

Willow, Part 1

Building a light, fast sea kayak

by Bill Thomas with Jane Ahlfeld

Photographs by Bill Thomas

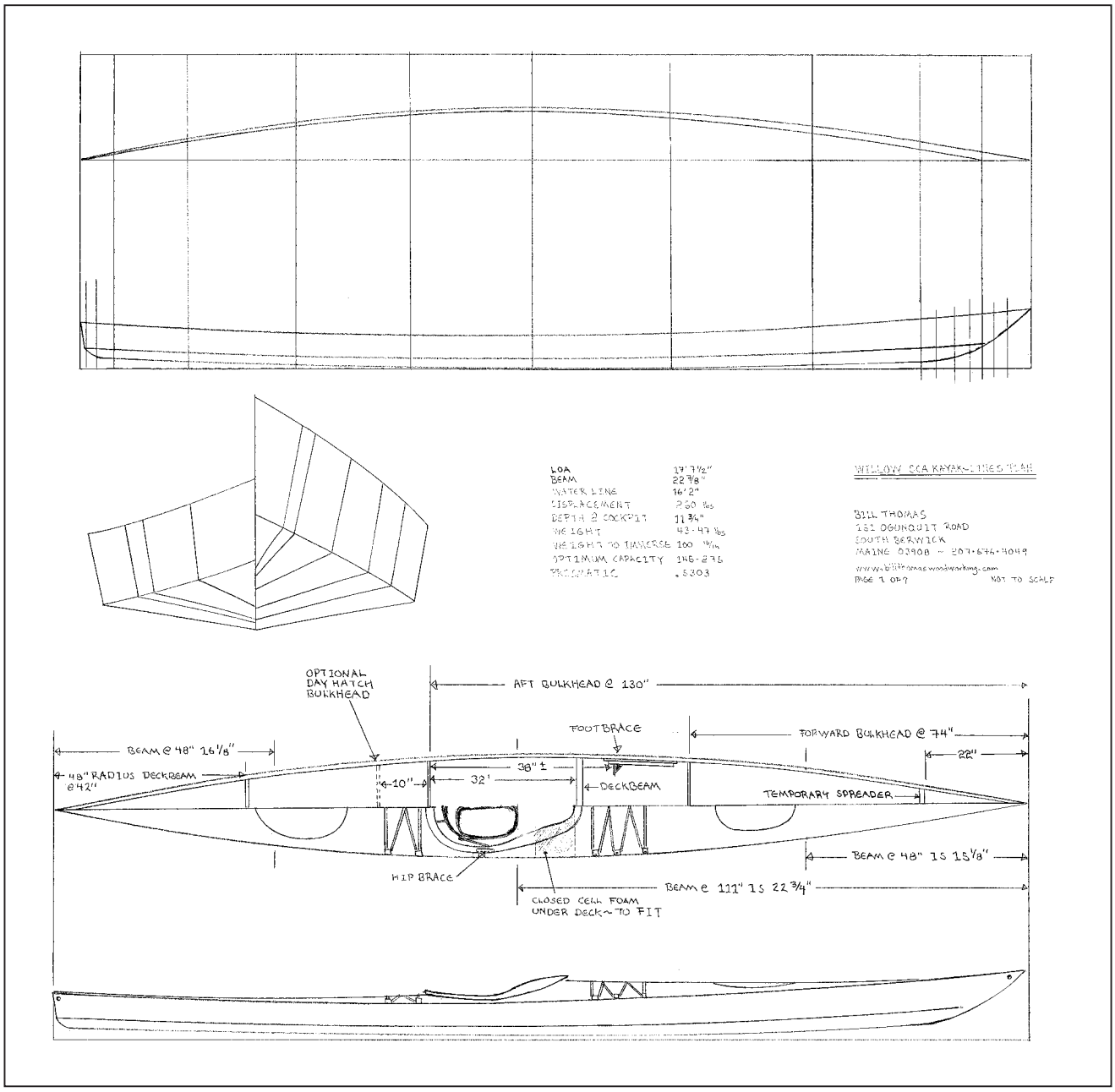
There is no debate about the virtues of sea kayaking. Sea kayaks are simple craft. They are easy to own, and the skill set needed to start paddling is easy to acquire. In most cases, a half day of paddling instruction and some sound judgment are enough to get one out on the water safely. Despite this simplicity, kayaks are used for long trips in big seas, explorations to remote places, extended camping trips in more charted waters, and those sweet short trips that revive the spirit. In short, sea kayaks are a very accessible way to get out on the water. What is debated (this being almost a sport unto itself) is, what makes a good sea kayak?

