BUILD GUIDE FOR GEODESIC AIROLITE BOATS

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Welcome

Welcome to the new Geodesic Airolite Boats Build Guide. If you're reading this guide, you've either purchased or are interested in one of our boats and we certainly appreciate that interest.

Although under new ownership, we strive to keep Platt Monfort's vision and spirit alive in all phases of the company, including this Build Guide. To this end, we've updated and clarified certain portions of the guide while trying to keep Platt's folksy tone intact.

Platt's background and passion was ultralight aircraft and the first of these boats was built as a "proof of concept" for an aircraft wing. At the air show, the little canoe got more attention than the wing and Geodesic Airolite Boats was born with the focus on building a structure to meet strict design requirements while removing anything that didn't contribute to that structure. To put it another way with our favorite Platt quote: "What ain't don't weigh and we are focused on ultra lite boats."

Many of the techniques and processes covered in this document are available on our YouTube channel. Most of our customers are relatively experienced woodworkers or have a comfort level around wood working equipment and our videos reflect that. They tend to be short; we don't spend a lot of time explaining the basic operation or safety equipment of each tool and we don't turn on the saws to show how they cut wood. We assume you know why it's there.

If you aren't an experienced woodworker, don't worry, you can still build our boats. It's been done many, many times over the past 30 plus years. And now you have the internet to help you with the basics! Wood prices can vary but it is relatively cheap so grab some wood, get comfortable with your equipment and you'll be out on the water in no time!

This Build Guide is organized into four sections to help you through the build process for your particular boat.

SECTION ONE: General information about materials and tools

SECTION TWO: General construction processes

SECTION THREE: Specific instructions for double ended boats (canoes and kayaks)

Your plans include a Bill of Materials and specific building instructions for the unique parts of your boat. This Build Guide and our YouTube channel should answer any other questions and we can always be reached at admin@gaboats.com should you need additional assistance.

Thanks for your interest in Geodesic Airolite Boats and enjoy your build!

Larry LaLonde, owner

SECTION ONE: Materials and Tools

Platt's description of his boat building technique: "Geodesic Airolite construction means a simple wood framework reinforced with triangles of Kevlar roving. The wood is under compression and the Kevlar is in tension. This structural shell is covered with super weight heat shrink airplane covering Dacron fabric. The fabric is varnished or painted to seal the porosity." Except for the extended description of the Dacron, it's hard to improve on that summary so let's get started on the build.

PLANS

Virtually all of our plans include full size patterns that can be cut out and transferred onto cardboard or (preferably) plywood to create the stations. Most of these patterns, even though full size, are actually half of the station and will need to be used as a right and left to create the full-size station mold.

Carefully cut the half pattern from the plans and lay it on your station material (either cardboard or plywood). If possible, keep the Base Line on your half pattern cutout on the factory edge of your material. If not, draw a reference line for the base.

Using small pieces of tape, fasten the half pattern to the material in a few places making sure the Base Line stays on the factory edge and the pattern lays flat.

Draw around the outside of the pattern to create half of the mold. Be sure to mark the Center Line (CL on some plans) at the top of the pattern and on the Base Line. On most patterns you will also need to mark the location of the stringers and gunwales where there are no notches. Remove the tape and fill in the gaps on the pattern.

Turn the half pattern cutout over and carefully align the Base Line and the Center Line, tape the pattern down and draw to complete the full station mold.

IMPORTANT STEP: At this point, before cutting the station mold, check for symmetry. You can learn more in our YouTube video Getting Started. From the bottom center of the station mold (where the Base Line and Center Line meet), choose some reference points on the pattern, usually notches or location marks, and measure from the bottom center to the reference point on each side. They should be the same distance, less than 1/16" difference. If not, re-tape and redraw, as necessary.

STRONGBACK

The purpose of the strongback is to provide a strong, stable platform upon which to build your boat. To accomplish that and to keep your boat straight, the strongback should not twist, warp or bend.

