Team Scarab building hints

This book demonstrates many of the techniques we have used over the years building plywood panel and foam sandwich flat panel boats. I hope these techniques will be useful when you build your dream boat. Team Scarab sells plans for homebuilders. We believe that building a boat using minimum number of tools can produce a beautiful, elegant boat. Many of our home-builders build boats in a shed, under tarps in the yard or even in their basement.

Ray develops his designs using the latest CAD drawing techniques. The plans are professional-quality and easy to understand. The panels are accurate so all the pieces fit together. The materials in the foam sandwich panel designs are high quality and up to date technology. Even though the designs and materials are modern, the techniques we use can be duplicated with minimum fuss by the average home-builder. All of our boat can be made with minimum tools and experience including the beams.

Some of the builders have added used catamaran rigs, cutting down the cost. We want to get the builder out on the water with a boat that he will be proud of and one that can compete with anything in its class. The instructions are simple and everything can be made at home. These boats are not punts but sophisticated machines that you can race or cruise with friends and family.

Our building technique for making laminated foam panel boats is an adaptation of chine plywood construction combined with the flat panel boats built using professionally made composite panels. The end result is a sleek beautiful boat, quick and easy to build at minimum cost.

These foam boats also hold their resale value, are light, strong and require minimum maintenance. We have many customers over the years who have tried to improve the technique by using vacuum bagging and resin infusion. We would never discourage innovation but we have found that the old and tried techniques using a bucket and brush work just as well and save money and time.

The weight difference between vacuum bagging and hand lay-up can be minimal when you consider the weight of a porta-potti and other necessities on board. The cost of consumables, pumps and other equipment makes it unreasonable for building a one-off boat. Most professionals that use these techniques quote the loss of materials when a lay-up goes wrong, sometimes a whole hull has to be dumped. We believe building a boat should

be a labour of love without adding any more stress than necessary to the job.

Flat panels have many advantages over the strip plank and conventional round bilge foam sandwich construction.

- The build time is less. Panels are lofted, cut out and joined on the frame.
- Frame can be simpler. Panels are rigid enough to hold the shape.
- If the panels are accurately joined there is less time spent long-boarding the boat.
- The only area that needs to be bogged is between the tapes not the entire hull.

In this book we will give your ideas how to build a foam composite trimaran but this technique can be used to build any size or type of flat panel boat. These techniques have been developed after making several boats using:

- strip plank,
- plywood (stitch and glue),
- moulded polyester
- flat panel composite.

We realise that some builders don't have the perfect shed to build their dream boat but it is important that supplies are kept dry. Rolls of glass will be damaged if they have come in contact with moisture. When it is hot I have found that sweat can leak from latex gloves and drip onto the laminating surface. This will leave a white area that will not completely cure and this should be avoided. Many chemicals that are used for boat building are dangerous and care should be taken to keep children and pets away. I have seen pictures of children helping their dad build a boat using epoxy resin to apply fillets without any gloves or protective clothing. People can develop allergies to these chemicals, sometimes severe.

Tools required:

The tools we use are basic handyman tools and some you can make yourself. It is always a good idea to buy the best quality tools you can afford.

Battery powered drill with a set of drill bits and a Phillips head screw driver bit. The drill is used to screw dry wall screws through foam to hold it in place until the resin hardens. This is not hard work for the drill so a less expensive one works fine.

Electric sanders.

We use random orbitals to sand large areas and flat orbitals for edges and corners. It is best to buy quality; ones with a Velcro pad save time when changing disks often. Building a boat is especially hard on sanders. We found that tradesman quality and couple of long boards are a good idea. I use a fibreglass long board made for car body work or one can be made from plywood with staples to attach the sandpaper.

Jig saw - a good quality one is recommended, a cheap one will last about half a day. Fibre glass and resin panels are very hard on jig saws and you will need special blades.

Small electric angle grinder fitted with a rubber backing pad and sanding disk. We use a grinder to sand the hardest fillers and areas where a strong secondary bond Filleting tools can be made from cake icing tools or any other metal implement shaped with a grinder. Grinders are also good for cleaning filler off tools Measuring tools (tapes), string line, squares, bevel gauge, rulers, chisels, when you forget to clean them properly. For resin and hardener measuring use metering pumps available from resin suppliers. For small amounts use medicine measuring cups or syringes. Compactors (parsley chopper). Any fibre glass material supply store should be able supply a couple of these. Look for those that are easy to clean.