A good kayak is one that meets its design criteria, assuming, of course, that the goals were sufficiently lofty. So, what were my goals when I designed the Willow? After almost 30 years of kayaking, 15 years of building, and nearly as many teaching, I have developed some definite ideas about what I want in a boat. While working at the drawing board or in the shop, I was motivated by a very precise vision.

I did not work in a vacuum (few people do). I have been inspired by the designs and adventures of a diverse group of paddlers. Chris Kulczycki, Nigel Foster, Frank Goodman, and John Lockwood are just a few of the designers whose work influenced me.

The overall goal was to create a well-performing, aesthetic boat that could be assembled during a week-long class. While a week is not enough time to finish a

While paddling among the islands of Penobscot Bay, Maine, designer-builder Bill Thomas carried his 44-lb Willow Sea Kayak to this spectacular and secluded campsite. All of the gear shown stowed easily in the slender kayak.



boat, the lion's share of the work needed to be done before the students took their new boats home. From a building and teaching perspective, I wanted a pre-cut kit and chose methods that fit the time constraints but did not compromise my other goals.

Willow is built in the stitch-and-glue method, using okoume plywood and fiberglass cloth set in epoxy to create a strong and lightweight hull. I chose a hard-chined design because I like the way these boats perform: very predictable handling. I felt building a multi-chined boat would be too time-consuming for a one-week class, and a fair round-bottomed boat in plywood is difficult to build. The Willow kayak's deck is cambered, visually appealing, strong, and installable in a day.

These construction concerns were balanced against the overall performance of the boat. As a paddler, I use my Willow kayak for day trips and longer camping adventures along the coast of Maine. As a Maine Guide, I also work out of the boat, leading trips and teaching the elements of coastal kayaking to new paddlers. I wanted a dynamic kayak.

Although the Willow is not a bold departure from other plywood kayak designs (there is only so much leeway here), the overall design is unique. Willow has a lot of rocker for a sea kayak. I think tracking is affected as much by the entry and exit of a hull as it is by the run, and have found that some rocker adds to stability in really big seas. The deadrise (athwartships V-shape in the hull's bottom) is pronounced, and this does several things for the boat. First, it helps ever so slightly to reduce the wetted surface. It increases volume (read: foot room) but lets me keep the freeboard low. This low freeboard, the moderately deep V, and the shape of the hull aft, all work together to control weathercocking. In most seas, Willow tracks very well, and the hard-chined hull responds to the subtle leans, which change the hull's shape in the water.

Willow Materials List

Okoume plywood:
4 sheets of 4mm
½ sheet of 6mm
½ sheet of 9mm

Lumber:
2 boards 10′ 1×4 clear straight-grained cedar or fir

Epoxy and fillers:
2 gal slow-cure epoxy with pumps
1 qt Cab-O-Sil
1 qt wood flour

Fiberglass cloth:
33′ of 6-oz 38″ cloth
16′ of 3″ 'glass tape

Building supplies:
33′ of 18-gauge copper wire
120, ¾″ bronze ring nails
Stainless-steel hardware for hatches
¾″ foam for hatch gaskets
Closed-cell foam for outfitting
Kayak seat
Footbraces
Sanding and finishing supplies

Rigging supplies:
3⁄16″ bungee cord
1″ flat webbing or pad-eyes
¼″ line for perimeter lines
Stainless-steel hardware as needed
Compass with mount

Longer boats are generally better boats; with a DWL of 16′2″, Willow has a theoretical hull speed of around 5 knots. In practice I have found that on longer trips, in most conditions, I can easily cruise at 4 knots. (For some reason, speed drops off toward the end of the day.) With an overall length of 17′ 7½″, Willow is a long boat. The overhang adds extra volume at the bow and stern.

