

Basic "Stitch-and-Glue" Manual

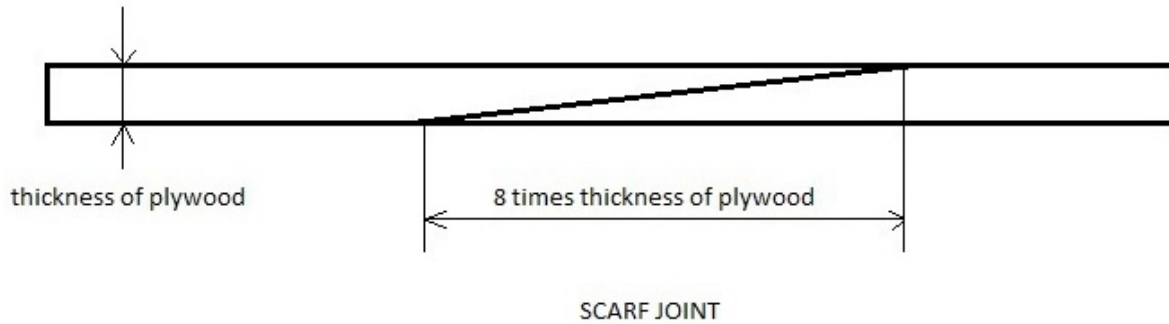
This manual describes the building of a small boat by the "Stitch-and-Glue" method, also known as "Taped Seams". The method originated in England in the early 60's and the first boat built was a Mirror Dinghy designed by Jack Holt.

In traditional boatbuilding the builder needs to transfer the dimensions of all frames, backbone, stem, stern post and sometimes the entire boat on the floor full size. This is known as lofting. It's a tedious process requiring a lot of kneeling and crawling. The chance of making a mistake is higher due to the fact that many numbers need to be transferred from the paper drawings to the floor. Using the shapes of the frames and other hull parts drawn on the floor, the builder has to assemble all of them from quality marine grade lumber. The cutting and assembly need to be very accurate. A bevel needs to be made at a certain angle depending on the location of the frame so that longitudinal members such as stringers and the planking can lay flat on the frame. All frames have to be set up on a level floor, secured with cross beams and braces and only then the actual planking of the hull can begin. As you can see it's a long and difficult process.

In the S&G method the shape of the boat is defined by the shape of the separate hull panels. They get stitched together around a small number of frames and then all seams are "welded" with fibreglass tape and epoxy resin. The hull of the boat takes shape in a matter of a few hours for smaller boats. No beveling of the frames is needed. Precise fits are not necessary. What counts is smoothness and fairness. In fact it's better not to have precise fits as they create stress points in the hull. A little gap is preferred. Epoxy putty made of epoxy resin mixed with filler takes care of small gaps, holes etc. Then a fillet is applied in the seams of all joining surfaces and fibreglass tape laid on top of it, wetted out with epoxy resin. The fibreglass tape serves as a stringer. Essentially the finished boat is a monoque structure. Here are the major steps of the building procedure for a small flat or v-bottom dinghy/kayak/canoe, etc.

JOINING PLYWOOD SHEETS

Boats longer than 8' (2.40m), which is the standard length of a sheet of plywood, will require joining of plywood sheets. There are three methods of doing that – scarfing, butt blocks and fibreglassing. Scarfing is essentially tapering of both sheets in the area of connection in order to have a bigger contacting surface. The length of the taper can be between 6 and 10 times the thickness of plywood. For example if you have a 1/4" (6mm) sheets the taper would have to be around 2" (50mm).