Metal strapping, about 20mm wide (used in house building and available from hardware stores) to hold foam panels together until resin hardens for foam construction.

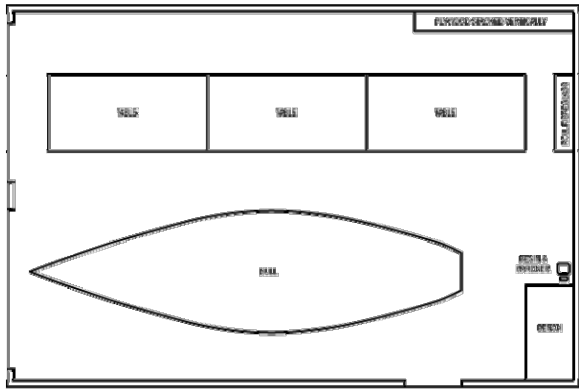
Vacuum cleaner

Scissors (for cutting fibre glass). We found Bosch electric cutter will cut fibre-glass and carpet and will last for quite a while before it needs sharpening.

- Knife with replaceable blades (sometimes called a box cutter).
- Mixing cups and jugs. Use cheap plastic ones and throw away when the resin becomes too hard to remove.
- Mixing sticks. Large ice cream sticks or tongue depressors available from craft stores.
- Paint brushes-cheap ones are best (if using polyester resin find paint brushes without painted handles).
- Safety gear-disposable gloves, goggles and masks when grinding
- A number of clamps.
- Spray guns and compressor if you are going to spray paint the boat. Apart from these tools you will need screw drivers and wrenches (spanners).

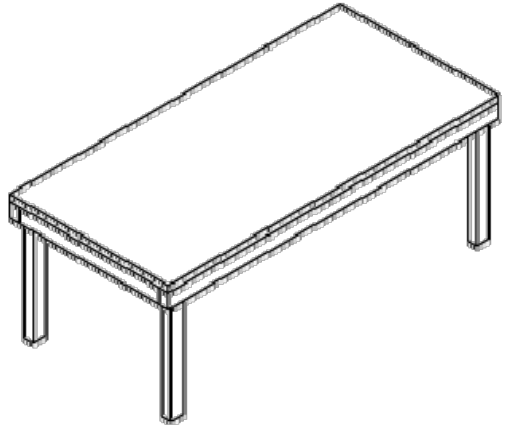
WORK SPACE

A well thought out work space will save time and make the job much easier and safer. If you are lucky enough to have a dedicated work area you can avoid moving things unnecessarily by planning ahead. Below is a plan that we use to build a small trimaran. The long tables can be used to laminate panels or scarf the sheet together.



TABLES

We built our tables using ¾" (17mm) plywood with wall studs for legs. The table is covered in plastic to stop the resin from sticking to the plywood. Below is a drawing of one of these tables. The boat panels are made full length. We use as many tables as it takes to make the length. The tables can be joined using clamps so when the panels are made the tables can be separated and used for various jobs like laminating and painting. We have used folding picnic tables with form ply on top.



FOAM

Foam provides good heat and sound insulation. It is easy to cut with a knife (until it is laminated) and bends more easily than plywood (before it is laminated). Foam can be laminated using epoxy, polyester or vinyl ester resins. Foam is more the difference in weight and resale value of the finished boat.

Attaching fittings to a foam boat can be a bit tricky. The foam must be removed where bolts pass through and replaced with strong filler to prevent crushing the foam, this can be achieved by drilling the bolt hole in the appropriate place and using a bent nail or cut down Allen key in an electric drill. Insert the tool in the foam and carefully spin, this will form a void which is then backfilled with filler then re-drilled. Any exposed foam around lockers etc. must be removed to a depth of about 10mm and backfilled with filler.

FIBREGLASS

Biaxial fibreglass cloth (0/90) is used to cover outside of the hull (plywood construction) or the foam panels prior to cutting.

Double bias cloth or tape (45/45) is used where the fibreglass needs to go around contours or where diagonal strength is required.

Uni-directional glass is used where strength is required in one direction.

Triaxial is used where strength is needed in three directions. This glass is difficult to bend around corners and wet out and is best used on a flat surface.