With a beam of just under 23″, Willow is narrow, but not in the extreme. The hull does taper in quickly going forward, and the deck is steeply cambered in front of the cockpit. The goal here is for paddle clearance and a slippery entrance. The cockpit is keyhole shaped: high forward for room; low aft for bracing, leaned turns, and rolling. There is deck where you need it, to brace your knees, but enough length to make entry and exiting easy.

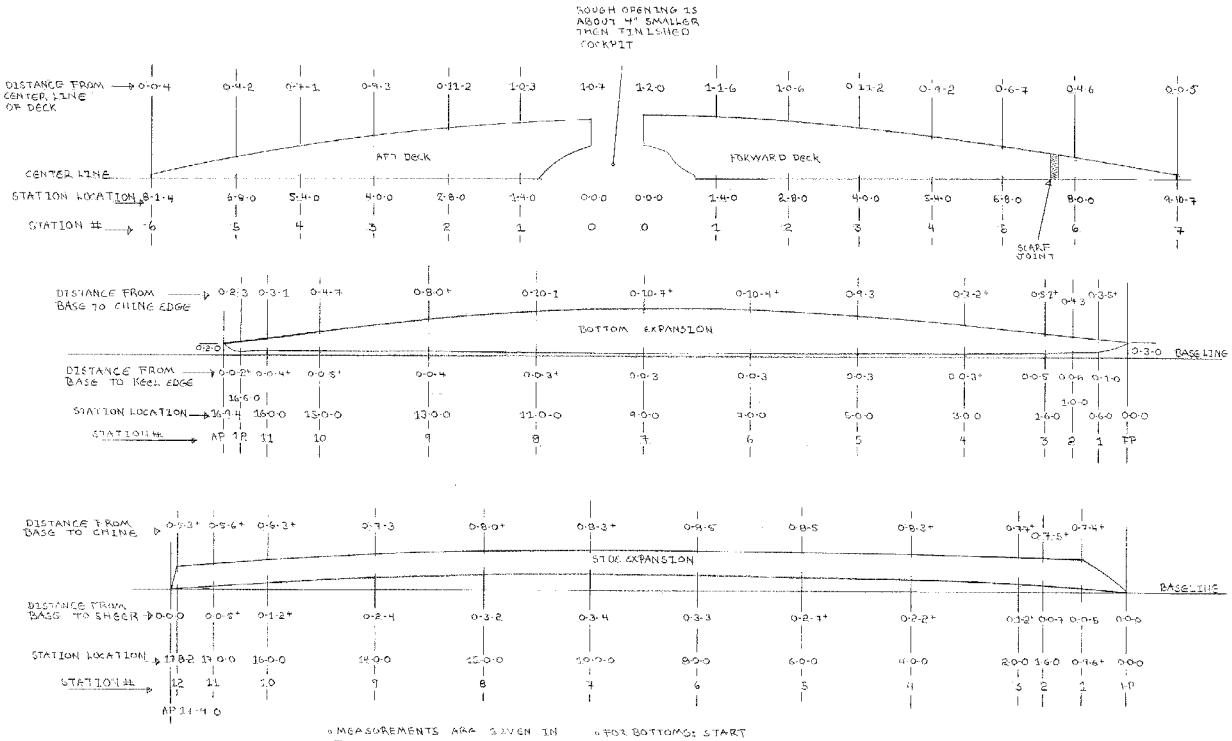
I think the whole venture has turned out very well. Students have consistently built good boats, and I have enjoyed countless hours on paddling trips or teaching in my own Willow Sea Kayak.



