Stitch & Glue Boat ~ A Build Log

In 2004 I thought it a cool idea to take an extensive river trip in a row boat starting in Manhattan and ending in New Orleans. The idea for this grand adventure came about after reading On The Water, Discovering America in a Rowboat by Nathaniel Stone and Lone Voyager, The Extraordinary Adventures of Howard Blackburn, Hero Fisherman of Glouster by Joseph Garland. And to make the adventure more interesting, I would build my own boat.

I liked the idea of rowing rather than kayaking because I felt I could more easily handle long days using the strength of my legs rather than that of my upper body as needed for a kayak. As it turned out, it didn't matter because while training my body kept on telling me that continuous days of that much exertion was not realistic. I threw in the towel when the boat was still in fabrication. Ultimately the boat was completed, I sold it to a neighbor who finished it as a kayak. It is the boat in the picture above.

Because I could not locate any viable stitch & glue plans for a row boat, I created a computer-aided design program called MakeBoat (available at www.wildtramper.com) to make templates for the boat. This program also analyzed it sea worthiness and provide various other statistical data. What follows is the story of building that boat.

References

Stitch & Glue Sea Kayak, by Vaclav Stejskal, First edition, (617) 926-2717, vaclavs@OneOceanKayaks.com. This is an excellent document.

How to Fiberglass Boats, by Ken Hankinson, 1986.

West System Application notes, URL www.westsystem.com, in addition to how to epoxy there are various other useful tricks.

Essential Sculling, by Daniel Boyne, 2000.

Background

1) I am now well into the building of the boat and have just started this log. It is 10/27/2004.
2) I have long past completed the definition of the boat using my custom computer aided design makeboat (mb.exe) program. The boat is 16 feet, 8 inch long; 28 inches wide; is 13 inches tall at the bow; tapers to 11 inches tall at the center; and is 11 inches tall at the stern; the shape is slightly teardrop with the maximum width located 13 inches from the center towards the stern. These dimensions are partially dependent upon the size of my garage to build and store the boat and the size of the rack on my car and of course a goal to keep the weight down so I alone can lift the boat. The hull is made up of 4 plates on each side, has a forward watertight compartment of about 36 inches length, has an aft watertight compartment

of about 24 inches in length. The estimated weight of the boat fully rigged is about 50 pounds (as indicated by mb.exe), but I believe this will be somewhat reduced (maybe 3 to 5 pounds) since I believe the density estimate for the fiberglass and resin is too high, but on the other hand there are always those unforeseen items.

3) The templates were created by a custom computer aided design program called makeboat (mb.exe) to generate template drawings and other useful information. Templates were printed on an Epson Stylus Photo 1280 printer. The print uses 12 inch wide roll paper, printed in banner mode. The four hull templates were printed entirely from a single width of paper, and they ranged in length from about 13 to 17 feet long. The printer created a 3/8 inch shrinkage over the length, however, the four templates otherwise tracked each other accurately.
4) At this time, the rig is expected to be manufactured by Hudson. It is of wing design. I expect (and hope) that Hudson will customize the rig for my needs, specifically (a) mounting hardware wielded on rig so that it mounts easily near hull walls and (b) the rig is flat rather than angled upward. It is desired to mount the rig with quick release, although I haven't come up with a reliable method yet. A quick release would make it easier to dock the boat at conventional marinas.
5) At this time, the foot stretcher is expected to be manufactured by Maas. This is a simple design, made of carbon-fiber, and uses heel-cup and Velcro straps (rather than shoes). It comes compete with adjustment rails.
6) At this time, the sliding seat is expected to be acquired from Carl Douglas of the UK. His product is called Aussie Rail, the rails are black hard-anodized, the seat is laminated wood of various species such as mahogany.

Philosophy

Many years ago when I was in high school I remember many of the students complaining about geometry. They would say "What is this stuff good for? This is a complete waist of time." Although I always enjoyed all forms of math, the answer to this question is it allows you to build a boat, among other things. My computer aided design program which created the templates for the boat was largely a problem in geometry, not complex geometry, but simple geometry. I also found my high school experience in geometry to help me think more clearly, for the variety of exercises known as proofs surely helps the process of logical order, or in more simple terms provides a technique to design and build things.