Glass can be wetted out using a brush, roller or spreader depending on the area to be covered. A compacting roller is used to consolidate the glass in the resin and to ensure there are no air bubbles. We use peel ply on most of the areas we glass. It ensures a smooth finish that cuts down on sanding later (we believe the extra cost is well worth it). Some epoxy resins leave wax on the surface (amine blush) which has to be washed off before laminating or painting. Some polyester resins leaves wax as well. The peel ply will remove this waxy layer needing only a light sanding before finishing.

RESIN

Epoxy resin is used to build plywood hulls. It can also be used with foam panels. It is mixed with hardener before it is used. You can order different hardeners to allow for temperature differences. Follow the manufacturer's

directions. Epoxy can cause allergic reactions in many people. It can range from mild skin irritation to carbuncles and lung and eye irritation. Always wear protective clothing and be careful around children.

Polyester resin has been around for a long time and there are still many old boats that have been built using polyester out there. With polyester and vinyl ester people do not develop the allergy as with epoxy but you need to check if EPA rules apply where you live, the styrene smell can be quite potent. Polyester resin can be either waxed or un-waxed. The un-waxed resin can be used whenever laminating and when the job can't be finished at one time. It will stay sticky and doesn't need to be sanded before the next layer is added. The low styrene emission polyester resins help lower the styrene odour but care is needed when working inside the hull where the fumes can build up. Care should be taken when using MEKP (Methyl Ethyl Ketone Peroxide) the catalyst. You should wear gloves and eye protection and definitely keep out of the reach of children.

Vinyl-ester resin also uses MEKP as a catalyst and acts in a similar way to polyester. It is more waterproof than polyester.

Always refer to the resin manufacturer's recommendations.

FILLERS

Resin and hardener (or catalyst with polyester) should be mixed thoroughly before adding any filler.

Fillers can be added to resin to use for either gluing applications where strength is needed or for fairing areas before painting. Material suppliers offer filler for particular purposes when you buy the resin.

We make our own fillers using different combinations depending on the job. If you want to make your own you will need to experiment with combinations until you feel comfortable with the result.

AEROSIL-CABOSIL

This is milled silica designed to be added to resin. It will help stop sagging of filler. It makes the filler hard to sand. We use it in combination with cotton fibres to make strong glue.

Q-CELL LIGHTWEIGHT FILLER

Q-CELL consists of hollow inorganic micro-spheres with exceptional whiteness and low bulk density. It is inexpensive and light weight filler for interiors and fairing the hull above the waterline.

3M GLASS BUBBLES TYPE K20

3M Glass Bubbles are very fine hollow glass spheres of consistent shape, wall thickness and size distribution, suitable for use as a cost effective volume filler. They make good filler for areas below the water line.

COTTON FIBRE

Cotton fibre is sometimes called flox, cotton flox or cotton linters. We mix cotton fibre with aerosil to make strong glue.

TALC

Talc can be mixed with resin and used as filler. It is easy to sand although a little heavy. It is good to have around when you get an attack of fibreglass itch. None of these fillers have a particular ratio; use what you need to get the job done. Q-cells bulk out the mixture, cotton fibre adds strength and aerosil stops filler from sagging.

FILLETING AND GLASSING

Resin is mixed with filler to form glue or filleting compound. The glass tape is laid over the fillet to make the joint stronger. Glass will not conform to a sharp edge so all edges must be rounded and all angles must be filled with a radius of filler (a fillet). The resin and hardener is mixed first and the appropriate filler is added until the mixture is like the consistency of peanut butter. Add the filler to the angle in your favourite manner. Some use a spatula and roughly fill the

Angle. Use a round tool to make a smooth radius to the appropriate size (large enough that the glass will bend without pulling away). The tool you use can be anything that resembles a cake decorating tool. A putty spatula shaped with a grinder works well.

If the fillet hardens before you have time to apply glass tape it must be sanded to ensure a good bond. It works well to apply glass tape either pre-wetted or dry over a wet fillet that has hardened enough to hold its shape. This saves time and you don't have to clean up any dags that you left the day before.

Pre-wetting the glass tape is a good idea if you are working in a confined space and it would be difficult to wet out the tape easily.