1. Although building a Willow Sea Kayak is a big job, most of the steps are fairly simple. Do enough of these simple steps, and you'll end up with a beautiful kayak. Whether you start with a small stack of plywood or a kit of parts, you'll need to set up the workspace and get organized. The space needs to be warm, dry, ventilated, and well lit with enough room to house your tools as well as ample space to work on the boat. A tablesaw is handy. Necessary tools are a bandsaw, a good jigsaw, a random-orbit sander, along with a solid collection of hand tools including a block plane and clamps, lots of clamps—15 each of C-clamps and pinch clamps to get started. Study the plans before starting; plan ahead. Have everything you will need to build the boat, all materials and supplies in the shop, before starting.



2. The first step is to create the long planks from which the bottom and sides will be cut. The dimensions are given on the plans. Rip the plywood on the tablesaw.



- MEASUREMENTS ARE GIVEN IN FEET INCHES EIGHTS
- SEE PAGE 4 FOR FULL SIZED PATTERNS FOR BOW AND STERN SECTIONS
- MAKE ALL PLANKS FROM 4mm BS1088 OKOUME PLYWOOD
- FOR BOTTOMS: START WITH 2 17'X12" PLANKS
- FOR SIDES: START WITH 2 18'X11" PLANKS
- SCARF JOINTS ARE 1¼" WIDE

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WILLOW PLANK EXPANSIONS

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3. To create a 17′ boat out of 8′ plywood, we will scarf the planks to length. A scarf joint is a simple bevel or ramp cut into the stock. For plywood, an 8:1 bevel is fine; for 4mm plywood, that works out to 1¼″-long bevel. Mark a line 1¼″ from each end of the plywood to be scarfed. Stack the planks so they stair-step back, each edge lined up with the marked line on the plank below. Securely clamp this stack to a bench.



4. Using a sharp hand plane, create a smooth ramp. The stratum of the plywood makes it easy to gauge your progress. Finish up with 80-grit sandpaper on a long-board. The goal is even, smooth joints with feathered, clean edges.



5. Epoxy is used in joining planks, laminating, and applying fiberglass cloth. Thickeners are added to the epoxy for some tasks. I use Cab-O-Sil for bonding strength, and wood flour for thickening and bonding. Whatever brand of epoxy you work with, carefully follow the manufacturer's instructions and stir the product thoroughly. In order for epoxy to cure, it needs the correct combination of resin and hardener, mixed together for a specific time period, before applying or adding thickeners. Whenever you use epoxy, work neatly and safely, and plan ahead so that you do not waste material or glue yourself into a corner.



6. Butter the scarf joints, using epoxy thickened with Cab-O-Sil to the consistency of mayonnaise. Epoxy does not adhere to plastic, so use 4-mil plastic between the bench, each layer, and any parts you don't want to glue together. Verify that the planks are square.



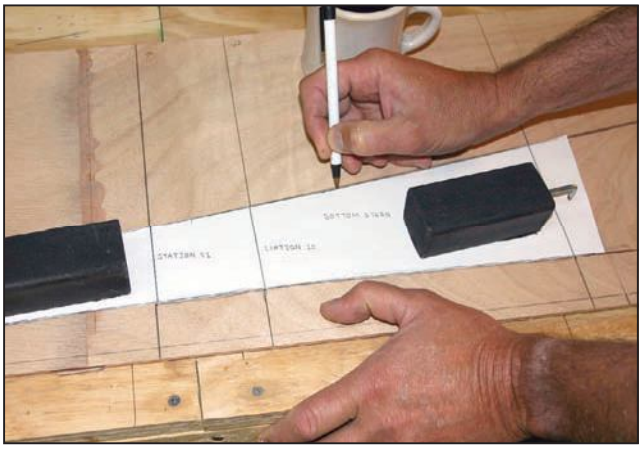
7. It does not take a lot of pressure to hold a joint together while the glue dries, but it does take some. I have found scraps of ¾″ plywood about 2″ wide positioned over the scarf and fastened to the workbench with screws to be a great clamping system. Don't forget the plastic between the plywood layers and the bench.



