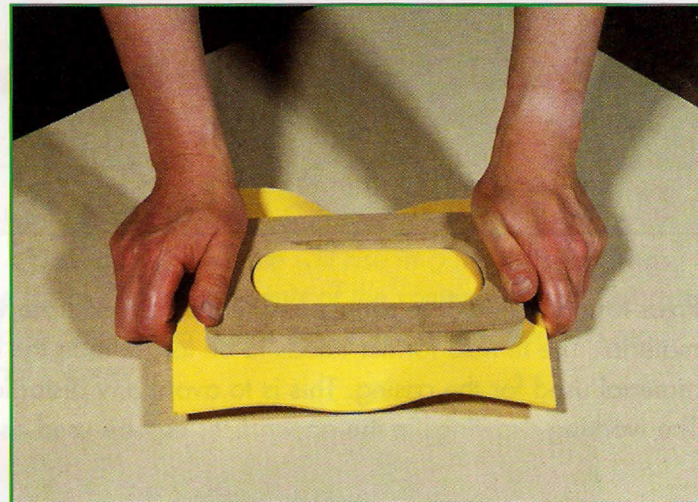


It is not necessary to have sides that taper, but a small radius along the top edge of the male former is necessary to ease the removal of the formed plastic. The male former needs to be fixed to a wooden base. To ensure the formers are aligned when forming, place a pen mark on the formers or dowel guides can be used.



The material is placed in a pre-heated oven. Follow the temperature charts in this publication to judge approximately when the material has reached its desired plasticity. When ready, the material needs to be quickly 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 for the second side of the Phone Pod casing.

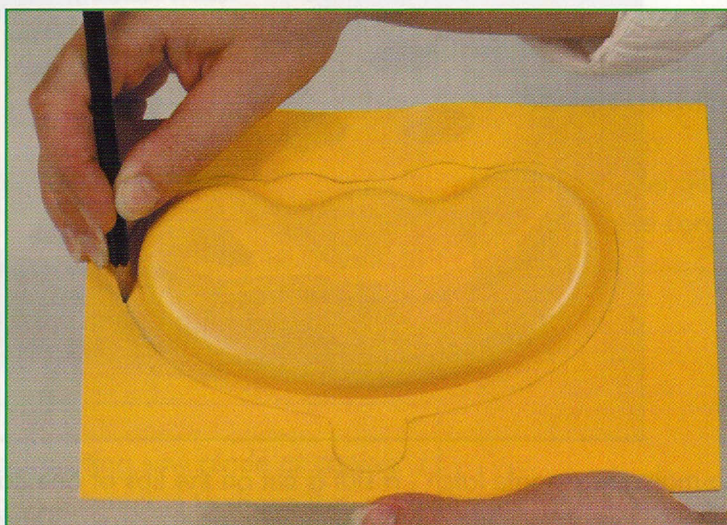


Assembly task B: Fastenings

The following assembly task describes three methods on how to enclose the Phone Pod casings together. This provides opportunity for pupils to consider how to access the pod to store and retrieve a mobile phone enabling them to develop their own individual outcomes.