Safety

New projects bring along the same old risks. I am a strong believer in using eye protectors, ear protectors, and gas or dust masks when appropriate. The key here is not to be complacent with your definition of appropriate. After enough projects, these devices will save you eyes, ears, lungs, and maybe even you life.

Also, I use disposable latex and nitrile gloves. When using solvents, I dispose of these gloves along with any soaked rags in a

small galvanized steel trash container so as to prevent spontaneous combustion and to mitigate the fumes.

Furthermore, I try to use the least toxic solvent as appropriate. Thus, for this project I am using alcohol rather than lacquer thinner or acetone for epoxy cleanup.

Notes On Work Bench

I felt it important to start my boat building project with the proper infrastructure. This meant a quality, flat, long work bench, 18 feet long and 32 inches wide. Since the concrete floor of my garage is anything but level, I made the posts with leg levelers. They consists of a short length of 1/4-20 all thread, a T-nut inserted into the end of the 2x2 posts, and a pair of 1/4-20 nuts jammed together to raise or lower the post. The all thread is placed into 1/4 inch diameter holes drilled into the concrete.

The frame of the work bench is made from a 4x8 foot sheet of 3/4 inch plywood cut into six 6 inch widths for the runners and four 3 inch widths for cross members. Since my favorite lumber yard can't cut a perfectly straight line, I used one of the manufactured ends of the plywood sheet along with a router outfitted with a flush cutting bit to make all runners straight.

The work bench was assembled with legs approximately every 3-1/2 feet. Turnbuckles were used on each pair of legs to align the table square and to give the table lateral strength. The surface of the table was finished with 3/4 inch MDF cut to 32 inch widths.

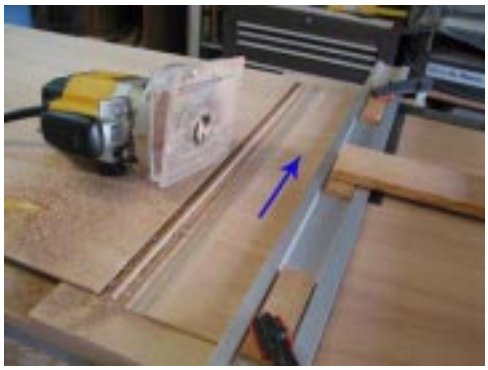
Notes On Plate Guides

My original plan to cut plate guides was with the table saw. As illustrated, I used a panel cutter along with an adjustable triangle to align the cutting edge to the table saw blade. Although this method did produce suitable plate guides, I aborted the technique because it was much too dangerous (a.k.a. nasty kickback) and it ultimately turned out to more time consuming.

Rather, I used a quality jig saw (Porter Cable) with the aid of a Plexiglas alignment guide. A line parallel to the Plexiglas edge is scribed into the guide with the offset from the jig saw blade and its base edge. When an outer plate guide was cut, a set of 1/4 inch holes were drilled at the junction points to allow the jig saw to cut the various segments. I used 1/2 inch MDF for the plate guides.

Notes On Scarfing Jig

I had a few problems scarfing until I understood the needs of the process, then all went perfectly. As indicated in the picture, the cut direction is critical. Initially I cut in the opposite direction which led to a ragged scarf edge. Then I compounded the problem by trying to redo the cut without having an overhang of about 1/4 inch which allows the jig to press down on the cutting material so it can lay flat during the cut. Thus: (1) Always cut in the indicated direction, (2) Always leave about 1/4 inch of extra material for the jig to rest on while cutting, (3) Always have a clean cutting board under the leading edge for the scarfed cut. (4) Use some extra material to further extend the resting area for the jig, and (5) If the cut isn't satisfactory, then start completely over with a new 1/4 inch of extra material for the jig to rest on.



The scarfing jig itself is made of 1/4 inch Plexiglas for a 1-1/4 inch diameter straight bit. The angle of the bit face with the jig is about 7.5 degrees. With the 1-1/4 inch diameter bit, the thickest material which can be cut is (1-1/4 times tan(7.5) = 0.165 =) 4.2 mm. The RPMs of the router are reduced to accommodate the larger bit.