The dimensions and construction of the strongback for your particular boat are shown on the plans. Platt recommends using a box beam made with 1x dimensional lumber and cardboard but any structural shape (I beam, C channel, T beam) can work. Most customers seem to avoid the cardboard and it can easily be replaced with dimensional lumber or plywood.

During the build, most of our boats sit inverted about two feet above the top of the strongback so it should be built to a height that allows you to comfortably reach that point.

BUILDING THE STATIONS

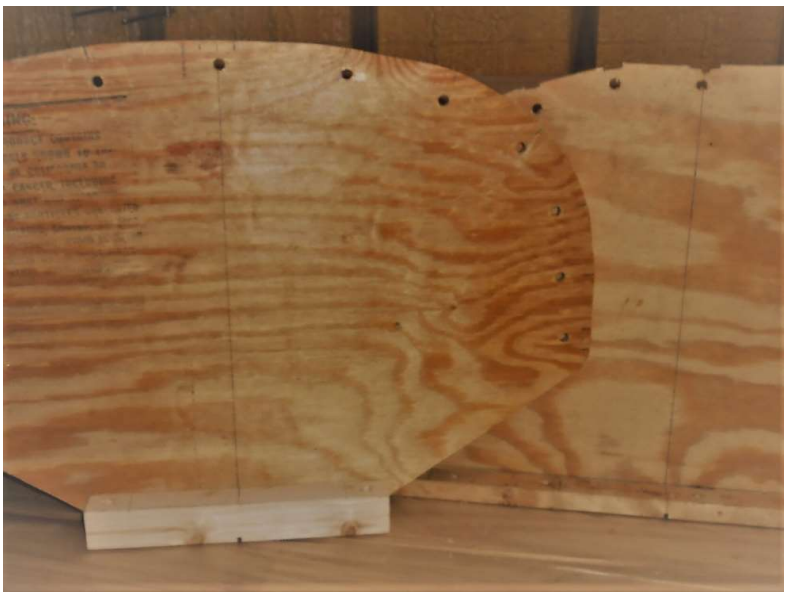
The stations can be built from very strong cardboard (at least 275 # test, like an appliance carton) or from thin plywood. If you live in a hot, humid area and are working outdoors, you will definitely want to go with the plywood. In Platt's words, "cardboard will get mushy from the humidity."

Once the plans have been transferred to the station material and checked for symmetry, it's time to cut the stations. Cut carefully and make sure that all reference lines have been transferred to the station material. After cutting, re-check the symmetry of the station molds using the reference lines and lay identical stations (canoes use duplicate stations) on top of each other to check their consistency.

Some customers choose to make oversize stringers (not recommended) but if you want to do this you may need to adjust the size of the notches at this point.

If you're using cardboard, you might want to reinforce the notches. As Platt describes them: "Another idea that makes sense is to make up stringer grabbers (small pieces of plywood with the appropriate size notches cut out) that are glued to the stations." This seems like a lot of work and if you're going to spend that much time working with plywood you might just want to make the station molds from plywood in the first place. We don't like to disagree with Platt as a general rule.

To complete each station, glue or screw a piece of dimensional lumber (1 x 2 or 2 x 2 works fine) to the base of the station, making sure to mark the Center Line. The 1" dimension will be attached to the station and the 2" dimension will go on the strongback. Cut a notch, about 1/8" x 1/8" through the station and the attached lumber at the Center Line. This notch will be used for alignment in the next step.



Note the reference lines and notches on the stations and the use of 1 x 2 and 2 x 2 cleats.

MATERIALS - WOOD

At some point, you'll need to decide which type of wood to use. From Platt's original construction manual:

"You need straight grain, clear wood for the longitudinal members of the boat. Spruce, Douglas fir, mahogany or poplar are the preferred woods. Sometimes you can find a decent board in the house building dimension lumber pile, because the sticks are small, and you can cut between the knots and do some scarfing.