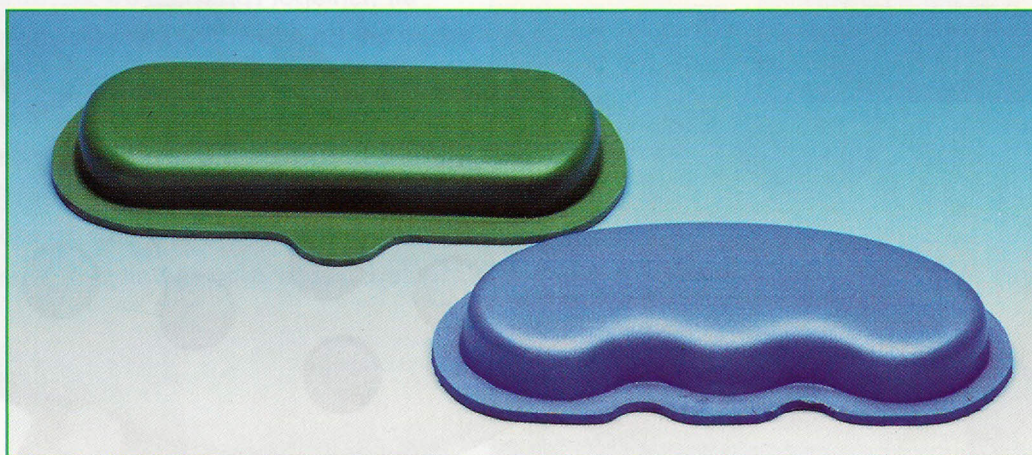
Method One

This method uses a simple mechanism to open and close the Pod and a 'toggle latch' to secure the contents. First, using a pencil, draw a line all the way around the outside of the casing approximately 10 mm away from the edge of the case. This will create a lip around each of the casings. The edge of your finger can be used or a guide can be attached to the pencil to ensure equal distance all the way around the casing. Tip: A polymorph shape can be moulded and attached to a pencil to use as a guide.



Secondly, consider the position of the toggle and hinge. To make further allowances for these fastenings on the lip of the casing, use a pencil to add to the existing lip line as shown in the photograph.

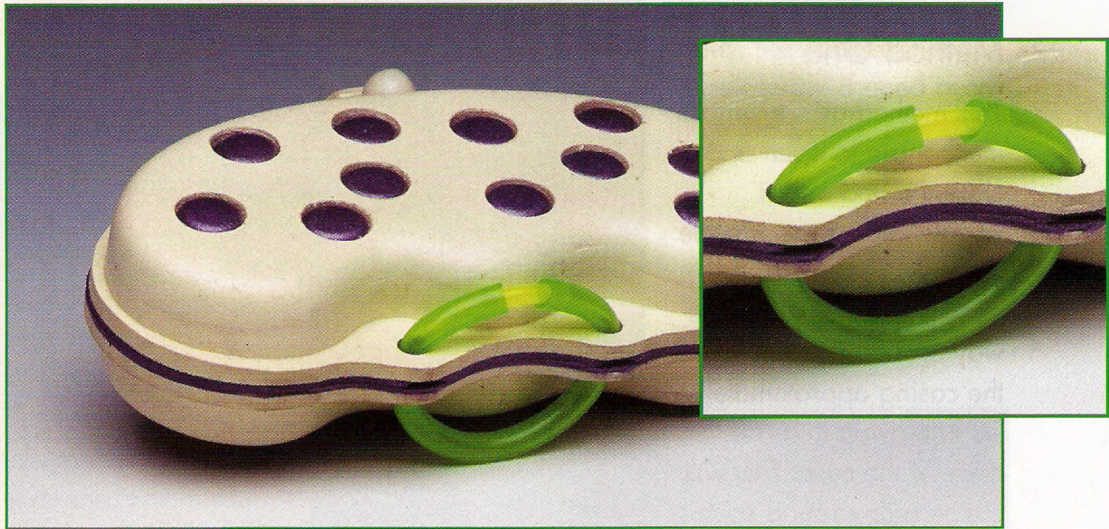
Shape the edges using a reciprocating saw blade or coping saw and file. Use this as a template to shape the remaining casing. Use wet and dry paper to finish and remove any pencil marks with a soft eraser.