8. The measurements for the expanded side and bottom panels are given on page 71. It is necessary to transfer this information accurately to the scarfed planks.

Start by cleaning up any excess epoxy at the scarf joints. Be careful; you do not want to sand through the veneer, as this might create an unfair bend in the plank when the boat is assembled. Start with the side panels first. Strike a dead-straight line along the bottom edge of one of the side planks. At the bow end (right-hand end to align with the plans), square up a line. This will be the forward perpendicular (FP); we take our station measurements off this point. Move left to station No.1 at 0–9–6+ and square up a line. These measurements are laid out in feet–inches–eighths, so 0–9–6+ equals zero feet–nine inches–six eighths and one sixteenth of an inch. Move aft (left), and lay out each station; always measure from the FP.

Once the stations are established, measure up from the baseline to find the points that define the plank shape. For example, on the side panel at station No. 3, the chine point is 0–7–7+ above the baseline and the sheer point is 0–1–2+ above the baseline. Lay out all the points that define the chine and sheer. Connect these points with a pencil line. For a batten, I use a ⅜″-square piece of cherry about 10′ long. If you do not have drafting ducks, use nails driven in at the points, to hold the batten in place. Draw your lines fair and true.



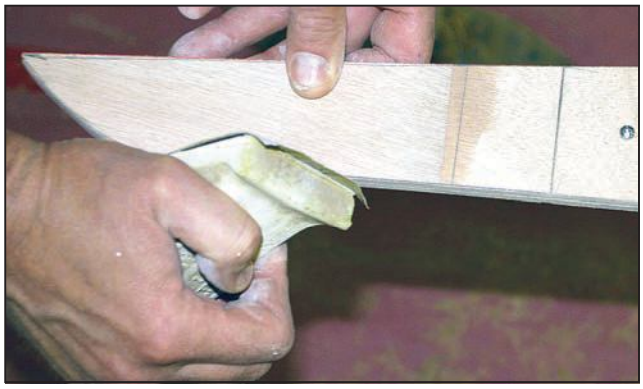
9. Once the batten work is finished on both panels, it is time to tune up the lines on the ends. The stern on the side is a point-to-point straight line, but the shapes of the bow and stern on the bottom panel and the bow on the side panel are more involved shapes. The full-sized patterns included with the plans will help to refine your drawn lines. Cut out the patterns, line up the station marks, and trace the shapes onto the planks. You can now cut out your hull parts!



10. Cut and shape the planks as sets. I use short screws to join the two bottom and the two side planks together. Use a good-quality jigsaw to cut the parts. Cut up to the line, but leave it.



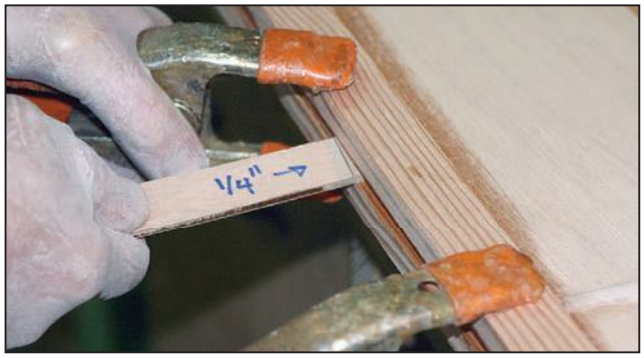
11. Use a sharp block plane to work down to the line.



12. Where the plane might flatten out the shape of the planks, use a soft sanding block and 80-grit paper to maintain the shape.



13. A look at the plans shows that the deck is attached to the boat by means of sheer clamps. These will be epoxied to the sides. You need to create long, almost 18′ stock. I start with ¾″ by 1″ by 10′ stock; fir or clear cedar works well. Scarf them to length. Using an 8:1 bevel, lay out the joint and make the cut with a handsaw, then clean up the cut with a block plane. Use clear, unthickened epoxy as glue with pinch clamps to hold the joint.



