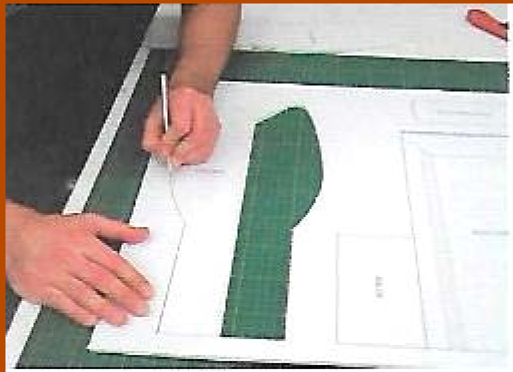
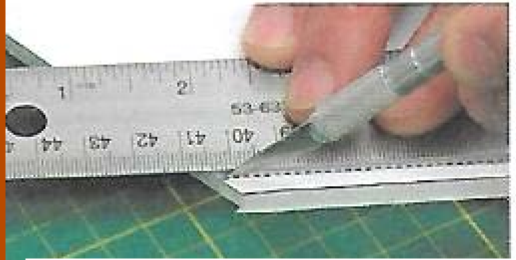
PRO 204 – Modeling Prototyping

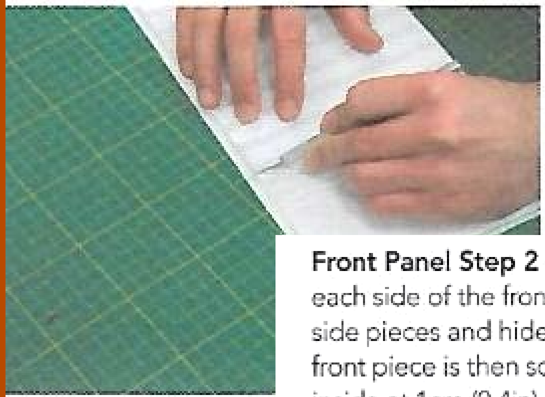
WORKING WITH POLYSTYRENE FOAM

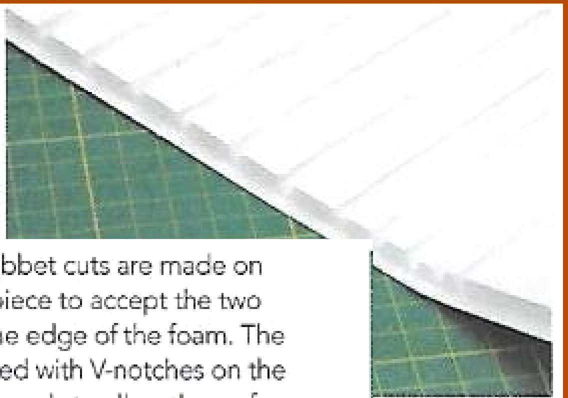


Step 4 Each pattern is printed on regular bond paper to one-quarter scale. These are then glued directly on to the foamboard. A sharp scalpel is used to cut out each piece of the model with a three-stroke approach.

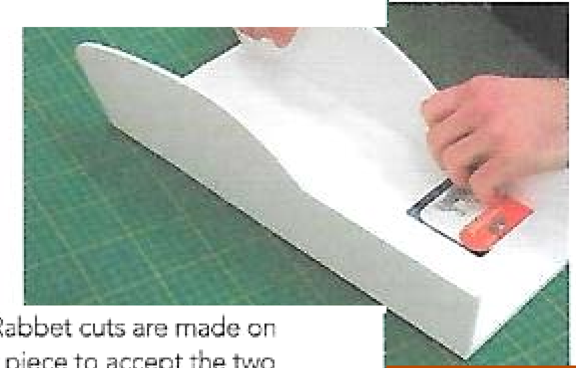


Front Panel Step 1 Trim rabbet joints on side pieces using a metal ruler. These channels will hide the edge of the back foamboard piece.

