Building a Scarab 18/650 folding trimaran

The plans for these two boats will be sent by email and contain everything needed to build these boats, including rig and trailer drawings and a list of all materials needed.

All the pictures in this article are of the Scarab 18 but the Scarab 650 is a very similar build.

This Scarab 18 is built using of laminated panel construction but can also be built using plywood.

The construction method can be adapted to any boat built with foam laminated panels.

Manufacturing the Foam Panels

We construct our panels by joining the foam sheets together the full length of the boat and then covering with glass. This method works well and calculation of soak coat recommended by the manufacturer of the foam and the theoretical amount of resin needed to laminate the glass are well within accepted levels.
We use LSE (low styrene emission) resin and the smell of polyester resin is minimal. So it shouldn't annoy the neighbours.

Building a foam sandwich flat panel boat is similar to building a boat in plywood. Separate sheets of foam can be laminated and then scarfed together by gluing and taping if desired. But if you have the space it is much simpler to join the foam before it is laminated the full length. The panel is smooth so it is easier to fill the boat before painting and there is no need to use a string line to line up separate sections of the hull panels.

The foam is cut to the desired length and the edges glued. We use resin mixed with aerosil. The foam is held in place with drywall (gyprock) screws. We place a piece of plastic under the joint to protect the table underneath and prevent our panel becoming a permanent part of the table. Once the resin sets (usually about 2 hours) the screws are removed. You can fill the screw holes with filler or leave them to fill with resin as you laminate the foam. If you don't fill the holes the resin will pass through the holes leaving a blob of resin underneath. This is easy to remove with a small grinder with a sanding disc.

Lay the glass over the length and smooth. Cut peel ply in short lengths (about a metre in the beginning). Mix the resin and pour it over a section of the foam (about a metre to begin). Allow gravity to help saturate the glass and soak the foam. Using a metal drywall spatula (10 inch wide works well) spread the resin and work it into the glass. When you are satisfied the glass is saturated and there are no air bubbles, add the peel ply. Work the peel ply until there are no air bubbles or excess resin.

Sometimes a small amount of resin poured over the peel ply makes it easier to work

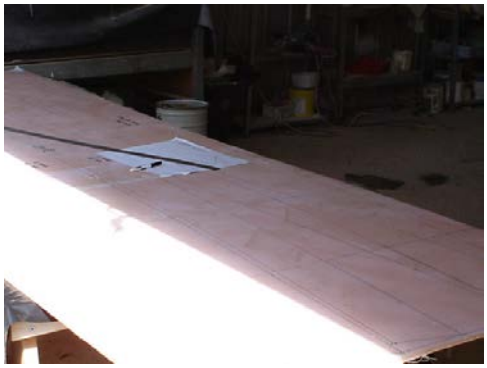
the air bubbles out. Finish one area then move on to the next until all the foam is covered with peel ply.

The time to build the full length panels is approx. 10% of the total build-time of the hulls but once the panels are cut out they are very quick to set up on the building frame.

Most of our customers build their boats using plywood but that is beginning to change. I can only think it is the rising price of plywood and epoxy resin.
We use polyester resin on our boats, partly for the cost and partly for the safety reasons.

LOFTING THE PANELS

Sheets of laminated foam joined to the appropriate length or scarfed plywood is prepared. A line is drawn on the edge and lines at 500mm are drawn perpendicular to the line using a square. The measurements supplied in the plans are marked on the lines. Screws in foam, or nails in plywood, are added at each point. A line is drawn using a flexible strip of plywood (we use an old sail batten). Most of the panels have more than one the same so after the first one is drawn it can be cut out and used as a template for the rest.



MAIN HULL

A temporary frame is made plywood or MDF thick enough not to distort. Level and square the frame using string lines and level. A laser level is an easy way to make sure. Another quick method is to mark the position of the bulkheads on the inside of the panels as you attach them to the building frame. Both of these boats have the permanent bulkheads in the same position as the temporary bulkheads. This ensures the bulkheads are level.

If the boat is to be built using plywood then the sheets are scarfed together and joined to the building frame. The edges bogged and sanded and the glass in laminated over the hull while it is still on the frame.

If using foam, the panels are attached to the building frame using drywall screws.

The panels are joined along the edges using soft metal strapping if necessary. When attaching the panels to the frame it is important to make sure the glass skins line up at the joints. On the outer curves the inside laminate skin must line up; on the inner curves the outside laminate skin must line up. Because of the thickness of the foam panels it will be very difficult to achieve a fair chine if this is ignored at this stage. It may be necessary to use clamps and cable ties to hold the panel together at the bow.