The trick here is to start looking in the 2 x 12 x 16' stack. This will be more wood than you require but it would have come from a better tree and therefore the pickings are better. Also look for trim or ledger boards, even spruce decking. Try vertical grain fir flooring. Pick the pile for the clearest piece. It is perfectly OK to splice two pieces together to make the required length of longitudinal members but do not splice the ribs, as they will be steam bent. Use a minimum of 8:1 scarf joint (matching angle overlap) glued together.

The ribs are cut from straight ash. If ash is not available, oak will do. This should be sapwood, not heartwood, and green if possible."

Clear, straight, lumber (and, apparently, mahogany) was more readily available in 1984 when Platt wrote this section, particularly in Maine, but things have changed since then, and we get a lot of questions about wood selection. If you are fortunate enough to have a sawmill nearby, you should have some excellent options and Platt's recommendations might work for you. If not, the big home improvement stores have lumber that is suitable to build a boat. Most of their 2x dimensional lumber is, honestly, too knotty, too loose grained and unstable (prone to twisting) for boat building but you might get lucky and find a suitable piece.

However, they offer a few premium woods (oak, poplar, pine/spruce and cedar) in 1x stock that works extremely well for our boats. Clear, straight poplar or "premium pine" works well for the stringers and other longitudinal members and red oak, even kiln dried, can easily be steamed into ribs, as can poplar. You can learn more in our video Choosing and Buying Wood. The disadvantage of this premium wood is that it only comes in up to 12-foot lengths so a scarf joint will be required for most of our boats. You can learn more in our video Making a Scarf Joint.

These wood alternatives are discussed further in the Frame section and on our YouTube channel, where you will also find videos about scarf joints and ripping long, thin strips. Even though scarf joints are very common in boat building, if you can find good quality, full length lumber you should use it.

Many builders have local wood such as cypress, juniper and white cedar available and ask if their unique wood is suitable for boat building. We can't test build boats with every type of wood but as a general guide, consider the following:

For longitudinal members (stringers**, gunwales, keelson and rub rails)** any dried wood should work. Don't use "green" wood for these pieces. For our smaller boats, you could use softer woods like cedar and white pine (we've successfully built boats with both) but for any boat over 12' we recommend stronger wood like spruce and poplar. The key for softwoods is the tightness of the grain. Most of the 2x dimensional lumber at the big box retailers is from trees that grow very fast so they can be harvested quickly. This results in the loose grain that is not a problem in a framing 2 x 6 but doesn't work well for the thin strips in our boats. At the other end of the softwood spectrum, we took down an old growth white pine in the Adirondacks that was leaning over a house. It had a very tight grain and was perfectly suitable for boat building.

For the ribs, the traditional woods for steam bending are red oak, white oak, ash and poplar. Conventional wisdom is that you can't steam bend kiln dried wood, but our ribs are so thin that the kiln dried woods re-hydrate very well, steam bend beautifully and hold their shape well. You can see kiln dried oak ribs being installed in our YouTube channel video Installing Ribs. We haven't tested kiln dried white oak but there's no reason to think it won't perform as well or better.

For the flooring, most of our boats (hard bottom boats not included) use some sort of plywood strips installed on the ribs. Your plans will have the details but virtually any wood or combination of woods can be used for the flooring. The flooring is supported every few inches by the ribs, so strength isn't as critical. We use cedar

flooring in most of our prototype boats because it's lighter and prettier than plywood, but you could alternate cedar and pine strips for a unique look.

Stem pieces are usually made from a combination of plywood and dimensional wood, but this can be problematic. On the Snowshoe 16, for example, the vertical piece of the stem is built from 3/8" stock and the horizontal piece of the stem is built from 3/8" exterior plywood. These two pieces are then glued together to make the stem. Now, Platt Monfort was much smarter than me but introducing a glued joint at what is arguably the most critical, stressed point on the boat doesn't seem like a great idea, even though thousands of boats have been built using these stems. This is one of two places on the build where we will change his method. On all of our prototype boats, we use ½" nominal plywood and build a one-piece stem by taping the two paper pattern pieces together and tracing the new pattern onto the plywood. We feel this makes a stronger boat and a simpler build. A sheet describing this method is included with all plans.