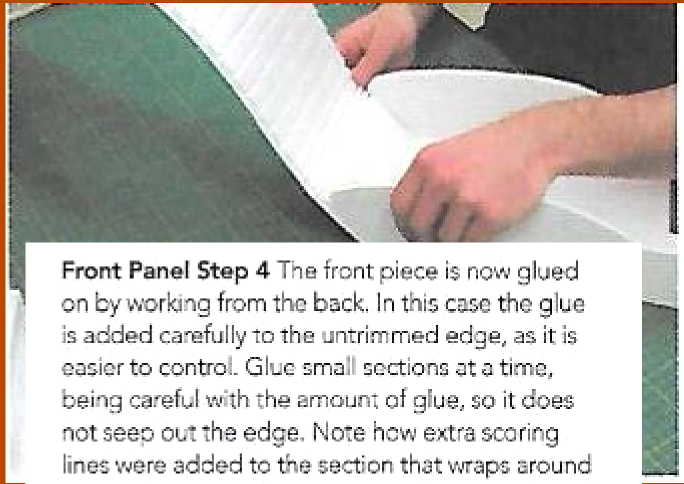




Front Panel Step 2 Rabbet cuts are made on each side of the front piece to accept the two side pieces and hide the edge of the foam. The front piece is then scored with V-notches on the inside at 1cm (0.4in) intervals to allow the surface to curve.



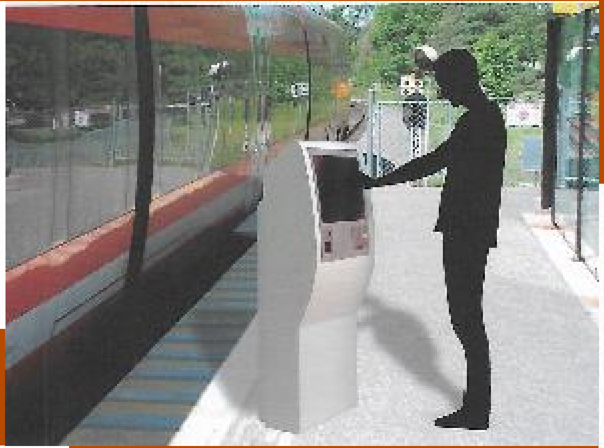
Front Panel Step 2 Rabbet cuts are made on each side of the front piece to accept the two side pieces and hide the edge of the foam. The front piece is then scored with V-notches on the inside at 1cm (0.4in) intervals to allow the surface to curve.

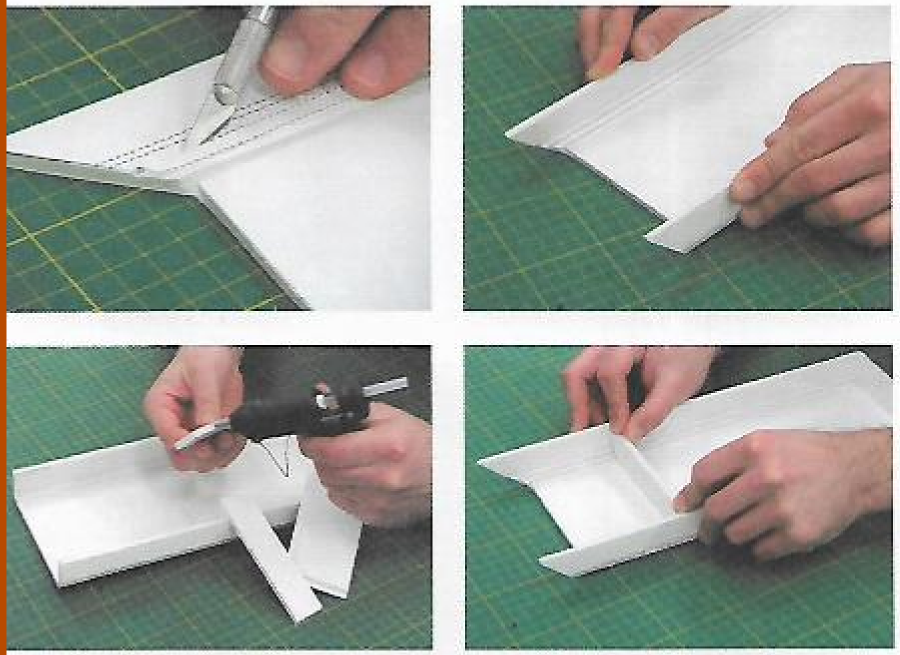


Front Panel Step 4 The front piece is now glued on by working from the back. In this case the glue is added carefully to the untrimmed edge, as it is easier to control. Glue small sections at a time, being careful with the amount of glue, so it does not seep out the edge. Note how extra scoring lines were added to the section that wraps around the tight corner.