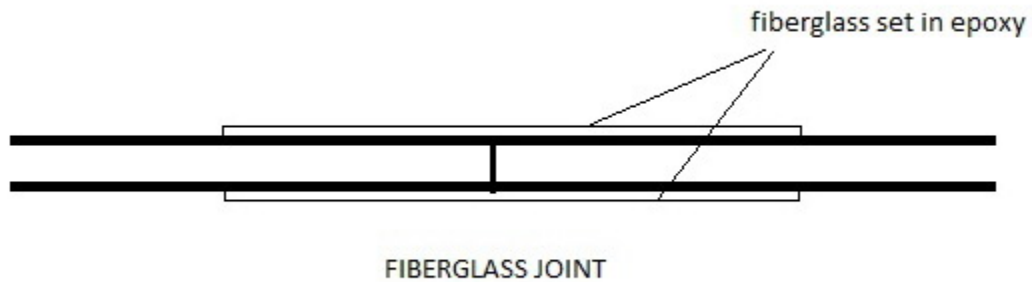


The two sheets of ply are stacked together and the top sheet is offset from the edge of the bottom sheet with the amount of taper. It's like a staircase and you have to knock out the "stair steps". Draw a guide line on the top sheet same distance from the edge as the offsetting of the two sheets. Then start planing with a hand or power plane until you get a smooth bevel. Glue both sheets with epoxy putty and apply pressure by putting weights on the joint. Place a piece of plastic before you put the weights on to make sure nothing sticks to the plywood because there will be some epoxy putty coming out. Also make sure both sheets don't slide away and the long edges are straight. Give it at least two days to cure. Then sand it smooth.

Butt blocks are simply a piece of plywood same thickness as the joining sheets about 8-10" wide (200-250mm) glued on one side connecting both sheets. Usually designers who specify butt blocks in their designs try to position them in places where they will be less visible or completely hidden, for example under a frame or inside a seat which is also emergency flotation or storage compartment. I have built two boats using butt blocks and it's one of my favorite methods. The joint is stronger than the strength of the connected pieces. It's easy and fast to make leaving no room for errors. One thing about butt blocks is they need to be shorter than the connected pieces to allow room where the fibreglass tape will be passing.



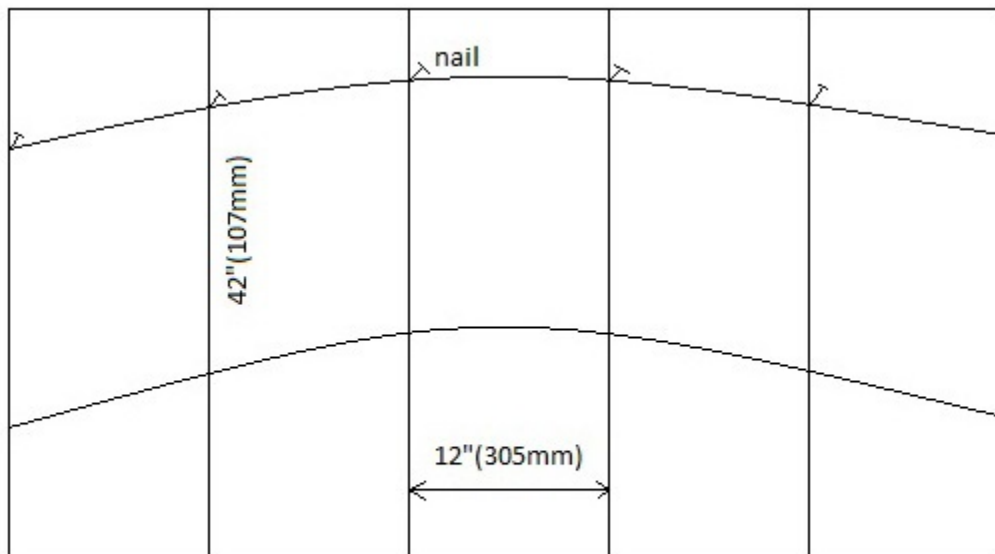
The third method is fibreglass joint. It's like a butt block but made of fibreglass and it has to be applied on both sides. The advantage of the fibreglass method over the butt block method is that fibreglass somehow better conforms to curves whereas the butt blocks tend to create sort of a bump or hard spot. But again, if the joint is properly placed in the boat, both methods are very good and reliable.