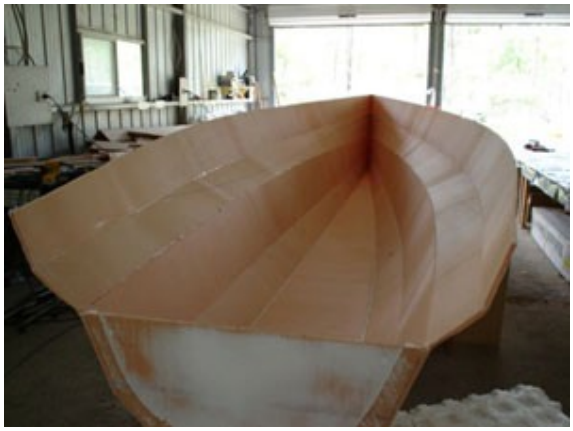
Fill the joints on to hold the panels together. When the filler is hard sand and fair the joint. A long board is the best way to ensure that the chine is fair. We usually cover the bottom three panels with double bias glass cloth over the panels and joints instead of tape. This provides extra protection if the boat is pulled onto the beach. The other joints are taped with double bias tape. Because the bottom three panels are hard to get to when the boat is upright, they can be filled and sanded before turning the boat.

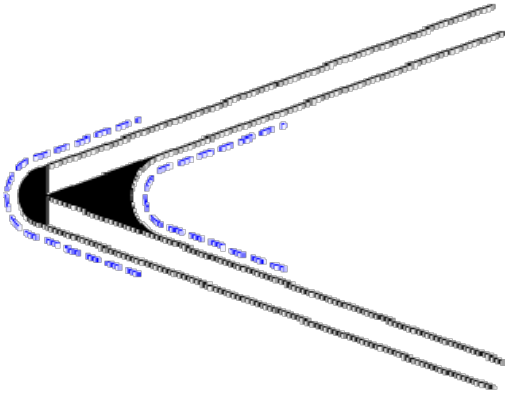
The main-hull is lifted off the frame and turned over. This boat was designed with a flat panel on the bottom so it can be rest on a piece of plywood or carpet on the floor eliminating an extra building frame. It also makes the boat low enough so it is easy to work inside.

When making boats using flat panels, and for joining bulkheads in all boats, you have to use a fillet. After a couple of hours doing this you can get pretty quick. All the boats we build, what seems like, miles of fillets and it is a time consuming task.

I have found that it is quicker and neater to use a wet fillet on inside panels when using tape to join panels together. Cut the glass tape and peel ply if desired. Apply a quick coat of resin along the joint and before it goes off mix the filleting compound (my favourite is resin mixed with aerosil and cotton fibres). The aerosil will retard the polyester resin and the cotton fibre gives it bulk. Mix enough resin to apply the tape. Apply the filleting compound (a little sloppier than normal) along the joint with a filleting tool (the length of fillet will depend on how quick you are, temperature and type of resin). Lay the glass over the filleting compound, brush on the resin and compact the glass to remove the air bubbles (apply peel ply if you want). Apply more filleting compound and continue until the end of the joint. As you compact you can shape the fillet to give it a smooth shape and you have avoided any sanding that might have been necessary if you have waited until the fillet had hardened.

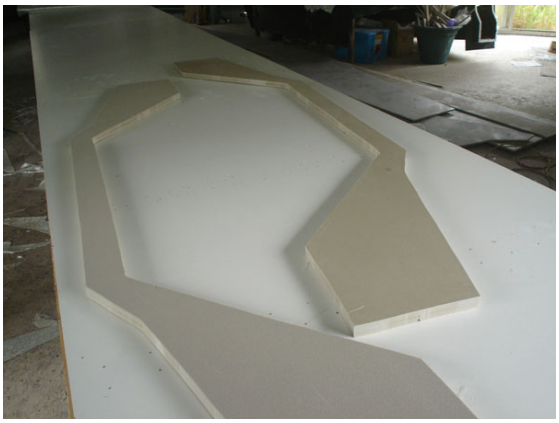
For the outside joints I use a filleting compound that is easy to sand and a long board to smooth and fair the joint at the same time.





Because it is narrow and difficult to reach, it can be a problem finishing inside the stem. The best way we have discovered is to sand the inside of the bow and use a section of pre-wetted double bias glass laid in as shown below. When the glass hardens resin mixed with aerosil is poured into the gap. This should be done gradually as the resin will generate considerable heat with a possibility of catching fire.