MATERIALS – ADHESIVES

There are thousands of wood adhesives on the market with different properties and uses. For experienced woodworkers this can be a personal preference but as a general guideline for our boats we break them down into two categories: **tight fit and gap filling**.

Tight fit gluing refers to a joint with very little gap, such as a scarf joint, and we've had great success with Gorilla Glue and Titebond III in this application. But there are only a few tight fit joints on our boats.

Gap filling glue is used where the glue becomes part of the structure. It bonds the wood together where the gap is tight but fills the larger gaps with a material that is structurally sound. Most of the joints on our boats fall into this category. Gorilla Glue will expand to fill gaps, but the expanded glue has virtually no strength. For gap filling, we recommend a structural epoxy such as the Superbond 2-part epoxy included in our kits (it has a viscosity similar to Vaseline and will stay in place as it hardens) or an exterior grade construction adhesive like Loctite PL Premium (not as strong as the epoxy). We've built several prototypes with both adhesives but would encourage experienced woodworkers to use products that work for them.

Some builders have asked about using **"cyano" or super glue** on a boat. It bonds quickly but is very thin and forms a brittle connection so there doesn't seem to be an application for it on our boats.

Although not an adhesive, some builders choose to build their boats using artificial sinew to make **lashed joints**. This is a very traditional way to build a boat, but we don't recommend it for a couple of reasons. First, a traditional boat is built with much larger stringers and fewer of them. They are attached to a limited number of thick frames to form the structure, which will probably have around 60 to 70 lashed joints. By comparison, a 14-foot Geodesic canoe will have almost 300 lashed joints. That's a lot of knots.

The other reason we don't recommend lashing our boats is because the sinew cuts into the wood as you pull it tight enough to make a secure joint, particularly if using soft wood or medium hardwood. If your hull is built from thick material, this isn't an issue. But our stringers and ribs are very thin and cutting into them even 1/16 of an inch can compromise the strength. Also, by definition, lashed boats are built to flex and this flex can result in the sinew "sawing" into the stringers and ribs even more. Lashed boats are very traditional and beautiful but we don't recommend this construction method for our boats.

As an alternative to get the traditional look, we recommend building the hull with epoxy and then adding sinew to the joints as a decorative touch. The last adhesive product is **Heat N Bond**, a hot melt adhesive with removable paper backing that is used to attach the Kevlar and Dacron to the wood. There may be other ways to make these connections, but the Heat N Bond is cheap, easy to work with, does its job very well and readily available so we aren't going to spend a lot of time testing other options.

MATERIAL – KEVLAR

Our boats use **2 strand or 5 strand Kevlar roving** wrapped across the hull in a triangular basket pattern. Builders regularly ask if they really need to install the Kevlar and the answer is that you can build a boat without it but there are some very good reasons to put it in. First, when designing these boats, Platt only included components that perform a critical function. Anything else was left out but the Kevlar was left in. Why? Because he figured (correctly) that it was necessary.

Platt described the basic design of his boat as "the wood is under compression and the Kevlar is in tension" but it's more than that. In a neutral state, the entire Kevlar "basket" is in roughly the same state of tension, little more than hand tight. As forces act upon the hull, going over waves, through fast water, getting in and out of the boat, even strapping it down to a rack, some of that Kevlar basket goes into a state of extreme tension but does not stretch which maintains the strength, shape and integrity of the hull.

Even more important is the support that the Kevlar provides the Dacron. The Dacron is shrunk over the stringers that run the length of the boat, but they don't contact the Dacron vertically. There is nothing supporting the Dacron between the stringers. The Kevlar basket crosses the hull on the outside of the stringers every few inches, contacting the Dacron directly, providing substantial vertical support and increasing the strength of the Dacron. Our **YouTube channel** has videos Installing the Kevlar and Tightening the Kevlar (VERY important!) on the importance of the Kevlar and how to install and finish it.