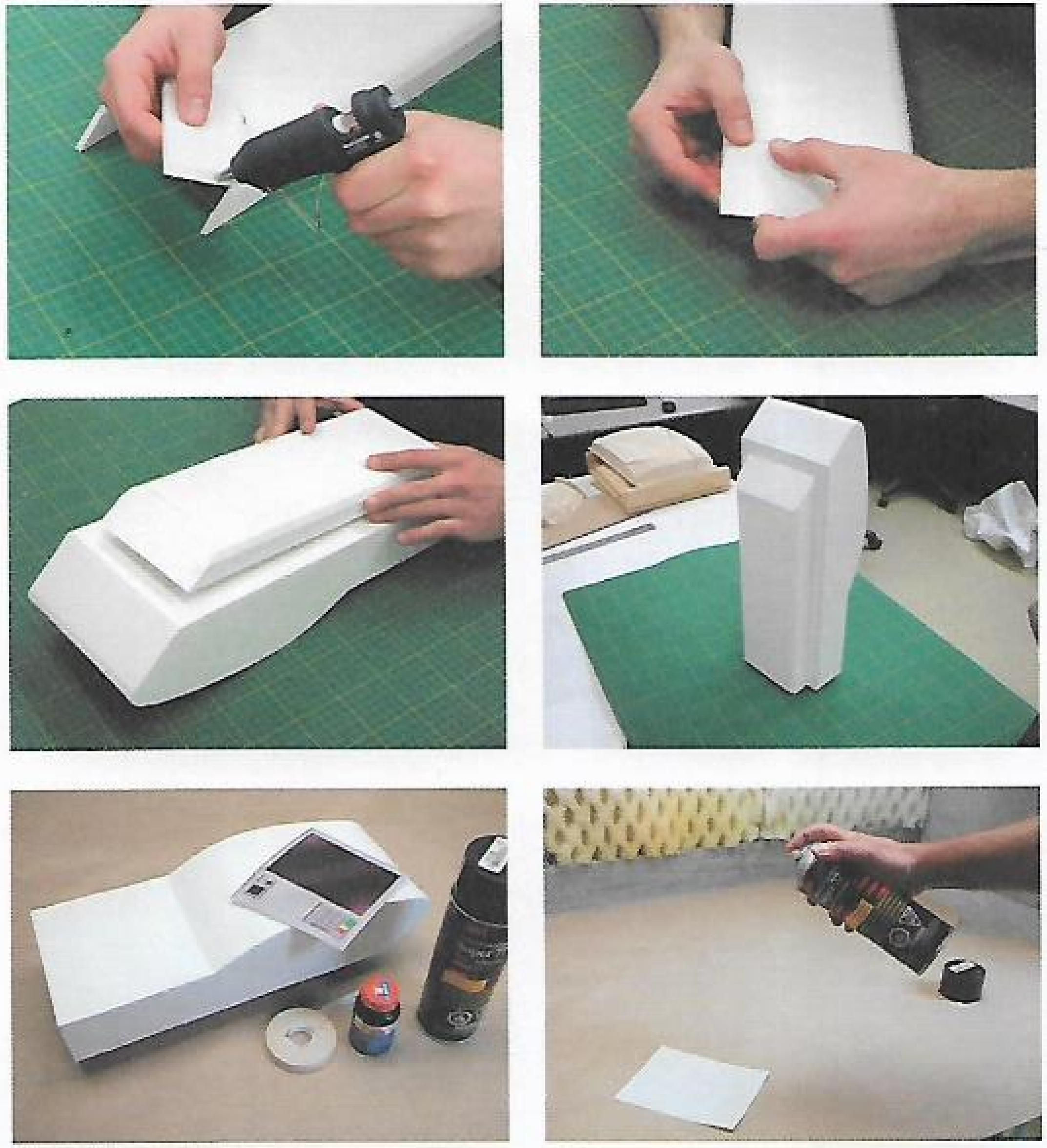
Front Panel Step 3 Attach the side pieces to the rear piece with hot glue. Apply the glue to the rabbet cut and hold while glue dries. Attaching the sides to the back first will make it easier to attach the curved front piece.

The final model is shown with a scale person interacting with the machine. The scale person was cut out from the initial Illustrator® outline on black foamboard. The composition below was created by superimposing the photo on to a background scene in Photoshop®.





Rear Housing Step 1 The sides and back are created in one piece of foamboard. The rear corners are rounded, which requires three V-notches to be removed on both corners.