The next job to complete on this boat is the supporting structures that hold the forward and aft beams. To make these beams foam is cut to the right shape and layers of foam are glued together. Many layers of glass are added to the foam shapes until all the laminates stipulated in the plans are added. The edges are smoothed off (a sanding disc in a grinder works well). Double bias tape is added to the edges to hold all the foam and glass together. The pivot holes for the folding system are drilled at this time. It is easier to drill plumb holes at this stage. A drill press, if available, works well.



Bulkheads are cut out using the off-sets in the plans. They are made using the same laminate as the panels. They are trimmed if necessary and tacked in place and then filleted and taped in the main hull.

The main beams are taped in. A ring of glass is laminated around the main hull from side to side on the forward and aft beams.

The centreboard case and the settee risers are taped in place and the top of the centreboard case is glued in place.

An inspection port (used to install the centreboard control lines) is cut before the bunk top/shelf is installed because it is hard to get at later.

If

you want to paint the inside of the lockers it is easier to do that before the floor is installed.

The bunk top/shelf is installed in two sections. The halves are trimmed and glued in place. There is a fibreglass angle glued to the top of the bulkheads to support the bunk top/shelf and give more area for the glue. It is easier to cut out all the locker holes before the bunk top/shelf is installed. A finger hole is cut in each locker cover. The foam should be removed from all the edges and filled with filler. The locker should be trimmed to make it slightly smaller than the hole to allow clearance for paint and hinges.

A temporary frame is set up for the cabin roof using the main cabin bulkhead, the forward bulkhead and scrap plywood.

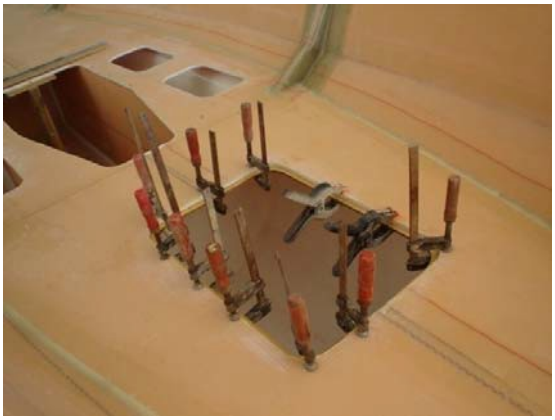
The cabin sides are attached to the frame and the other cabin panels with metal straps. Foam is bent over the frame and attached to temporary pieces of foam attached to the cabin sides. Glass cloth is laid over the foam and wetted out with resin. We use peel ply as well to cut down on finishing later. The edges of the cabin sides and roof are then taped.

This is a good time to make a hatch top. Plastic is laid over the cabin roof and foam is temporarily screwed down and glassed on the top surface.

The hatch is removed and glassed on the under-side.

The cabin top is removed and finished on the inside. It is much easier to glass the roof at this stage and the cabin can be finished now if desired.

Plywood inserts are added to hold the locker lids.



The cabin top is temporarily joined with metal strapping, tacked, filleted and taped. The hole for the hatch is cut out and hatch surround added with scraps of foam laminated strengthened with unidirectional glass.

The hatch is finished off with scraps of laminated foam added around the edges and taped. The edges of the foam are removed and filled with filler.

The holes in the cockpit seat risers are cut out when the risers were made. They are taped in and storage divider added. Cockpit seats attached.

Cockpit is taped. Edges of the cockpit are rounded off using a long board and taped. Plywood inserts are added as stops for the locker doors.

An aluminium post is cut and attached to a block on the cabin floor and one on the cabin roof. The foam on the deck directly over the mast post is removed and replaced with a high density filler to prevent the weight of the mast crushing the deck.

A plywood template for the window shape is temporarily attached and the shape drawn on the cabin sides. Holes for the windows are cut and the foam removed around the edges and filled.

Main hull is filled and sanded. We use Q cells because they are inexpensive and easy to sand. If the boat is faired correctly before the panels were taped then only the areas between the tapes need to be filled.

The cockpit and the interior can be filled and faired in the same way. Drain holes are drilled in the stern and the foam removed around the edges.

The anchor locker is cut and finished inside. A support to hold the fore stay is added to the forward bulkhead. The foam around the edges is removed, filled and the plywood-insert added hold the anchor lid.

The centreboard pivot is manufactured and installed in the centreboard case.

