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 from the plans 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. Then 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. Then on all frames 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. After that 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 on top. 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.

JOINING PLYWOOD SHEETS

Almost any boat you build from plywood will require panels longer than 8' except some very small dinghies. There are three popular methods of joining plywood sheets – scarfing, butt blocks and fibreglassing. Scarfing is 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. Most used is 8 times. For example if you have ¼" (6mm) sheets the taper would have to be around 2" (50mm).
I have done scarfing on plywood only once when I was building a 10’ (3m) kayak which was going to be left with clear finish. Some builders make a special jig for tapering of the plywood sheets. When I did the tapering I used a method shown in Devlin’s book. 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 planning 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.

To spread the pressure more uniformly use a piece of scrap wood over the joint and then place the weights on top. Check alignment of both sheets before walking away.
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.

There should be about 2” (50mm) gap from butt block to the edge of the panel. This is done to make room for the fibreglass tape.

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 problem here is that the builder has no control over the proper saturation of the fibreglass butt block which is underneath. The best that can be done is to wet out thoroughly the fibreglass and the plywood in the joining area. The top fibreglass butt block can be wetted out properly then plastic and weights are placed. The weights will also flatten the joint to the point where very little sanding will be required after epoxy is cured. I have used this type of joint on a 9’ (2.80m) fishing kayak which I designed not long ago. I placed the joint in the rear compartment and it’s basically invisible. The outside is faired and no one can tell there is
a joint. 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 properly placed in the boat both methods are very good and reliable.

*More epoxy putty should have been added to the joint to fill the gaps between the two panels.*
LOFTING

Lofting is the process of transferring the dimensions of frames and panels from drawing to plywood. In many plans the designers use the long edge of the plywood sheet as a baseline from which to measure the distances. It’s very convenient and accurate. Also some sort of grid on the plywood sheet is very helpful to transfer points. Usually it is made by drawing vertical lines 12” (305mm) apart using the short edge of the plywood. It is 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. 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. Then hammer 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 side panels. Don’t forget to draw these lines too. They are important!

Marks and lofting on plywood
Apply pressure to the batten to get a smooth and fair curve.

As boats are symmetrical they have two side panels and two bottom panels (in the v-bottom hulls). 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 draw the second panel. Transfer the location of 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. So now we have both side panels of our small dinghy cut out. 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. In some designs (for example our 7.5’ dinghy “Colibri”) the frames are assembled from dimensional lumber. In our designs the thickness of the planking is already deducted. Some designers give the dimensions to the outside of the planking in which case the builder has to deduct it when drawing the frames. Now we have all the major hull components cut out so we are ready to start stitching up the boat.
STITCHING UP THE BOAT

Align the middle frame with the marks on the side panels. Attach both side panels using drywall screws. Two screws on each side are enough. Don’t drive them all the way down. If you are building a flat bottom boat work right side up. If building a v-bottom boat, do it upside down. Then attach the bows of the two side panels with copper wire. Usually three stitches equally spaced are enough for the bow. Drill the holes for the stitches about 3/8” (10mm) from the edge of the plywood. Don’t tighten them too much. Just snug by hand is enough. Attach the transom. Use stitches or drywall screws. For stitching use 16 or 18 gauge copper or aluminum wires cut in pieces of about 6” (150mm) long.

Note the two temporary spreaders. Once the boat is welded with fibreglass tape in epoxy and the rubrail is installed the spreaders can be removed.
If building a flat bottom boat slide the other sheet of plywood underneath the assembly we’ve done so far. By rocking it gently back and forth outline the shape of the bottom panel. Cut it out and drill holes for the stitches about 3/8” (10mm) from the edge of the plywood every 4” (100mm). Transfer the position of the holes from the bottom panel to where the holes on the side panels will be. Drill those holes. Stitch the bottom panel to the side panels by doing two stitches on one side, two on the other. This way we minimize the chance of ending up with a twisted boat. When done with the stitching measure the diagonals from the corners of the transom to the bow. Both readings should be same within ¼” (6mm). If everything is OK tighten all stitches.

If you are building a v-bottomed boat the bottom will be made of two panels. The best way is to stitch both panels as they are stacked on top of each other along the keel line. This way you can drill the holes for the stitches simultaneously through both panels. Wire them up but don’t tighten the stitches too much. Now open the panels like a book and place them on top of the assembly we did earlier. That’s why we did it upside down for the v-bottom hull. When the entire hull is stitched up turn it over in normal position. You may have to place some sort of support under the chines to keep it more or less level. Measure the diagonal in the same way we did for the flat bottom boat. If everything is OK tighten all stitches.

*It’s very important to measure the diagonals before “welding” the panels with epoxy putty. If there is any twist in the hull it will get locked in by the epoxy and you will end up with a twisted boat.*
TAPED SEAMS

There are now two ways to continue the building process. One is to make temporary small fillets (tabs) between the stitches with a mixture of epoxy resin and wood flour. This mixture is called epoxy putty. It has the consistency of peanut butter. Then pull the wires out and apply a long continuous fillet of epoxy putty.

The hull is “spot welded” ready for the filleting and fibreglass tape.