The straight edge I used to guide the scarf jig is an aluminum extrusion which allows clamping in the center while the guide edge slightly floats above the material. This small amount of float allows the router shavings to collect underneath it so as not to block or bind the travel of the jig along the guide.

Notes On Scarf Gluing

When joining scarfed edges from otherwise 8 foot plywood, I used four blocks to align the lengthwise edges of the plywood, and these were aligned with the aid of a laser level and then clamped in place. Of course a dry fit of the scarfed joint is done before gluing.

Epoxy is buttered on both scarf sides and then the material is clamped in place. High density polyethylene (HDPE) is used to prevent the epoxy from adhering to the clamping devices. For clamping, I used two 1x4s plus two 3/8 inch shims. One of the 1x4s is aligned above the scarfed joints, then the two 3/8 inch shims are centered on this 1x4, then the second 1x4 is placed over the first 1x4 and two shims and all this is then clamped to the workbench. This technique provides nearly uniform pressure for the joint while the epoxy cures.

10/28/04 First Cut of Plywood

Using my Porter Cable jig saw at a medium speed (set to 4 on a range of 1 to 6) with a 19 tooth per inch scroll blade, I carefully followed the edge of the template outline, leaving about 1/32 inch extra (to be sanded to the line later). The cuts were all made from the ends toward the center, in this manner the more delicate ends were most protected.

Before the cut, the port and starboard full length plywood sheets were sandwiched together with the good sides facing towards each other. The scarfed joints were aligned and then a bead of hot-melt glue was applied along the edges of the sheets so that the mirrored set of plates could be cut simultaneously. The four full size (17 foot long) templates were taped on the plywood after they had been positioned and aligned relative to each other. A laser level was used to ensure the 17 foot length axis was straight. Periodically inset from the template edges I had previously made small cutouts which were then taped over to better secure the template to the plywood.

Before any jig saw cutting was done, all the stitch wire holes were drilled with a 1/16 inch bit.

After each cut, the partially cut plate was temporarily stored and another bead of hot-melt glue was applied to the cut edge of the remaining plates. The process was repeated until the rough cut of all four plates were complete.

Note: I replaced the jig saw blade periodically (about four 16 foot length cuts). The sharpness of a new blade was quite noticeable.

10/29/04 More Plywood Cuts

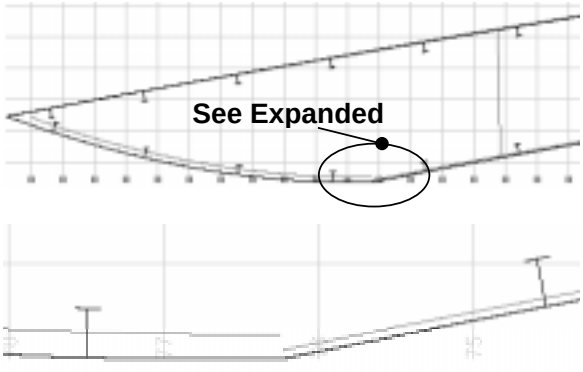
Each of the four plates with one side rough cut has its other side being used to hold the port and starboard plates together with a bead of hot-melt glue. To obtain completed plates: First, the rough cut edge was sanded using a 1/4 sheet palm sander with 100 grit sand paper. I initially tried a random orbital sander with 150 grit sand paper, but it was too aggressive to control the sanding to the template line edge. Second, I used the jig saw on the opposite edge to again cut to within 1/32 inch of the template line. For some of the plates, I was able to clamp the opposite cut edge directly to the length of the 18 foot workbench. For the others where there is significant shape, I used the 4x4 blocks, and here the sandwiched plates were held together with small clamps and several 1/16 inch drills used as guide pins when placed in the wire holes.

Once the opposite cut was complete, its edge was sanded with the palm sander. This time I used both small clamps and several 1/16 inch drills used as guide pins. I found that more guide pins were better (especially at the plate ends) so as to insure the two plates would be sanded true to the template guide line.