MAKING THE CENTREBOARD PIVOT

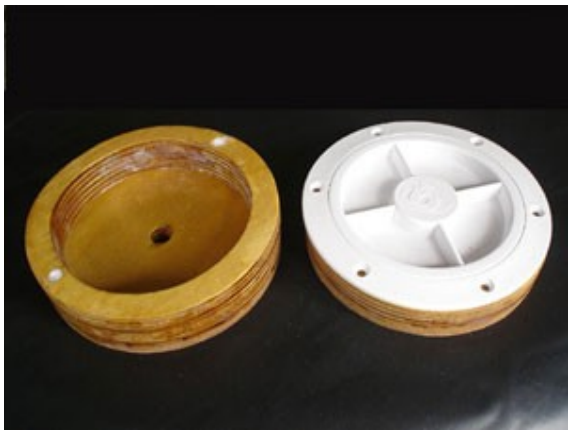
It is difficult to make a pivoting system in a centreboard leak-proof. Our system relies on totally encapsulating the pivot bolt and using two inspection ports (one each side of the centreboard case) for access. Two 12mm thick plywood discs are cut with a diameter the same as the outside diameter of the inspection port unit. Three 12mm thick plywood rings are also cut, same outside diameter and the inside diameter to allow fitting the inspection port. The inspection ports must be the ones that have an ‘O’ ring under the ‘lid’.

Two rings are glued to one disc and one ring glued to the other disc. The discs are drilled for a 12mm bolt and all covered with epoxy resin to seal the plywood. If desired the bolt hole can be drilled oversize and filled with high density epoxy bog and then re-drilled.

The disc with two rings is glued to the outside of the outboard side of the centreboard case and the disc with one ring glued to the outside of the inboard side of the case. The discs must align so pass a bolt through the whole assembly while the glue cures.

The inspection port should be screwed to the outboard assembly before gluing to the case as there is not much room to wield a screwdriver between the case side and the hull side, use plenty of sealant under the inspection port. The inspection port is then screwed to the inboard assembly with sealant between.

When the time comes to assemble the centreboard in the case the bolt is passed through from the inboard side to the outboard side and the nut tightened. The inspection port 'lids' are then screwed in and gently tightened.



PAINTING THE BOAT

The boat can be painted with different marine paints with roller or sprayed. We have found the Jotun system works well is easy to apply and very durable.

Jotun Pengard is a high build epoxy primer and fills some small blemishes. We spray one coat with an air-less sprayer wait 2 days and sand. It gets harder to sand if left for a long time. Using an air compressor to blow the area will reveal small blemishes. Fill the areas with filler, sand and respray.

Johun Imperite 300 is the top coat. It is shiny, tough and comes in many different colours.

When spraying the top coat we use a top loading gun with a 1.4mm diameter hole. The first coat should be light and allowed to tack off for about 15 minutes. This will prevent the paint from running on the next coat. The second coat can be a little thicker. If using a light colour then 2 coats may be enough. If painting a darker colour then 3 coats will probably be needed to cover the white primer.

ADDING THE NON-SKID.

Mask the area to be painted. There are several brands of non-skid on the market that can be either brushed or rolled on the area. If you like the boat to have the same colour non-skid as the hull you can mix different materials in the paint.

ADDING THE WINDOWS

The plywood template for the windows is temporarily attached to the cabin side and a line drawn marking the outside dimension. Because we were using smoked colour Lexcen the area underneath the window is painted black. The windows cut from a sheet of 6mm tinted (smoked) Lexcen. A jig saw with a Makita No 42 blade at a fairly slow speed worked well. The edges are sanded and a small bevel made on the outside, all holes drilled and countersunk for the screws. The holes in the cabin side are drilled and filled with solid filler (aerosil and resin). Then the holes can be re-drilled.

The area around the window are masked to prevent Sikaflex from ruining the paint. It is a good idea to have someone to help hold the window as you apply the Sikaflex to the back. Press the window to the cabin side and screw. A bead of Sikaflex around the outside of the window is added to prevent any leaks.

HINT – best to wear a few latex gloves on each hand and discard as they become contaminated with Sikaflex

The locker covers are painted, trimmed and attached with hinges. Small pieces of stainless steel are bent and added as latches with some spectra rope added.

Drain holes cut, foam removed and filled are at the level of the cockpit floor. Rudder gudgeons were attached to the stern.

HATCHES

Hatch is attached using an aluminium or stainless bow and a telescoping stay.

Forward hatch was attached with Sikaflex and stainless screws.

BUILDING THE BEAMS

Most of the beams in Ray's designs are made in moulds. Directions for building the beam moulds are included in the plans. The best material to use to build the mould is

form ply or plywood saturated with resin.

This mould was built using form ply. Form ply is readily available, is relatively inexpensive and has a smooth surface so the glass doesn't stick (but resin coated plywood will work as well).