MATERIAL – DACRON

We get more questions about Dacron than any other topic. Why do you use Dacron instead of Nylon? Is it strong enough? Does it puncture or tear easily? How do you finish it? How do I make it stronger? Most of these questions will be answered in our section on covering and finishing the hull but this section is about why we use certain materials, so we'll answer that question.

Like so many answers, this one goes back to Platt's design where "the wood is under compression." The wood hull completely finished without the fabric covering isn't in compression. Some parts are in compression, some are in tension, and some are neutral. Shrinking the Dacron exerts a surprisingly powerful force over the hull, pushing almost all of the wood into a state of compression. In other words, the Dacron isn't there just to keep the water out; it's a critical structural component.

Nylon is a common boat covering very similar to Dacron but with slightly different properties. It can't be heat shrunk and therefore can't be a structural component. It can be installed wet, pulled tight and allowed to dry, which will allow for some compression of the wood frame, but it absorbs moisture and tends to loosen up again when the boat is put in the water, reducing that important compression. Platt's background in aircraft design led him to the Dacron as part of the structure and it's still the correct material for our boats. We're

constantly experimenting with coverings and finishes and will update our web page, YouTube channel and this build guide with new developments.

MATERIALS – HULL AND DACRON COATING

The finished boat will need spar varnish, spar polyurethane and, in some cases, paint. These will be covered in the appropriate construction sections and on our YouTube channel.

TOOLS

Surprisingly few tools are needed to build one of our boats: saws, a small plane, a steamer, steam box, an iron and lots of clamps.

- **Table Saw**: To cut the stringers and ribs, most people use a table saw, although these parts have been cut with a band saw and even a circular saw. We recommend using a thin kerf blade to avoid wasting 60% of the wood. These parts are very small so you can equip your table saw with a 7 ¼" blade if desired. For most boats, you'll be cutting around 17 longitudinal pieces and 25 ribs so you may want to equip your table saw with a jig. Our YouTube channel has a video Cutting Components on a Table Saw of a fairly simple jig that you could adapt to help cutting these pieces.
- **Jig Saw or Band Saw**: There are a few component pieces that will need to be cut out as well as the stations if you choose to make them from plywood. A jig saw or band saw will work for these.
- **Hand Saw**: Although not required, a hand saw or pull saw works very well for trimming the ribs and the stem pieces after installation. It also is used to make the stringer-to-stem connections. These can also be carefully cut with a jig saw but a Japanese pull saw is the ideal tool.
- **Small Plane**: A small, low angle block plane can be used to quickly chamfer the edges of the ribs, stringers, keelson and gunwales and to fair stringers into the stem. A hand rasp can also be used. Our YouTube channel has a video Cutting and shaping ribs from ripped stock on making ribs that shows a hand plane being used to chamfer the edges.
- **Steamer and Steam Box**: This is your setup for steam bending the ribs. There are many, many instructions and videos on the internet about making steam boxes, including one on our YouTube channel. Rather than providing a design, we recommend that you find one that best suits your situation with the materials you have available and build something you feel comfortable with.
- **Iron**: A standard household iron is used to melt the Heat N Bond and to shrink the Dacron. It may (will, actually) get a little messy from the Heat N Bond so don't use your good iron. Our YouTube video Installing the Kevlar on attaching the Kevlar shows what can happen to an iron.
- **Clamps**: You will use LOTS of clamps, more than you thought possible, and you'll get frustrated when you run out. For example, if you're building a boat with 24 ribs and want to install all of the ribs at the same time, you'll need about 170 clamps. We use a combination of spring clamps and Clamp Its and you can see them both in our YouTube video about installing ribs.
- **Other Tools**: Other shop tools like a drill and bits, screwdrivers, pliers, and a small hammer might be used as well as some painter's tape.