Over the next couple days, I was able to rough cut and sand to the line all plates. As always, time is just consumed. I estimate that each plate took about 2 hours to rough cut and sand, with the lions share of time used for sanding.

11/1/04 Bow & Stern Sanding

The template outlines identify both the inside and outside hull paths, the location of the wire holes, and the location of the guide plates. A 1x1 inch numerically indexed grid is also provided. The plates were cut to the inside hull path so that they would fit the guide plates. This path is the result of the plywood thickness and the angle between adjacent plates, thus for larger angles (such as the main body of the boat) the distance is important but small, but at the bow and stern the angle is much smaller and the distance between outer in inner paths is more dominant.



The plate with the most effective contrast between bow/stern and body is the one adjacent to the bottom plate. This is because the bottom plate always follows the centerline

axis and its adjacent plate only follows it in the area of the bow/stern. At the time of this writing, it was unclear as to how to taper the plate in this area. So rather, I am waiting to see how it fits when the panels are dry fit joined. The other plates should not have this problem since it is relatively arbitrary what the exact shape of the bow/stern is and by sanding the bow/stern for these plate on either line should only make the boat a bit longer or shorter. I'll get back with an answer.

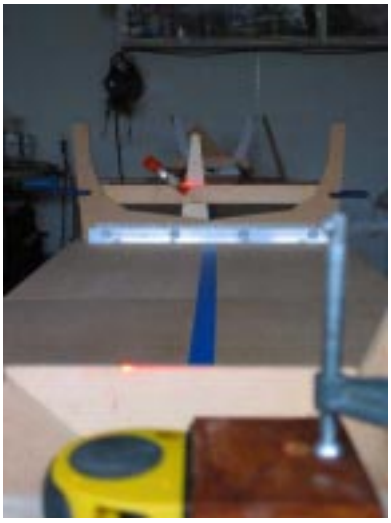
11/3/04 Bench Setup

Now that all my plates are cut and sanded, they are temporarily stowed in the shelf under the table. Cardboard protectors are placed on all the fragile ends.

With masking tape running down the center of the work bench, I used the laser level to identify a straight line and marked its location. I also applied masking tape orthogonally at the three locations for the base plate guides and marked the lines. These locations are zero, -72 and +72, but the actual distance is a slightly smaller 71-7/8 which accommodates the shrinkage caused by the printer.

A problem I always seem to wrestle with is how to mount a board orthogonal to a work bench. Using dimensional lumber is not reliable, so I used 1/8 inch thick L-shaped extruded aluminum that was 1.5x1.5 on a side. My assumption (*excuse me*) was the angle of the L would be 90 degrees, but this was not the case. Since I had already committed myself, I resolved the problem by thin shim. This resulted in perfect orthogonal alignment with the work bench surface. Remembering a similar problem on a past project, there I resolved the problem by using a square steel hollow rod.

The three base plate guides were aligned to their orthogonal locations, leveled, and adjusted for height using the laser level. *Post note: The extra effort to precisely align the base plate guides saved follow-up problems since the wire holes of all the plates at the guides ultimately lined up perfectly.*

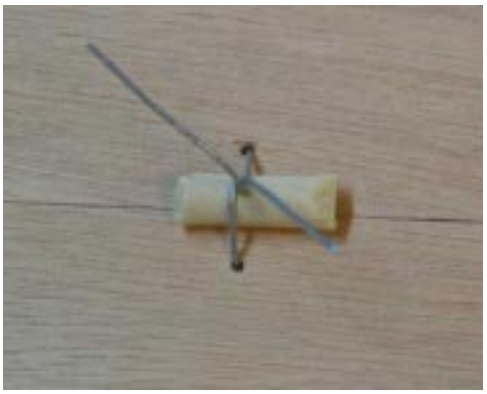


11/4/04 First Panel

Miraculously, the locations of the three base plate guides coincided exactly with the necessities of the first panel. For the most part, this panel pair did not require any addi-

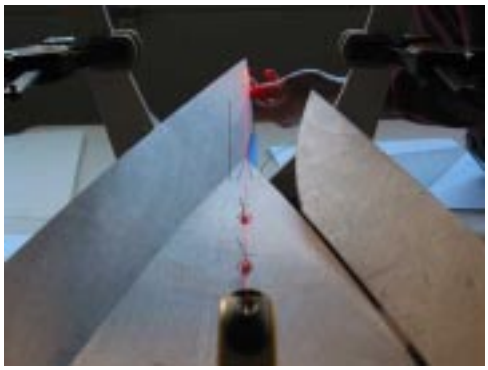
tional edge sanding. This is the first real proof that the computer program, its templates, the care to align the templates straight, and likewise the care to edge sand the plates to the template line is thus far correct.