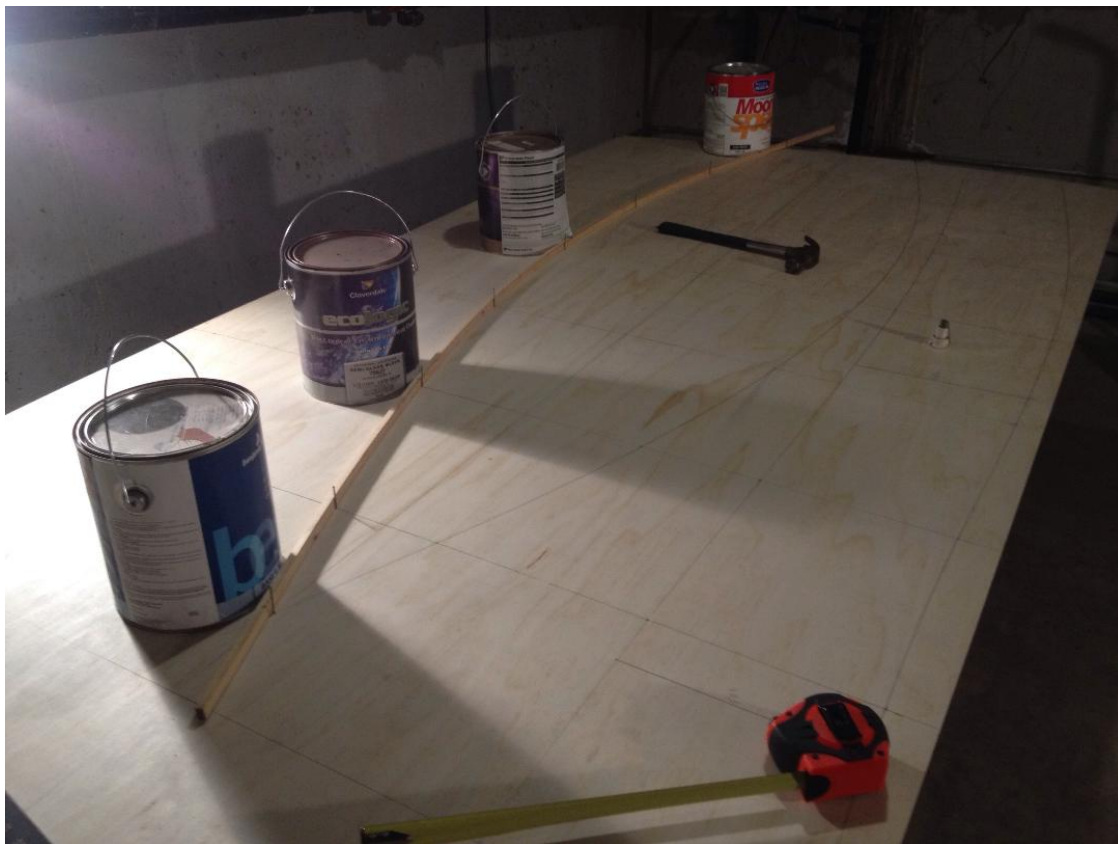
LOFTING

Lofting is the process of transferring the dimensions of the frames and panels from the drawing to the plywood. It's a much simpler and faster process compared to lofting in traditional boatbuilding. In my plans I use the long edge of the plywood sheet as a baseline from which to measure the distances. It's very convenient and accurate. A grid on the plywood sheet is helpful to transfer points. Usually it's made by drawing vertical lines 12" (305mm) apart using the short edge of the plywood. It's like a coordinate system with the long plywood edge being the X ordinate and the short plywood edge the Y ordinate. Here is how to draw the vertical lines 12" (305mm) apart. If we have a second sheet of plywood (and we usually do as even the smallest boats require at least two sheets of ply), just slide it on top of the sheet on which the drawing will be done and align the long edges of both sheets. Then by carefully offsetting (moving) the top sheet to the right draw the vertical lines of the grid 12" (305mm) apart. We use the natural straight edge of the plywood sheet! Of course a drywall square can be used too.