SECTION TWO: General Build Processes

Note: Many of these are also covered in our Getting Started Getting Started video

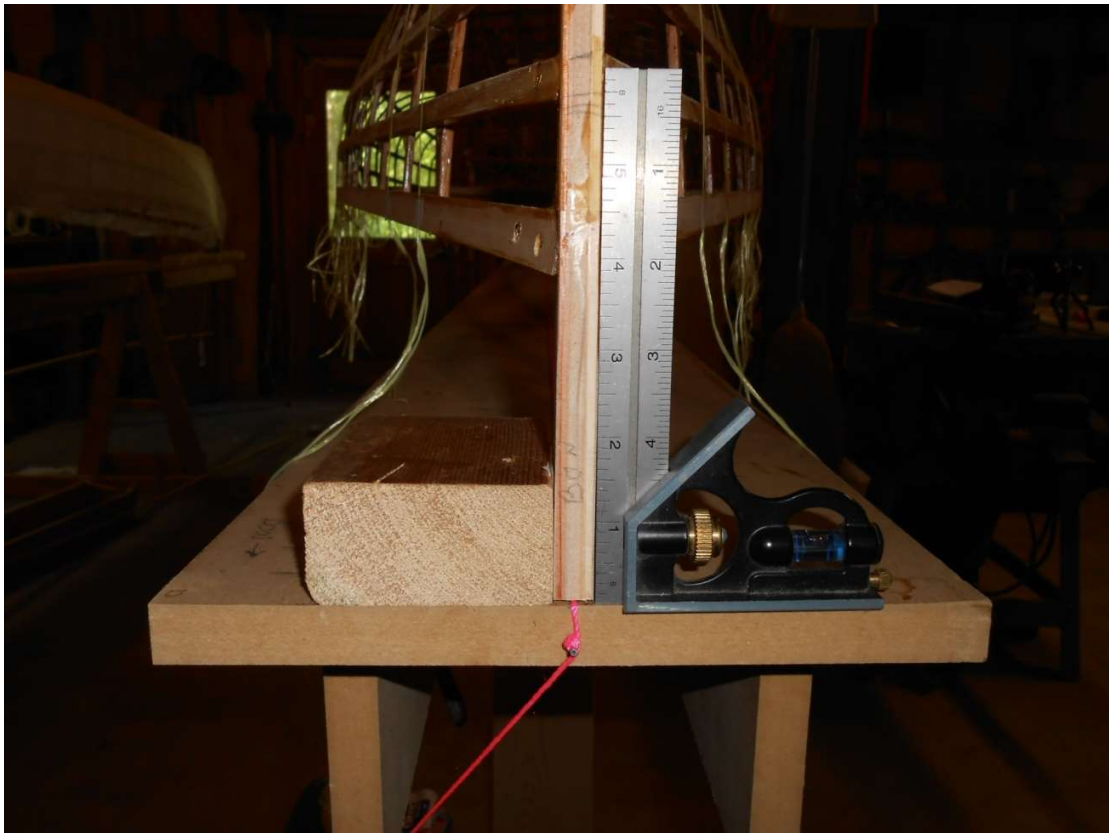
At this point you've selected the wood, built the strongback and stations and cut the stem pieces (or transom). You're ready to start building. NOTE: There is some "down time" building these boats waiting for adhesives and varnish to dry. To get the build started, consider cutting the bow and stern pieces first and cut the rest of the small pieces (thwarts, gussets, etc.) during one of these periods.