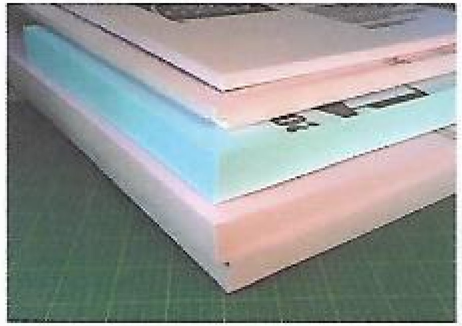
Final Assembly Step 2 The final step is to glue on the decal that captures the interactive elements of the self-serve kiosk. Spray glue works well, but should be used only in a spray booth or outdoors. Double-sided tape or rubber cement are suitable substitutes.

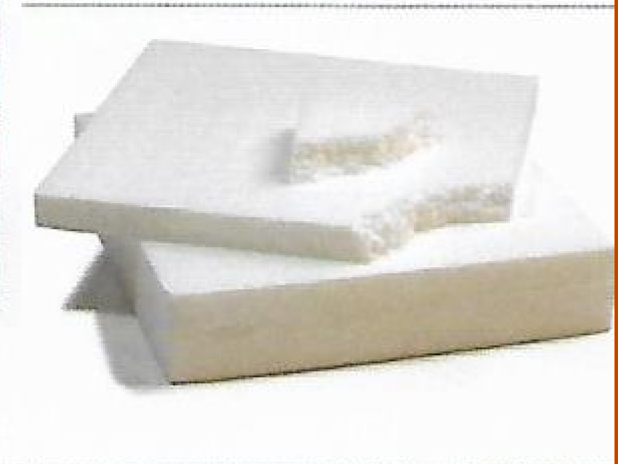
POLYSTYRENE FOAM

Closed-cell polystyrene foam is an inexpensive and easily worked material for low-fidelity form exploration work. It is made by infusing polystyrene plastic with gas during the manufacturing process. Although its main use is in housing insulation or product packaging, it is also very popular as a desktop modelmaking material since it can be sculpted quickly with the simplest of tools. This material is suitable for complex forms made by a subtractive sculptural process. The iterative mindset reigns when working in polystyrene foam. A fluid process allows the designer to move between hand sketching, foam modelling and digital modelling so as to keep the ideas flowing.

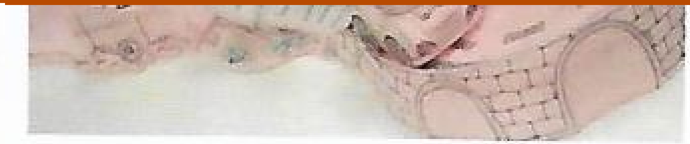
There are two different kinds of polystyrene foam. Extruded foam (XPS) – or Styrofoam – is a readily available solid insulation material sold in various thickness sheets by builder's merchants. Depending on the supplier, it will be manufactured in different colours, including pink, blue or white. It may also be purchased as thicker pallets from specialty suppliers. The low density of the material 40kg/m3 (2lb/ft3) makes it extremely easy to work with.

Expanded polystyrene foam (EPS) is the second kind, and is essentially the same material except it consists of beads that are pre-expanded and then fused together with steam. This manufacturing process is suitable for making moulded shapes and is frequently used in product packaging. EPS is typically white in colour. The beaded construction also makes it harder to work with than XPS, as the beads tend to break off and create unsmooth edges and surfaces. It is therefore inferior to XPS as a modelling material.





Expanded polystyrene foam is less suitable as a modelling material owing to its beaded construction.