Start marking the points along the lines of the grid using the dimensions from the plans. Curved lines require more points to define their shape. Straight lines need just two points. When all the points are marked double check for any errors. Hammer in a small nail at each marked point and bend a batten (flexible molding or PVC pipe) around the nails. Keep it in place with some sort of weight – a thick book, milk containers filled with water, rocks, etc. Draw the line with pencil. In some boats you will have straight lines. Then just use the long edge of the second sheet of ply and draw the line between two points. The location of the frames must be marked on the panels. Don't forget to draw these lines too. They are very important!



Marks and lofting on plywood



Boats are symmetrical in reference to center line. Once you draw one of the panels on the plywood, cut it out and flip it over as a mirror image. Use it as a template and trace with a pencil the second panel. Transfer the location of the frames from the first panel to the second. Now you can cut out the second panel too. For cutting of long straight and curved lines I use a circular saw with the blade set just to clear the thickness of the plywood. Sometimes for smaller boats I use a hand saw. It's a good exercise and the cuts are very straight. For small radius curves such as on the frames or support knees it is best to use a jigsaw. If you haven't cut the frames yet now is a good time. Just transfer the dimensions from the plans, connect the points (usually straight lines) and cut them out. Now we have all the major hull components cut out so we are ready to start assembling the boat.

STITCHING UP THE BOAT

Assembly sequence may slightly differ depending on the design but it usually starts by attaching the frames to the bottom, at least for flat bottom boats. In some designs (for example our "Colibri" and "Tweak" dinghies) the side panels are attached to the mid frame first. Always follow the work instruction. There are more details there. This manual is for general guidance and introduction to the building method. After completing the stitch up process your boat should look like in the photo below.



Cut off the tails of the zip ties. Make sure the hull is not twisted by measuring the two diagonals. Then start placing small tabs of epoxy putty (made by mixing epoxy resin with bread flour until it reaches the consistency of peanut butter) between the stitches. After 24 hours you can cut off the stitches and the “spot welds” will hold the boat together. The next step is to apply a continuous epoxy putty fillet inside all seams covering the small “spot weld” tabs. The best applicator I’ve found for applying epoxy putty inside the seams is the “pastry bag” method. It’s a plastic bag (ziplock or similar) in which the epoxy putty is poured from the mixing container, cut one corner off with a scissor and squeeze it. The fillets become very uniform and clean. After the fillet is applied use a rounded plastic squeegee or a tongue depressor to shape it nicely so the fibreglass tape can be laid on top. Wait about an hour or two before applying the fibreglass tape onto the fresh fillet so it can harden a bit to preserve it’s shape when the tape is applied on top. But don’t wait for the fillet to harden completely. Then you’ll have to do a lot of sanding and even then, there will be air bubbles left under the fibreglass. So always work wet-on-wet! Saves a lot of sanding, time and the quality of the job is superior.





“Pastry bag” ready for application





Rounded plastic squeegee for filleting. A tongue depressor can also be used.





Make sure the tape covers equal portions of each panel. Don't push too hard. Fillet is still soft.

It helps to have the fibreglass tape pre-cut for the separate sections of the boat. For example cut short strips for the buoyancy chambers and the central cockpit area. If this is your first project start with areas which will remain hidden under seats or inside buoyancy chambers. By the time you get to the open visible areas you will be doing a professional looking tape job. Mix some resin with a hardener and place the tape over the fillet covering equal portions of each panel. Start applying the resin. Tab lightly with the brush until the fiberglass tape becomes transparent. I use cheap 2" chip brushes. Keep moving relatively fast because the resin is kicking in. At the same time take care not to leave any white unsaturated spots. Don't put too much epoxy either. Just enough to saturate the tape. Lift the tape a bit and brush some epoxy underneath. Wetting out is easier this way. When all the taping on the inside of the seams is done let everything cure for at least 24 hours.