14. Epoxy the sheer clamps to the boat sides. If you are going to install your deck with staples, dress the sheer clamps down to a thickness of ½″ now. The clamps sit proud of (above) the top edge by ¼″ (see Photo 24); use a small scrap of plywood with a ¼″ mark to help maintain the lineup. Use clear, unthickened epoxy to coat both the sheer clamp and the top ¾″ of the side. It is okay to do both sides in one operation, but you must work neatly so you don't glue the sides together. Make sure to glue up a pair—not two left or two right sides.



15. The sheer clamps run to the ends of the boat and join at the bow and stern; bevel the ends now. An angle of about 11 degrees works fine for both ends. Make the cut with a hand saw, then finish up with a block plane. These joints will probably need to be tuned up once the hull is together.



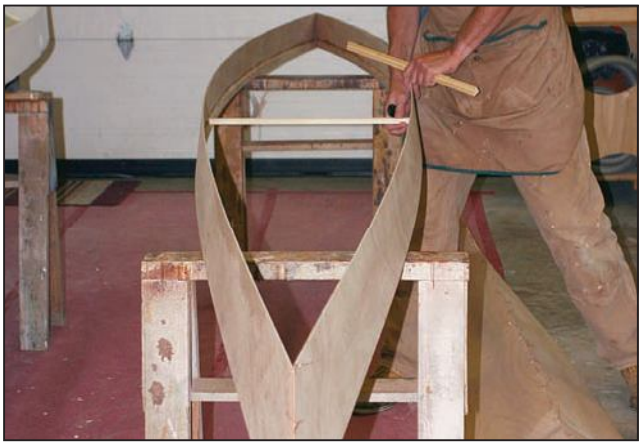
16. The parts are now ready. Let's assemble the boat. Cut about 33′ of 18-gauge copper wire into 3″ pieces. This should yield about 130 pieces.



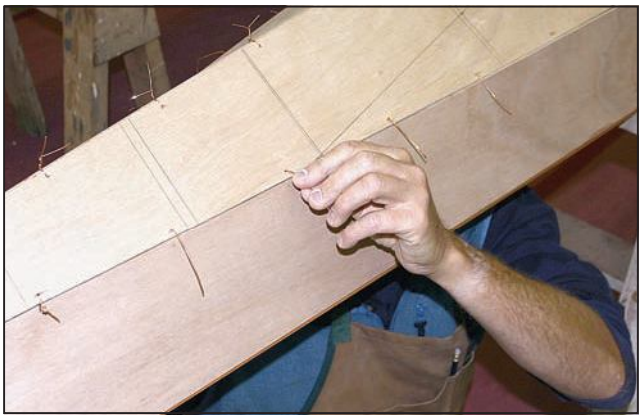
17. Clamp the bottom panels together as a matched set. Drill 1/16″ holes, 5″ apart, and ¼″ in from the edge of the planks along the full perimeter. To speed up the process, I use the simple jig shown above.



18. Loosely wire the keel together—just the keel, not the chine edge yet. Spread the panels apart, and you have a kayak bottom.



19. With the sides capsized—sheer clamps down and facing in—wire the sides together at the bow and stern. Place a temporary spreader stick amidships, so the beam is approximately 23 ″.



20. Place the stitched-together bottom panels on top of the side panels; use a stick that spans the panels to temporarily support the bottom. Note that we are working upside down here. Line up the bow ends so they meet, and drill a couple of holes so wires can be used to tie these planks together. Pass one wire through both the bottoms and side panels, and snug it tight to hold the alignment. Starting at the bow, wire the hull together, working your way toward the stern. Work aft about five or six holes at a time, alternating sides as you go. Drill holes that pair up with the holes you have already drilled in the bottom panels. This keeps the boat symmetrical. It can be a bit of a challenge fitting the wires through the holes in the ends of the boats; working in the center section is easier.



21. While the boat is still upside down, tighten the keel wires. Line up the panels so the inside edges of the planks touch. This can be fine-tuned later, but it is easier to reach the wires while the boat is inverted.