MAKING FOAM COMPOSITE PANELS

There are many advantages to building a foam laminated boat. Foam boats don't sweat, generally weigh less and have a higher resale value than plywood boats. One of the disadvantages is the foam has to be removed around exposed edges and backfilled with solid filler and wherever anything is bolted through the foam panels (to prevent crushing the foam).

This is where the method of bucket and brush comes into its own. Some people prefer to vacuum bag the panels or use resin infusion but building a one off it can be a very expensive exercise. You can use pre-made panels from a supplier like ATL if you prefer. Pre-preg glass contains the resin and either UV light or heat and pressure are required to catalyse the resin. Most pre-made panels are made using Pre-Preg with heat and pressure to catalyse the resin. But until Pre-Preg fibre glass becomes more popular and the price is reduced these panels can be very expensive.

We use Klegecell foam because it is readily available in our area. A sheet (2170 x 1220 x 10) costs around $120, a little cheaper if you buy in volume. The Scarab 18 takes approx. 30 sheets of foam and it comes in 30 sheets to a box here. Other PVC foams can be used like Core cell or Gurit.

We choose to make our own panels for convenience and cost. We use low styrene emission polyester resin (but you can use epoxy resin). If you make your own panels they can be made to the right length which eliminates scarfing. Sometimes there is a long delay when ordering pre-made panels and there is always a risk they may be damaged in transit. The panels can be made to length before glassing. You will need a smooth flat surface the length of the desired panel (length of boat). If you use the tables as described earlier they can be joined together using clamps or bolted together. The foam is glued together to the right length (polyester/epoxy resin and aerosil works well) and the foam is attached to the table using drywall screws. Foam can be cut to any length before glassing and scrap pieces can be added to the length. When the glue is dry remove the screws and fill the holes with resin and filler (Q-cells). Roll the glass out over the foam and smooth it out. The weight and number of layers of glass fibre cloth will depend on the size of the boat and the strength desired. Spread the resin beginning at one end and only covering as much as you can work at a time. We use a drywall (gyprock spatula to spread the resin). Make sure the glass is covered and compacted into the resin. Cover with peel ply and smooth out the air bubbles. It is much easier to work epoxy because of the longer set up time. The foam can shrink as the temperature changes. Because epoxy takes longer to harden the panel can change dramatically leaving wrinkles

in the panel so constant temperature must be maintained for about 12 hours. When making epoxy covered panels in an open shed we used heat lamps and stacked panels on top of each other to keep them warm. We made the panel, covered it with plastic and made another panel on top. The exothermic reaction of the resin also kept the foam from shrinking as the temperature outside dropped. You can still average one panel (full length) a day without panic. This technique doesn't work with polyester. The resin reacts with the plastic and you end up with crinkly surface where the plastic is distorted. If you are lucky enough to live in an area where you can use polyester, you have tolerant neighbours or a system for removing the styrene fumes then there is not this problem. With polyester the panel can be trimmed with a knife before the resin hardens completely, usually after an hour or less and turned over in a couple of hours. This would depend on the temperature. One panel length can be easily achieved in one day which would be about the same time for a vacuum bagged panel at less cost.

To loft the boat panels a straight line is drawn on the edge of the fabricated panel and the line and marked at 500mm intervals. A square can be used to draw lines perpendicular to the base line. Mark the dimensions given on the plans along the perpendicular lines. Panel pins are nailed at the marks and a flexible baton is bent to create a smooth line. The baton can be made from a narrow piece of plywood the length of the overall panel. Draw the lines onto the peel ply.

The panels and bulkheads are cut out using a jig saw. We use Makita jig saws and either 42 (flat top) or B28 (spade top) blades.

To calculate the cost of making your own panels the following measurements may help. This is for one panel (1220mm x 2175mm). This size panel was used to build a Scarab 18 or a Scarab 650. Foam thickness and glass size and amount of resin will change for larger boats.

- 1 10mm Klegecell foam sheet
- 4.6 litres polyester resin
- 4.5 metres of 450 biaxial glass
- 4.5 metres peel ply

Calculate and multiply by the total number of panels specified in the material list to find out the price of the laminated panels for a particular boat. We have found that the cost of using foam/polyester panels for a 22 foot trimaran is about $2,000AUD more than for a plywood/epoxy panel boat. When you consider the advantages of the foam boat and the resale value, then it could be worth it to you.