The mould is joined with screws or glue with the inside edges rounded off with filler and resin. An easy way to make the fillet is with plasticene. It is a quick clean fillet but it will have to be redone for each beam. Pilot holes are drilled as markers for the pins that hold the folding system. The pilot holes are blocked with small bits of plasticene.

NOTE – It is very important to drill the pilot holes through the moulded beam before removed from the mould.

The mould is waxed 5 or 6 times for the initial use polishing off after each coat is dried (usually a single coat of wax is sufficient for subsequent mouldings).

To avoid air bubbles it is best to use gelcoat or resin mixed with aerosil and allow it to tack off before using a layer of 225gsm chopped strand mat glass using un-waxed resin once the gelcoat is touch dry. Allow the resin tack off and then apply layers (the laminates specified in the plans). To avoid shrinkage apply no more than 900gsm of glass at a time, all the time using un-waxed resin(if using waxed resin recoat in less than 24 hours. For the last layer add wax to the resin. This is a job that can be planned around other jobs to save time. Using this method the beam will not shrink and will be finished ready for paint.

When the beam is removed from the mould it can be trimmed with a diamond disc in an angle grinder.

BUILDING THE FLOATS

The float frame is set up and levelled. Panels are attached as with the main-hull panels with screws. The float joints are filled, sanded and faired. The float is glassed the same way as the main-hull (double bias cloth over the bottom 3 panels).

The floats are removed from the frame and taped inside. The floats were levelled and the bulkheads trimmed to fit. All the bulkheads are taped in the floats. A stringer was added in the centre to help the deck hold its shape

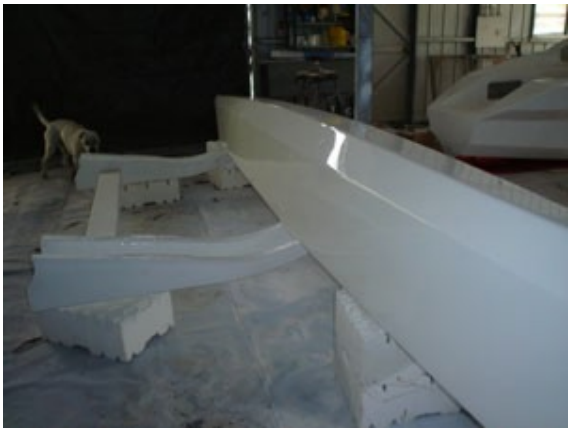
The laminated panels are too stiff to bend over the deck shape. We attached scraps of foam on the outside of the hull to temporarily hold the deck. The foam was joined to the right length and drywall screws were used to attach the deck foam to the hull. Care was taken to not screw into the hull itself. The deck was laminated with glass cloth and resin on the outside. When the glass hardens still attached to the scrap foam. The scraps were removed and the inside of the deck was laminated.

Another way is to use laminated glass and cut partly through and bent the panel over and attach to the scraps of foam. Apply bog to the cut away pieces and sand. Late after the beams are attached the deck can be glassed covering the deck joint. It will make a very strong deck.

This shouldn't be a problem if using plywood: the plywood will bend in a fair curve.

The floats are levelled and the beams are set up through the appropriate bulkheads.

After the beams are joined to the float, the deck is trimmed and joined to the hull with glue and held down with temporary metal straps until dry. He edges are sanded using a long board, faired and taped. Both floats were filled, painted and non-skid applied.



BUILDING THE CENTREBOARD AND RUDDER

The centre board and the rudder are made using layers of plywood. Two pieces of 12mm plywood are laminated using a couple of layers of glass cloth and epoxy resin between. When the board is shaped the glass inside gives a sharp finish to the trailing edge directions in the plans.

The boards are shaped a small grinder with a sanding disc. Then the board is cut to shape. A template is included in the plans. After the correct shape was achieved the board was covered with glass cloth and epoxy resin. The board is filled, sanded and painted.

A rudder head is made using a form ply mould. The mould is waxed and layers of glass are wrapped around the mould. Peel ply was used on the outside to minimise the time spent finishing the head. After the mould was removed the rudder head is trimmed to shape and joined to the rudder blade with a stainless pivot pin. The pintles are screwed onto the blade to match the gudgeons on the stern

The tiller is made from laminated hoop pine and varnished.

FOLDING SYSTEM

The folding system is made from structural grade aluminium water cut. The file is available on Drop Box when you purchase the plans. The file can be copied and taken to your fabricator to be cut using a water jet cutter.

ASSEMBLING THE BOAT

We used an engine hoist to hold the floats in position until the pins were inserted. You can manage without the hoist but it is definitely easier if you have no help available.