The other way is to flatten as much as possible the wire stitches from inside so they lay closer to the plywood. This is easily done with a flat screw driver. Just press lightly on the wire until it’s bent towards the seam. Then a long and continuous fillet is applied in the seam between the two panels and the wires are buried underneath. You can do it either way. It’s your choice. I prefer to leave the wires inside and then cut them out on the outside as close as possible to the plywood. Some people are pulling them out by applying heat to the wires to soften locally the epoxy fillet holding it. I was never consistent in doing that. Anyway, even if part of the wire is left inside it’s not a big deal. Copper doesn’t rust even if moisture somehow creeps into the joint through the fibreglass which happens very rarely. 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 you put the epoxy putty cut one corner 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 lay on top. Wait about an hour or two before applying the fibreglass tape to the fresh fillet so it can harden a bit to keep 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.
Note the continuous fillet. Soon (in 1 - 2 hours) fibreglass tape will be applied on top.

Rounded plastic squeegee for filleting.
Short pieces of 3” (75mm) wide tape are precut for the front and rear compartments. The key to successful fibreglass job is preparation. When your hands are all sticky with epoxy which is “kicking-in” (hardening), it’s hard to measure and cut tape properly.

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 precut 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. 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, cut all wires as deep as possible and 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 precut 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.
Dry fitting the lengths of tape.

Properly saturated tape becomes transparent. If any air gaps underneath cut with knife and apply more epoxy. Note how it covers the holes (which were filled with putty) from the stitches.
SANDING AND FAIRING

Now we have our little boat all taped up – inside and out. If you haven’t coated all surfaces with unthickened epoxy now is a good time. After all epoxy work is cured it’s time for sanding. I do the sanding with 60 grit sandpaper. It may seem rough for some people but I found that the higher grits actually get clogged very quickly. I use 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. Keep an eye for any drips which are now hardened and remove them. Then 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 or you can make your own simply by mixing fine glass bubbles or phenolic microballoons in the epoxy until you reach 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 wood 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 it with 60 grit sandpaper. 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.
Now we can install the skeg (fin) on the bottom. It provides lateral resistance and helps the boat keep good tracking. First cut a cardboard pattern tracing as close as possible the shape of the bottom. Then cut the skeg from plywood or any available lumber with thickness between ½” and ¾” (12 to 20mm). “Spot weld” it in place holding it temporarily with some masking tape or any other support. Make sure it is straight. Once the “spot welds” are cured you can apply a continuous fillet the same way we did for the fillets inside the boat. If you want the skeg to be strong and rigid place some fibreglass tape too.

Note how while fairing the boat, the skeg was installed with small tabs of fairing compound. This way you save materials and time. Instead of mixing small portions of epoxy try to plan ahead and always have something extra for glueing. Otherwise you have to throw away expensive epoxy.
INSTALLATION OF APPENDAGES

Turn the boat over to normal position. Place all additional frames according to the plans. Then some cleats will have to be glued to hold the seat tops. Install any hatches, inspection ports, drain plugs, etc. Now is a good time. Later on you will have limited access. Before you glue the decks or seat tops over the buoyancy compartments apply a final coat of unthickened epoxy inside.

_Front deck is held in place with masking tape until epoxy putty cures. Then a nice and clean fillet is applied in the seam, sanded and faired. Check for drips inside and clean while you can._
A support knee is installed held in place with masking tape until epoxy tabs cure. Then fillet and small pieces of fibreglass will make it as strong as it can be. The hole will be used as anchor point for the seat backrest.

Cleats to support the seat. Note how pressure is applied to the cleats on the side panels.
The next step would be installation of rubrail, breasthook and transom knees. These elements provide additional strength. The rubrail stiffens the sheer and also provides protection when the boat is tied to a pier, hence the name rubrail. It can be made of a single piece of around 1 3/8” by ¾” (35x20mm) or laminated of thinner pieces. Either way, first clamp the stock in the middle of the sheer and slowly progress towards the ends using c-clamps or spring clamps. When the rubrail is cured remove the clamps and shape it nicely with a plane or a rasp. Sand it and fill any gaps with epoxy putty. Now you can take the shape for the breasthook and transom knees with cardboard patterns. Cut them out of plywood or any available stock wood. The shape is not critical. When installing them apply a fillet of epoxy putty underneath and also some fibreglass tape for reinforcement. Very often you will be using the knees as handles to transport the boat. So they need to be strong.

![Installation of rubrail with only two clamps in the middle. The holes from the zip ties will have to be filled though.](image-url)
Cockpit coaming made of half round molding. Installed with c-clams, spring clamps and wire stitches.

Rubrail, transom and bow knees are installed. Seat, oarlock socket pads and transom reinforcement are getting glued. Note the gap between the seat and side panel. Later will be filled with epoxy putty.
FINISHING AND PAINTING

Before applying the first coat of primer you will have to sand the boat one more time. Then wash it with soapy water and rinse thoroughly. Then dry the surface with clean rags. This is done to get rid of a thin greasy film 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. Nothing fancy, expensive and poisonous. Most small boats spend not 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 into 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: alex@plyboat.com