When you are done with the taping of the inside of the boat and the epoxy is hardened you can turn the boat upside down, fill all stitch holes with epoxy putty and after it cures round all outside edges so the fibreglass tape can lay on top without leaving air bubbles underneath. Fill any gaps with epoxy putty and make everything round and smooth. Brush some unthickened epoxy (epoxy without filler) in the area of the seams and place the pre-cut strips of tape. Wet it out thoroughly until it becomes transparent. Wait for at least 24 hours until everything is properly cured.



*Fill any gaps with epoxy putty and make everything round and smooth.
Fiberglass tape likes round edges and smooth surfaces.*





Properly saturated tape becomes transparent. If any air gaps underneath cut with knife and apply more epoxy. Note how it covers the stitch holes (which were filled with putty before applying the tape on top)

SANDING AND FAIRING

Now we have our little boat all taped up – inside and out. After all epoxy/fiberglass work is cured it's time for sanding. I do the sanding with 80 grit sandpaper using a sanding block and a rubber disc for the drill on which sandpaper is attached. First, try to knock down the binder tread of the fibreglass tape until it tapers down to the plywood. Then lightly sand the entire boat. Don't sand too deep into the fibreglass tape. Keep an eye for any drips which are now hardened and remove them. Vacuum all the sanding dust and wipe everything with alcohol or warm water mixed with some vinegar.

Next comes the application of fairing compound. You can purchase a ready made one like Bondo or you can make your own simply by mixing fine glass bubbles or phenolic microballoons in the epoxy until it reaches the consistency of peanut butter. Glass bubbles and phenolic microballoons create a very fine fairing compound which is also very easy to sand. A good indicator for the right consistency would be when you lift the mixing stick and the mixture is not flowing down. Same as when you mix bread flour for the fillets. The fairing compound can be applied directly with the mixing stick in small portions along the seams. Then using a wide squeegee spread it nicely and uniformly along the seams. The gap between the fibreglass tape edge and the plywood will be filled and the texture of the fibreglass tape too. Try not to apply too much fairing mixture. Just enough to fill the low spots. You may have to do a second run later on if you are not happy

with the result. After the fairing is cured sand. Wipe again and apply final coat of unthickened epoxy. This last step thoroughly and uniformly seals everything, provides additional moisture-proofing and creates smooth stable base for the paint.



These are the basic steps in assembling a small stitch and glue boat. Depending on the design, there will be some additional things to install like seats, rubrail, oarlock socket pads, skegs, decks, etc. The installation of each of the above is mentioned separately for each design in the work instruction. If you are a first time boat builder and would like to get acquainted in more detail about mixing and working with epoxy, there are tons youtube videos and info on the web.

FINISHING AND PAINTING

Before applying the first coat of primer you will have to lightly sand the boat one more time. Then wash the hull with soapy water and rinse thoroughly. Dry the surface with clean rags. This is done to get rid of a thin greasy film called amine blush which is a by-product of the reaction of epoxy curing with air. It has to be removed so the primer can get a good bond.

Prime the boat with two coats. Sand with 220 grit sandpaper to create a tooth for the paint. Then apply 3 to 5 coats of paint depending on the color. Use a roller and brush. I paint my boats with ordinary exterior house (porch) paint. For some boats I use Rustoleum metal paint and I am very happy with the result. Most small boats spend no more than 3-4 hours per week in the water in the summer months so there is no need for expensive marine grade paint. Sometimes I use a pigment which is added to the epoxy to create a nice decorative mahogany finish on some details such as rubrail, cockpit coaming, seats, support knees, etc. Of course wood stain can be used too. Just make sure it is water based otherwise the epoxy won't be able to adhere properly to it. That's it! Your boat is ready for adventures! Enjoy it and be safe! If you have any questions please e-mail to: alexbalex@yahoo.com