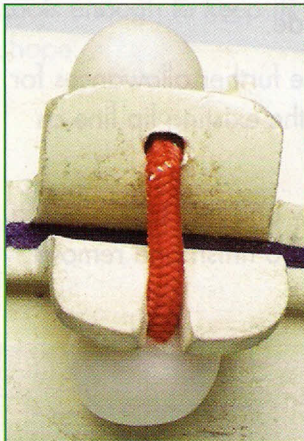


Manufacturing the hinge and toggle

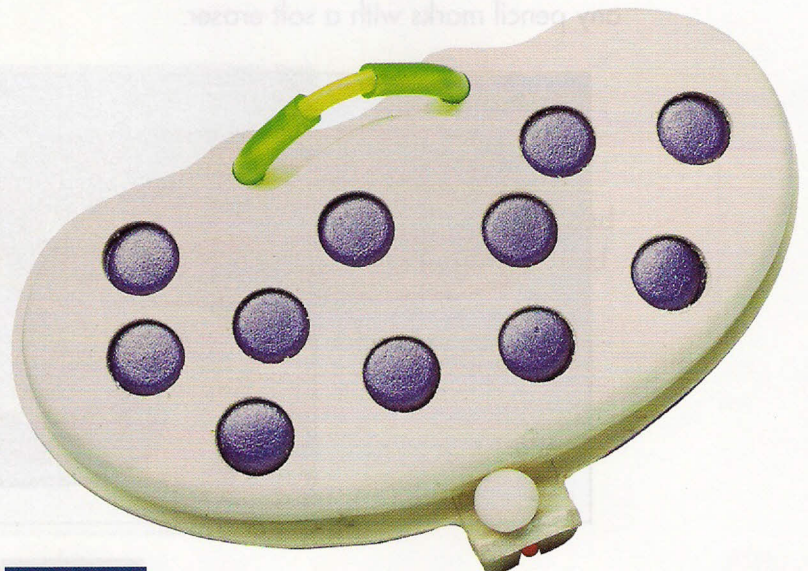
To make a hinge, two 6mm holes are drilled through both lips of the casings as shown in the photograph below. A 6mm fluorescent flexible tube (approx. 150mm) is fed through the holes. A short piece of 4mm fluorescent PVC solid cord (approx. 40mm) is then pushed inside both ends of the 6mm tube finishing the hinge.



To make the 'toggle latch', a slot is cut on the lips of one casing and a 6mm hole on the other to accommodate a 6mm bungee cord (approx. 30mm is used). The two lips are then heated and shaped using a line bender as shown in the photograph below.



The toggle is made by embedding the two ends of cord inside the formed polymorph. One end of the cord is glued inside a polymorph shape and when dry the cord is thread through the 6mm hole. Another polymorph shape is glued to the opposite end of the cord and attached through the slot.

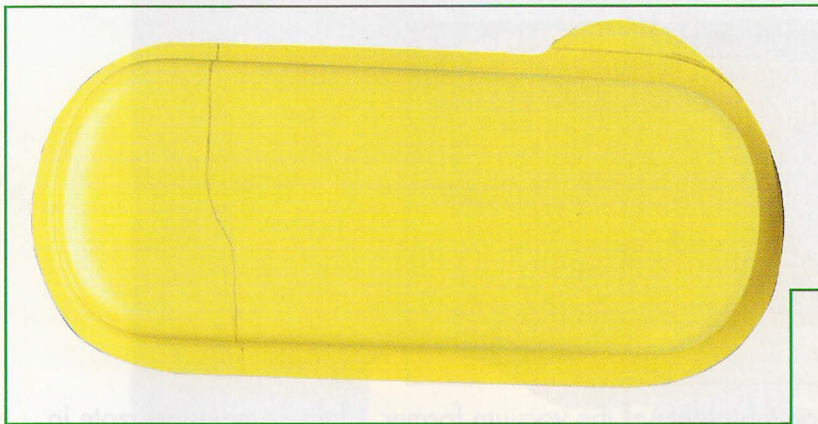




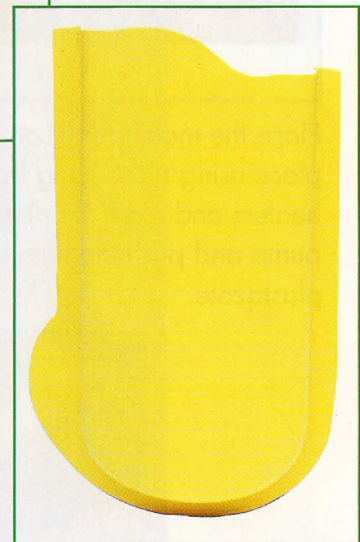
Method 2: Sleeved Case

Access to the pod is achieved by cutting a section off the top of the casing. A 6mm thick plastazote sleeve is adhered to the inside of the casing and is used to enclose the Phone Pod.

As in the previous method, using pencil, draw approximately a 10mm line away from the edge of one casing. The left photograph shows an example of a casing where



material has been left to accommodate a hole which will be used to attach a length of bungee cord.