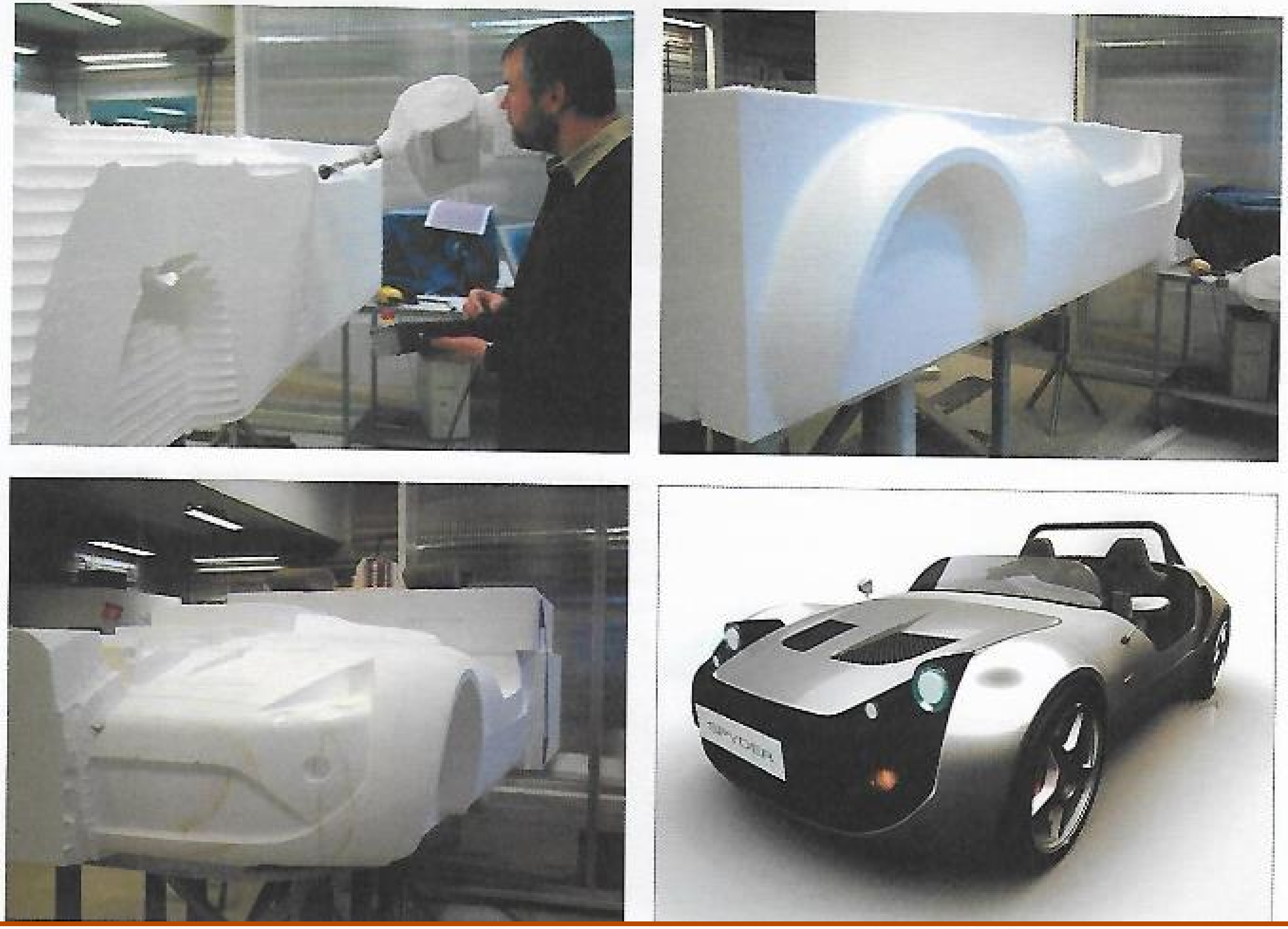
Foam is a fast and effective material for early form explorations, as shown in this extensive model by Nancy Mistove for Funrise Toys. Surface details and visual interest are added with marker pen and simple paper labels.

Applications for Polystyrene Foam

Polystyrene foam is suitable where speed and a lower level of fidelity are needed. Exploration of form and overall visual proportion is a typical application. Although not very strong it is sometimes used in early user testing of ergonomics and fit. The main benefit is the low cost and the fact that it can be worked with simple hand tools into complex forms right at the designer's desktop. The speed with which foam can be worked also allows multiple variations to be realized and evaluated side by side.

For larger models it is often more cost-effective and easy to handle than other, heavier modelling materials. Polystyrene foam is, for example, used to verify tool paths for CNC machining as the material is inexpensive and can be cut quickly before investing in a more expensive machining board.

Polystyrene foam does, however, have limitations. The low density and soft structure means that it is easily dented and will not hold fine details. For ergonomic testing the material does not exhibit the final product weight properly and if weighted it will be prone to breaking. Polystyrene foam models are generally unpainted, or painted only in a neutral colour such as white. This is usually appropriate for low-fidelity prototypes and avoids unnecessary discussion about product details at the early stage of a project.



A full-size foam model of the Olme Spyder sports car is CNC machined in polystyrene foam at Umeå Institute of Design, Sweden.