I wired the bottom plate together with the loose wire ends pointing upward. I used #20 AWG steel wire and short lengths of 1/4 inch dowel to stitch the seam together. The dowel is a nice trick to hold the two plate halves in alignment. They also have the added benefit whereby any dowel can be moved slightly after the wire has been tensioned to bring the plates in alignment.

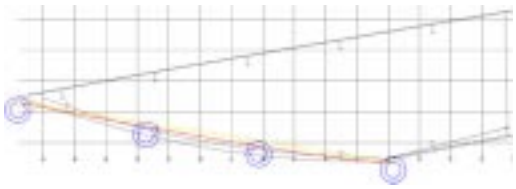


11/6/04 Tortured Wood Problem

When I dry fit the second plate with the hull bottom, I realized there was too much stress at the bow and stern ends. Attempts to force the plywood to conformity was not possible. This problem was an oversight in the high level design process whereby I had desired gentle curves at bow and stern rather than a straight edge, but the upshot of this was a nasty tortured wood problem. The photograph below shows a laser line projected on the untortured panel held in its approximate final position. The laser line cuts what is otherwise the sloping curve. After quite a bit of contemplation, I came upon two solutions: One was to leave the shape as it is and fill the gap with more plywood and fillers, and the other one was to remove most of the gentle curve by somewhat straightening the panel ends. I choose the latter since it would provide a more durable boat.



To make the fubar cut, I used a new template and a router with a 45 degree guided bit. The template guide was created with the aid of a simple computer drawing program which allowed me to overlay the original curved plate end with a new slightly curved path. In the drawing below the black lines and grid are the original template, the red line is the new curve, the yellow line is a straight reference, and the double blue concentric circles are the cut paths of the 45 degree guided router bit on either side of the 4 mm plywood. I then printed a true size drawing, laminated it to a piece of 1/2 inch MDF, and cut the template out. Then I aligned the plate on the template, drilled a few locations from the wire holes so the opposite plate would align identically, and made the cut with the router.



I chose to use the 45 degree guided router bit since at the bow and stern of this boat the angle that the plates join is about 90 degrees, thus 45 degrees generates an approximate perfect miter. After all the plates are glued, a large reinforcing fillet is applied on the interior, and the miter is essentially sanded down so a rounded epoxy fillet can be applied to better accommodate the Fiberglas.

11/7/04 Coming Together

11/9/04 Wired!!!

mention that the need for additional guide plate support was not necessary - especially since the boat being build will not have an integral deck. Spot measurements of the boat width showed that the panels very nicely bent to the designed shape.

11/10/04 Glue Stitching

One squirt of #105 West System's resin, one squirt of #206 slow hardener, one large teaspoon of #406 colloidal silica filler, and one small teaspoon of #405 filleting blend filler (for color match) - this ratio produces a consistency of thick ketchup or thin mayonnaise, with a quantity to fill a small syringe. Beads of epoxy were placed about every 3 inches and then smoothed using the rounded end of a West System's plastic stir stick. along the hull bottom, the epoxy mixture was more the consistency of ketchup, but along the more vertical walls of the two upper panels the mixture was closer to mayonnaise to prevent running.

11/12/04 Executive Decision

I found this wherry on the web (www.wmspear.com/Billspage/kate.html), but alas its been moved so all my tales of it are from fading memory. The boat's name is Kate, and is patterned after a true wherry called the St. Lawrence River Skiff. I have also seen one of these works of art at the home of a friend, although it wasn't in such fine condition. This boat is hand crafted, is 19 feet long, and is 42 inches wide. This photo was taken while the Kate was in Alaska, and I believe there were two in the boat with loads of gear.