22. Turn the boat over. Check the fit of the sheer clamps at the bow and stern. If needed, use a sharp chisel to pare back wood until the plywood ends at the bow (and also at the stern) come together. It's a nice touch having a tight fit here. Having the clamps run to the ends of the boat helps to create a solid hull-to-deck joint and fair ends. Wire the ends of the boat securely. The photo shows the finished stern just before deck installation.



23. The maximum beam of 22⅞″ is located 111″ back from the bow. The beam measurements are from the outside of the hull planking, plywood to plywood. Use a scrap about ¾″ square and about 24″ long to help lay this out. Measure down the center of the boat and place the stick at 111″. Measure from the bow, along the side of the boat to the stick; check that both sides are the same (typically this is 111½″). Mark the sheer clamp so a spreader stick can be installed.



24. The spreader for the maximum beam will be left in the boat while building. Pre-drill it for nails, and tack it in place. Leave the nailheads proud for removal later.



25. Having three fixed points, with defined beam measurements, is one of the reasons the Willow kayaks go together so well. If the planks are cut true and the beams are correct, we can level the boat at two points and assure a symmetrical and fair hull. The plans show beam measurements 4′ in from the bow and stern. Using two sticks ¾″ square by 24″ long, fix the beam at each of these two points. See the plans for the actual beam width and placement. Attach the sticks to the sheer clamps with screws. To hang the boat from these sticks (as shown in Photo 26), use scrap ¾″ plywood stock screwed to sawhorses. Hang the hull so that both the forward and aft beam sticks are level.

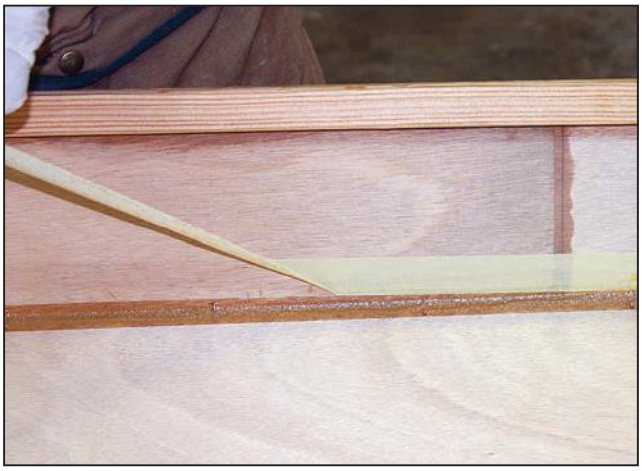


26. The next five steps need to be done in the same time frame. To prep the hull for fillets, use a screwdriver to bed the wires, inside the boat, down against the plywood joints. The inside section of the wires will be covered by fillets of thickened epoxy, so these wires should be really tucked in. We are about to fix the hull's shape; there won't be another chance to get it right. Is the

beam correct? Is the boat level at the stations 4′ in from the bow and stern? Are the wires tight and the panels lined up so the inside edges meet? Do the bow and stern look good? Is there any twist at the stern section? If so, correct it now. Trust your eye. Now check it all once again.



27. To bond the keel and chines of the boat, we will make ½″-radius fillets of thickened epoxy. The bow and the stern will receive larger fillets and 'glass tape. We need to work very neatly here: the inside of the hull is going to receive a layer of 6-oz fiberglass cloth, and 'glass cloth won't lie well over uneven fillets. Use masking tape to define the fillets' size. Run the tape along the wire holes, creating about a ½″-wide path. Mix up about 6 oz of epoxy and thicken using a mixture of two-thirds Cab-O-Sil and one-third wood flour; stir up a mixture akin to thick peanut butter. This is enough epoxy for one chine. Use a fillet tool or rounded stick to apply this mixture along the seams. The chine fillets stop about 24″ in from the ends. Run the keel fillet up toward the bow and stern; this will connect to the bow and stern fillets.