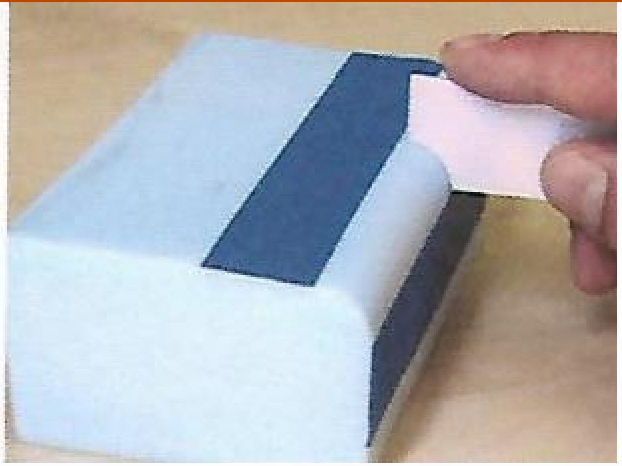
Working with Polystyrene Foam

Shaping

Polystyrene is a thermoplastic. This means that under heat the material will become flexible and then melt. It can therefore be easily shaped and cut with a low-voltage electric tool known as a hotwire. Several advancements have been made to hotwire technology, including hand-held tools that add flexibility and carving potential for a finer level of detail. These specialty tools are worth the investment if you want to make a great many foam models. Hotwire tools do, however, cause the plastic to melt and emit toxic fumes. Good ventilation is therefore necessary.

A polystyrene sphere is made by rasping the overall shape, followed by successively finer grades of sandpaper and a sanding template.

In addition to hotwire tools, rasps and sandpaper are used to shape accurate surfaces. In the example below, a polystyrene foam sphere is shaped with successively finer tools. Start by cutting a cylinder that has the same diameter as the sphere (see picture above). The height should also be equal to the sphere diameter. If necessary, laminate two or more sections of polystyrene foam together to attain the necessary thickness. The rasp is used for the initial rough removal of material followed by a coarse-grit sandpaper to establish overall form. The final smoothing is done with medium-grit sandpaper. The sphere is made perfectly round by using a sanding template of the correct radius. The sanding template is made from foam as well with a fine-grit sandpaper glued to the inside radius.



The computer should be used where it saves time and makes the work easier and more productive. This can be as basic as creating outlines in Illustrator® and then printing them out on paper, which is then affixed as a cutting outline.

Remember to think additively. It is easier to make bits and pieces and add them together, rather than try to carve everything out of a solid block. Sometimes the designer may wish to add a little more material to thicken a surface or change a detail. Plasticine can be used in cases of quick exploration as it can be easily added on top of foam, although it cannot be painted. Sometimes a section of the model will be cut away and replaced with a new piece. This deconstructive approach is very common in explorative work and creates a fluid workflow that is open to changing and examining variations on the design.

Taping and sanding an edge radius. The radius is checked with a radius gauge.

Carpenter's glue or paper glues such as rubber cement and white glue work best for polystyrene foam.

Gluing

White paper glue or carpenter's glue (which is very similar) and rubber cement are used for laminating sheets together for thicker models as well as to affix labels or decals. Thin amounts of spray glue will also work, but this is a less environmentally-friendly option. For attaching small pieces or detail, cyanoacrylate glues will work well.