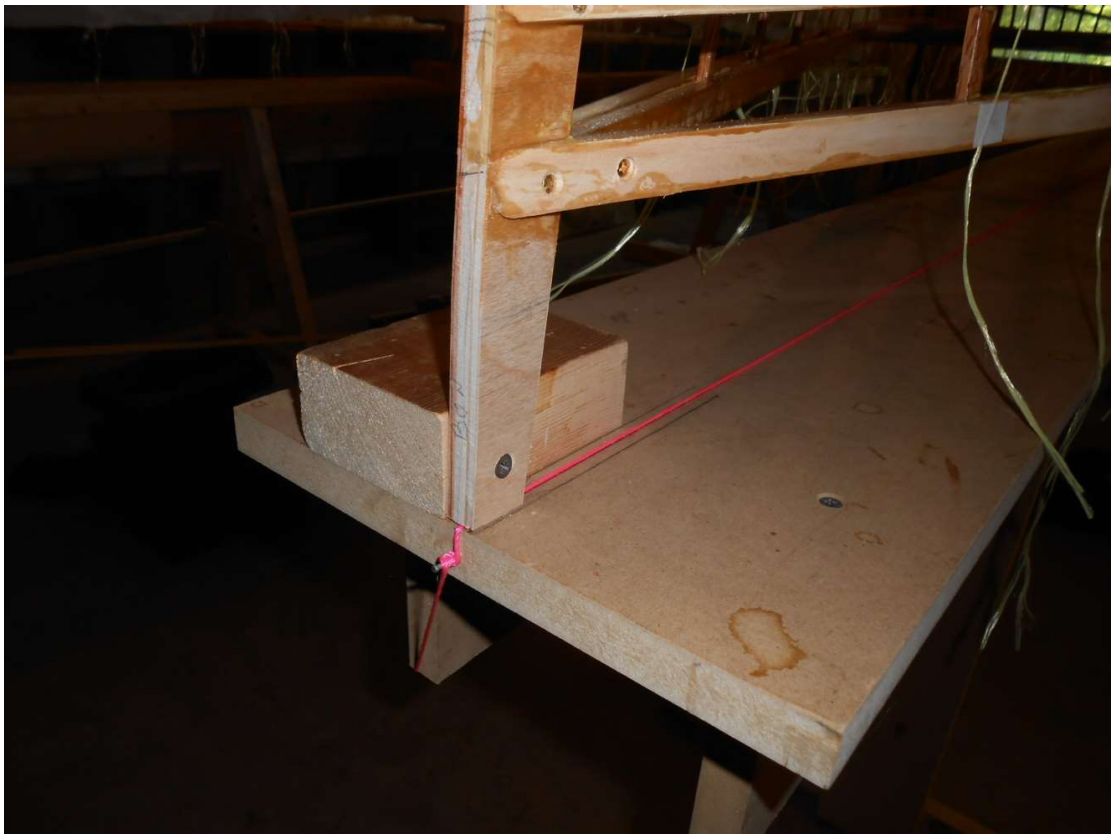
SET UP THE ENDS OF THE BOAT

From Platt: "Now make a center line down the center of the strongback. I always use a fine wire strung from nails in the ends of the wood. This is stretched taut. This gives a two directional line, horizontal and vertical…a monofilament fish line would also work."

After locating your strongback center and pulling your wire or string taut along the center, measure the thickness of the wood you're using for the stem (bow). Attach a cleat (block of wood) to the end of the strongback at exactly ½ of that thickness from your wire (below). Use a piece of wood with a clean square edge because these cleats at the ends of the strongback will determine the straightness of your build.

Clamp the stem to the cleat, check to make sure the string runs down the center of the stem, check for square and shim if necessary (note the small white paper shim between the block and the stem in the picture below.) The boat in this picture is mostly finished but it shows that you'll be using this block attachment throughout the build, so do it right at the beginning.





SETTING UP THE STATIONS

Start off by locating the station centers (space between stations, from your plans) and mark a line across the strongback with a square. To install the stations, the front edge of the station is aligned with the square mark on the strongback, and the notch will straddle the wire.

The station is then attached to the strongback with sheet rock screws. To help keep the station in place during installation, pre-drill the sheet rock screw holes in the 1 x 2 and clamp the station to the strongback while installing the screws.

At this point, the stations should be perfectly aligned on the strongback because the notches are straddling the wire, and the edge of the station matches the square line. However, the top of the stations (where the keelson will be installed) must also be checked. Any twist in the strongback or variance in cutting and building the stations will be obvious at this point.