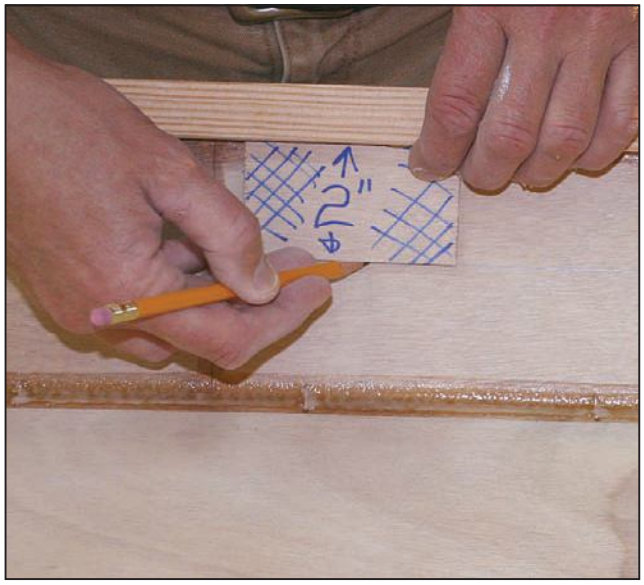
28. While the epoxy is still soft, clean up any excess and pull up the tape. As you work on the ends of the boat, keep an eye on these fillets to make sure they do not sag as they cure.



29. Mix up about 4 oz of epoxy and thicken for fillets: two-thirds Cab-O-Sil and one-third wood flour. Use a long 1″-radius tool to work epoxy into the bow.



30. While the bow fillet is still wet, lay a 36″-long piece of 3″ 'glass tape on top of it. Using a disposable chip brush and unthickened epoxy, coat the tape to finish off this fillet. While working in the bow, lay a 24″-long piece of 'glass tape on each of the two seams where the bottom and sides meet. Wet this out with unthickened epoxy as well. Repeat these same types of fillets and tape in the stern section.



31. Both the inside and outside of the hull will be sheathed in 'glass cloth. This encapsulation makes for a very strong hull. To get a clean edge for the interior cloth, make a pencil line along the interior sides 2″ down from the underside of the sheer clamp. This is where the fiberglass will stop. Run masking tape above the pencil line.



32. Wait until the fillets have cured before starting to fiberglass. It takes a 15′ piece of 38″-wide 6-oz fiberglass cloth to cover the inside of the boat. Lay the cloth inside the boat and use a wallpaper brush to smooth out the wrinkles. Mix up 8 oz of epoxy to start with (it will take more), and start to wet out the 'glass. A squeegee works well here, but I have had good luck using a chip brush with bristles cut down to about ¾″. Don't use so much epoxy that you "float" the 'glass; use just enough to adhere the cloth to the hull. Make sure the cloth lies down uniformly flat, working any air bubbles out to the edges. Add more epoxy to places where the epoxy is too thin. Pay particular attention to the keel and chines.



33. This is how the inside should look when you finish epoxying the 'glass.



34. When the 'glass is bonded to the hull, but before the epoxy fully cures, use a razor knife to cut along the edge of the masking tape. Pull up the excess cloth and tape, leaving a clean, smooth edge that can easily be feathered in when the epoxy is fully cured.

Bill Thomas lives in South Berwick, Maine, where he designs and builds boats, custom cabinets, and furniture. He is a Maine Guide and an instructor at WoodenBoat School, where he will teach "Build Your Own Willow Sea Kayak" June 3–9 and September 9–15.

Jane Ahlfeld teaches seamanship skills and sailing on the WoodenBoat waterfront, and she is a computer consultant.

In our next issue, we'll make and install the deckbeams and bulkheads.

Although you can build Willow directly from these pages, working to the large-scale plans with full-sized patterns will ease the job. Those plans ($95), as well as kits and finished boats, are available through Bill Thomas Woodworking, 151 Ogunquit Rd., South Berwick, ME 03908; <www.billthomaswoodworking.com>.