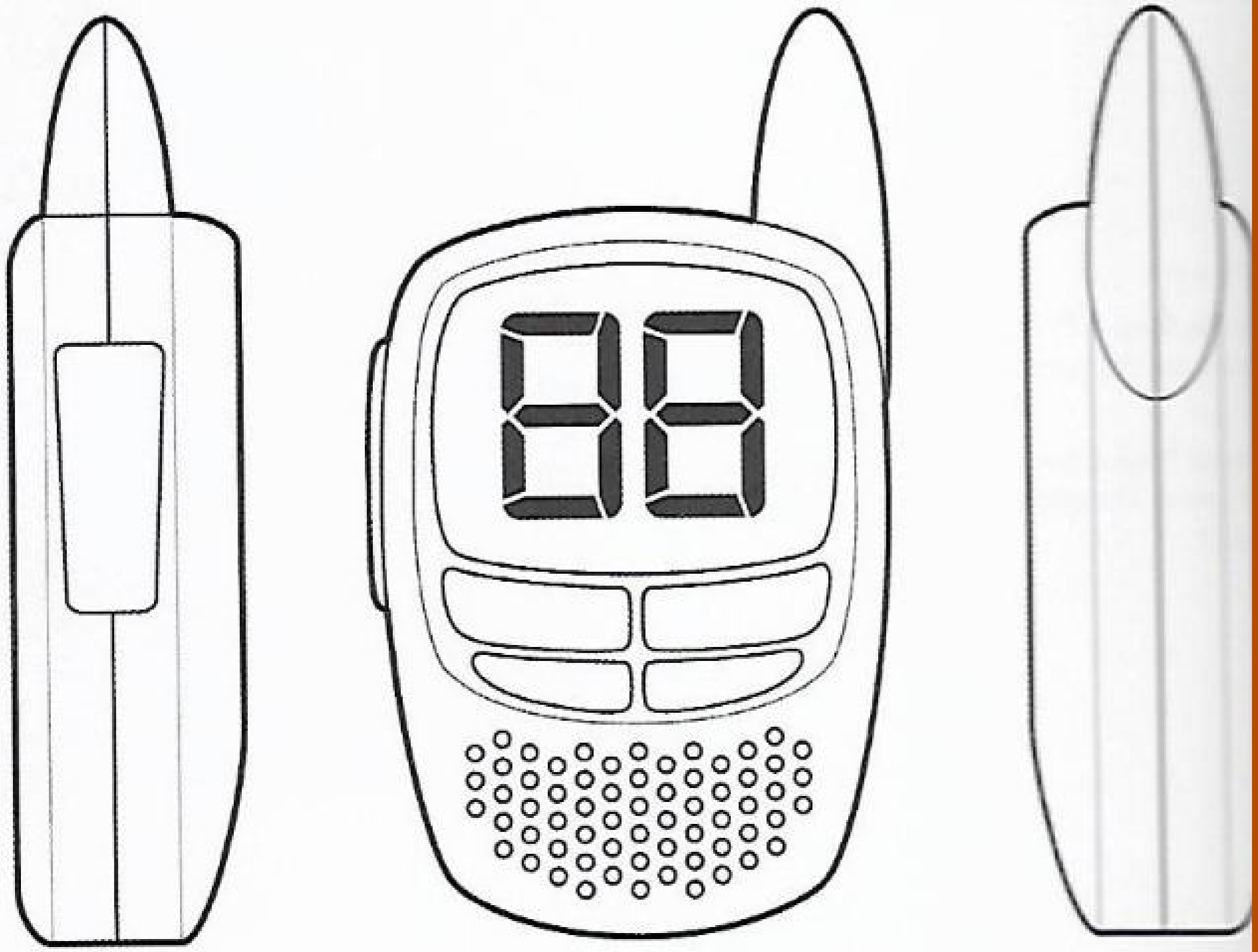
Solvent-based glues such as contact cement should not be used as they will chemically eat through the polystyrene foam and ruin the work. Hot glue melts the foam surface upon contact. Hardened hot glue also presents problems for cutting and sanding, as it is harder than the foam.

Water-based polyfillas are suitable as they do not react chemically with the polystyrene foam and they sand as easily as the foam itself.

This tutorial will show you how to make a model in XPS foam. Small details such as the LCD and buttons will be illustrated on paper labels designed in Illustrator® and printed on a regular inkjet printer. The labels and lack of paint both save time and keep the workmanship clean and crisp.

Overview The model consists of a main body and an antenna. The main body has a top surface that is blended between the flat-top LCD plane and a horizontal plane A that demarcates the flat side contour. The antenna has an elliptical cross section.

Step 1 A full-scale 2D rendering layout is created in Illustrator® (see page 163). Alternatively, this could be hand-drawn (for a very quick model) or created in CAD. This drawing will be used as a template for foam cutting and sanding. The labels for the LCD display and speaker grill will also be printed from this file.