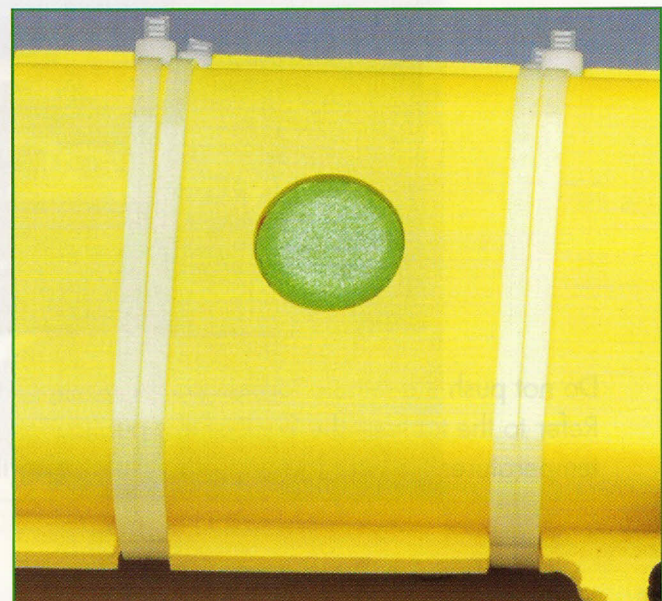


Shape the edges using a reciprocating saw blade or coping saw and file. Use this casing as a template to shape the remaining side. Use wet and dry paper to finish.

Position the two sides together and temporarily secure with masking tape wrapped around the outside. Draw the shape of the top cut using a pencil on both sides.

Separate and cut the top section away on both sides. Smooth with files and wet and dry paper.

To secure both casings together, tie wraps can be used. Mark off the width of the tie wrap on opposite sides on both casings. Carefully cut four rebates with a coping saw and a file. Wrap the tie wrap around both casings. The photograph illustrates the use of two tie wraps in each rebate.

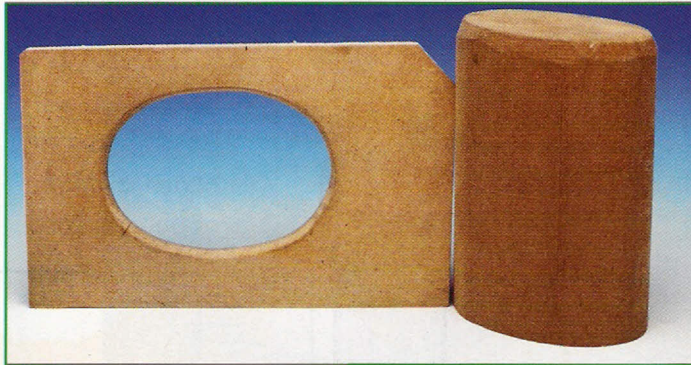




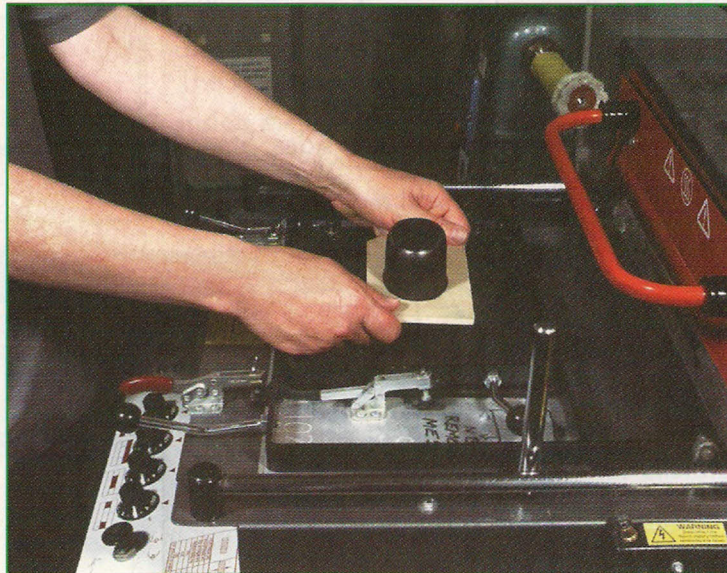
Vacuum forming the sleeve using 6mm plastazote

The plastazote sleeve is manufactured using two formers, a male and a female. The sleeve needs to fit accurately inside the casing.

Tip: To manufacture the male former use the mould or formers used for the casing in assembly task A. Cut in half, glue together and sand to achieve a smooth radius. The female former is manufactured from 3mm wood and is 6mm larger in diameter than the male former and sanded to smooth sharp corners.