My thought is maybe to colorize my wherry in a similar manner. With pigmented interior and exterior, several issues are relaxed. First is extra care required to allow the natural wood grain show is gone, and second a pigmented epoxy skin will help exacerbate some UV issues.

11/13/04 Filleting

As with so many first time endeavors, filleting the butt joint seams of the plates turned into a difficult endeavor. The process is rather simple: First apply a base coat of clear epoxy over the length of the joint to be filleted, let it soak into the wood, and then wipe off any excess. This is the preparation for the colloidal silica thickened epoxy so that when it is applied the wood doesn't wick out the epoxy resin. A mayonnaise thickened mixture of epoxy and colloidal silica is applied to the joint and contoured to a smooth radius with the aid of a bent squeegee.

My boat has four plates on each side, so there are a total of seven fillets. I had planned to tackle this job over three sessions: The first for the three seams near the keel line, then rotate the boat and do the two seams on the starboard side, and finally rotate the boat again and do the two seams on the port side. Rotating the boat lets gravity work for you rather than against.

I mixed the epoxy in small batches and added the colloidal silica to the proper consistency. The mixture was transferred into a wax paper made pastry bag for application. The problems I encountered were: (a) The first batch of about 8 ounces had some unmixed (i.e. lumpy) colloidal silica. (b) The second batch of about 10 ounces was too much quantity so the material in the pastry bag got hot and cured before it could be used. I should have learned from the first batch to keep the quantities down. I recommend mixing not more than 5 ounces (or 10 squirts) of epoxy at a time, and even this quantity is difficult to homogenize. (c) The third batch was not thick enough so that it sagged when applied to anything but a horizontal slope. A ketchup like consistency is nice if gravity rules since the fillets will form a natural shape, but a more mayonnaise like consistency is needed to minimize sagging. Anyway, it was a good decision to tackle the fillets in three passes. Hopefully experience will lend a hand for the next two sessions.

11/14/04 More Filleting

The next day I rotated the boat and applied fillets to the two starboard seams. By the time I finished, I felt I had mostly mastered the technique. First, mixing smaller quantities to the mayonnaise like mixture was a big help. Ten squirts of resin and hardener with colloidal silica is still difficult to homogenize, but is achievable. The last batch was half that amount and was definitely the most consistent. Second, I learned a better method to create the curved fillets, a technique similar to applying wallboard compound. I spread a generous bead of epoxy mixture along the length of a joint, then with a squeegee I drew the mixture along the seam. Depending upon the angle between the two plates, the angle of the squeegee to the plates was controlled so that an approxi-

mate 1/10 inch tall fillet resulted in the center. Furthermore, the squeegee's front edge (i.e. business end)was rotated slightly so that most of the excess material was pushed off to the more easily accessible side (i.e. top of hull). The squeegee was then used as a trowel to gather up the excess material, and this was placed along the next section of seam. Then after several hours of drying, I went back with a one inch wide flat wood chisel and scraped off material in various locations near the fillet that should not be there. I found that running my fingers along these areas easily identified areas to be scraped.

11/16/04 Still More Filleting

Once more I rotated the boat and applied fillets to the port seams. By now I feel I'm sufficiently expert on the process. I found that smaller batches are better, with 8 squirts of epoxy best. This quantity allows for very good homogenization of the colloidal silica to a mayonnaise like consistency. I learned that between each application with the squeegee, it must be wiped clean. I used an open paper towel set down on the work bench and just wiped both sides of the leading edge, although I'm sure other techniques will work just as well.

11/17/04 Oops - Reality Sets In

While out on a one hour row, I did something nasty to my body. If feels like some tendentious along the rib cage. Reality set in, that is, if I have problems with rowing for short periods, then how will I ever be able to row day after day for 4 to 8 hours a day. My worst concern has come true. Thus I have decided to abort the trip and hence the boat project also comes to an end. Now (two weeks later) the boat is but a wooden hull with epoxy fillets along its seams and no fiberglass waterproofing. It is placed in the eves of my garage for some later decision. Someone suggested that it might make a good planter. Such is life, I tried.