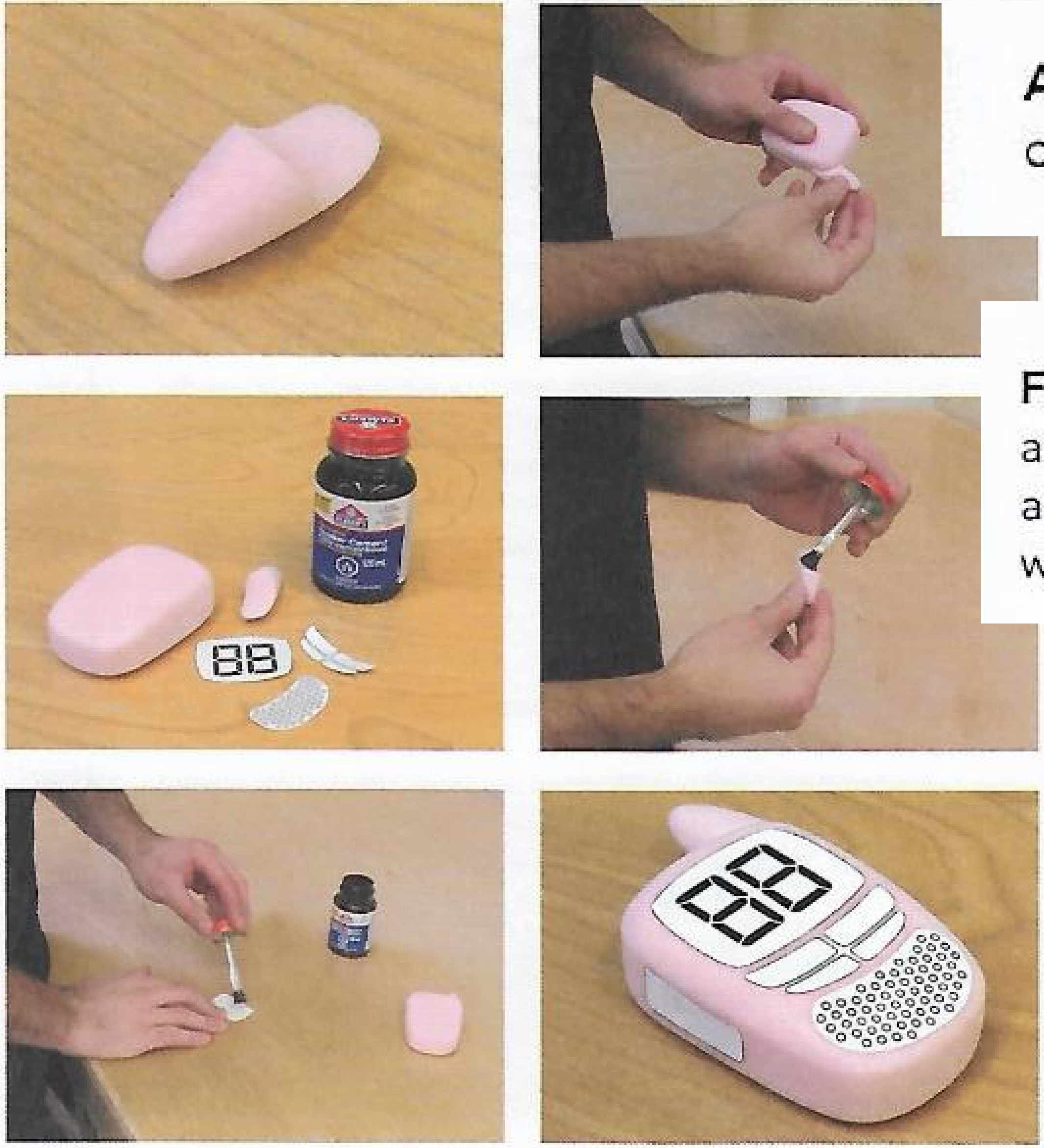
Main Body Step 3 In order to create the convex top surface, the transition is marked with masking tape. A top label is also added that defines the top LCD plane.

Main Body Step 4 The convex top surface is carefully shaped with 320-grit sandpaper. Since the paper label resists sanding more than the foam, the transitions are kept crisp and clean.

Main Body Step 5 A side-profile template can be used to check that the profile is as intended. This step is not strictly needed, but helps maintain a predefined shape. A new top label will later need to be printed and applied, since the label has been sacrificed during sanding.

Antenna Step 1 The top and side views of the antenna are cut out and affixed to a piece of foam.

Antenna Step 2 Both profiles are now cut on the hotwire. The elliptical cross section is sanded by hand.



Antenna Step 3 The final elliptical antenna is checked against the main body for fit.

Final Assembly Step 1 New labels are printed and trimmed. The model is now ready for final assembly with rubber cement. White paper glue will also work well.

Final Assembly Step 2 Printed labels are affixed.

Sekian

td 01-2021