Place the male former on the platen of the vacuum former. Clamp 6mm plastazote in place using a reducing frame if necessary. Heat the plastazote until spongy, remove the heaters and raise the platen gently to push the mould into the plastazote. Turn on the pump and push the female former gently down over the top of male former and plastazote.



Do not push the female former too far down as the plastazote will stretch and split. Refer to the table at the back of this publication for recommended times and temperatures for heat forming plastazote using this technique.



Remove the formers and cut the plastazote sleeve to an appropriate size to fit inside the casing. With a sharp knife cut a slit along the top of the sleeve to enable access inside the Phone Pod. At the final assembly stage the plastazote sleeve can be secured to the inside of the casing with double sided adhesive tape, spray adhesive or hook and loop tape.

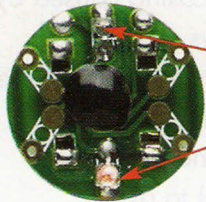




Assembly Task C: Circuit

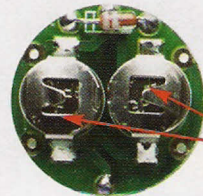
The following methods illustrate examples of how to integrate the pre-manufactured circuit within the Phone Pod.

Mobile Phone incoming call detector circuit.



surface mount LEDs

Front of Circuit



Replaceable 1.5V coin cell batteries

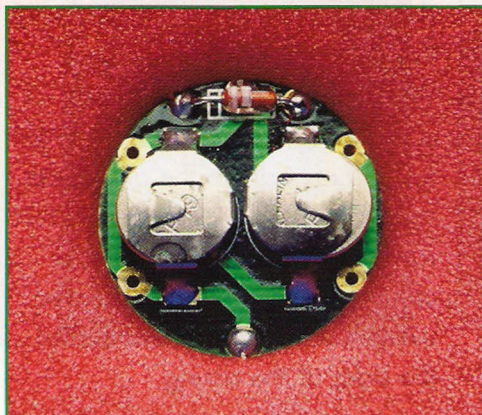
Back of Circuit

Method One:

The circuit can be positioned inside a 3mm plastazote housing that has been vacuum formed through a 22mm hole.

Several plastazote housings can be vacuum formed at once by using a simple mould with 22mm holes drilled and spaced at least 40mm between centres into 6mm MDF. The mould is then raised at least 6mm off the platen when placed inside the vacuum former. Vacuum form as normal adhering to recommended times and temperatures.

The circuit is secured in position by using a second lining heat formed from neoprene or plastazote. This lining is adhered to the inside of the casing using hook and loop tape, spray adhesive, or double sided sticky tape.

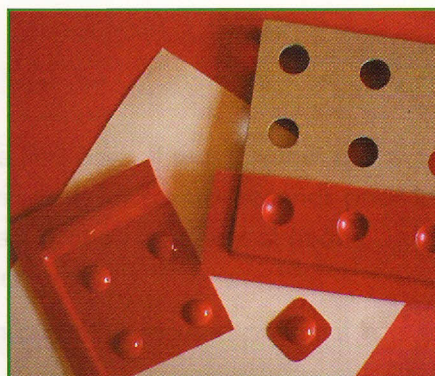




Method Two:

An alternative method is to vacuum form several circuit housings together using 1.5 mm thick vacuum forming plastic. Several holes need to be drilled using a 25mm forstner bit through 6mm MDF and spaced at least 40mm between centres.

The former needs to be raised at least 12mm off the platen of the vacuum former to allow domes to be formed underneath. Clamp the glossy side of the vacuum forming sheet face down in preparation for forming.



When formed, the housings are separated and finished with wet and dry paper.

To seal the plastic housing and circuit inside the casing, vacuum form 3mm plastazote over the inside of the casing with circuit housing in position following the process described on page 19. Disassemble and adhere the plastic circuit housing back in position inside the casing with double sided sticky tape.



Place the circuit into the plastic housing. Then place the formed plastazote over the top and adhere to the inside the casing with spray adhesive.

For a more decorative effect use 6mm fluorescent tube with 4mm fluorescent rod pushed inside and cut into 5mm lengths. Finish with wet and dry and polish. Drill 6mm holes through the circuit housing and casing. Punch holes in the plastazote using a 6mm hole punch. Push the rod and tube through the holes to attach the plastic housing to the inside of the casing.