On each end of the strongback, set up a temporary brace that will hold a string slightly above the highest point of the installed stations over the center line (see picture above). A piece of scrap wood cut ½" longer than the highest point will work fine. Clamp the scrap wood to the cleat on the strongback, pull the string taut, making sure it is approximately aligned with the center of the end stations and look for misalignment of the center lines on all the stations.

They should be very close because the notches at the base of the station are aligned but the center lines at the keelson must also be aligned. The fix may be as simple as a small shim between the station and the strongback or reattaching the station to the 1 x 2. In rare cases, the station may need to be re-cut but if the symmetry was checked earlier, this shouldn't happen.

Once the bases are aligned over the wire, the keelson center marks are aligned under the string and the stations are attached to the strongback, the strings and wires can be removed and you're ready for the next step.

MAKING A SCARF JOINT

Note: see our Making a Scarf Joint video for more

Ribs should never have a scarf joint because of their relatively short length and because they will be steam bent. ***The longer components may require a scarf joint but if you can get full length wood you should use it.***

There are three considerations for a scarf joint: First, how do you build the joint? Second, where on the boat should the scarf joint be located? Third, do you make large scarf joints and then cut the strips or cut all the strips and make a lot of smaller joints?

A scarf joint can be built using any number of tools; table saw, band saw, miter saw, hand plane and depending on your tools and comfort level there are a lot of instructional videos on how to make one. We use a miter saw and simple jig to make scarf joints and have a YouTube video showing the jig, the saw and the assembly technique.

Where on the boat should the scarf joint be located? The worst place to locate a scarf joint is in the middle of the boat where it will be subjected to the most bending force. They should be more toward the bow or stern where the strips are a little straighter. For example, if building a 14-foot boat, you'll probably use 16-foot lengths. Instead of scarfing together two 8-foot pieces, buy a 2-10 foot pieces and 2-6 foot pieces. You can also use a 2-12 foot pieces and 1-6 foot piece (cut in half) for a 14 foot boat. The scarf joints should also be alternated from end to end and moved using the extra length, so they don't end up in a line directly under each other. In the case of the inner and outer gunwales, the inner gunwale scarf joint should be toward one end of the boat and the outer gunwale joint toward the other.

Do you make one large scarf joint or cut the strips and then make the joints? The technique for making the joint is the same but regardless of how the joint is built, some planning is required to ensure the length of the joint runs along the length of the boat. Any bending force joint should be parallel to the joint, not perpendicular to it.

CUTTING RIBS AND STRINGERS

This section is intentionally vague because it's completely dependent on your equipment and comfort level with that equipment. However, to build most of our boats, you'll be cutting about 17 of the long pieces (stringers, keelson and gunwales) and 25 ribs. That's a lot small thin strips that need to be cut accurately so you may want to consider some sort of "thin strip jig." There are many different jigs available, both DIY and commercial models so you should be able to find one that suits your equipment and skill level. We have a YouTube video **(**Cutting Components on a Table Saw) showing a relatively simple, inexpensive table saw jig that has been used to cut hundreds of strips. Some version of this jig could be modified to fit almost any saw.

Depending on your saw, you may also want to consider a zero clearance insert. If your insert has too large a gap at the blade, the strips could be forced into the gap during cutting, creating a potentially dangerous situation. Zero clearance inserts are available for almost any saw and there are many instructions on how to make your own on the internet.

Another modification might be a thin kerf blade if using a table saw. If you have a substantial supply of wood, it may not be necessary but each cut with a standard blade is about half the width of a rib so you can throw away a lot of wood as sawdust. The good news is that because the pieces are so small, you can usually mount a 7 ¼" blade to the table saw, saving the expense of a 10" thin kerf blade. If you're using thick stock from a sawmill, you can rip the stock into manageable sizes using the standard 10" blade and then switch to the 7 ¼" blade for the final cuts on the ribs and stringers.

Again, these are quite vague but there are simply too many ways to do this and too many types of saws to cover every option. We have to assume that you know your equipment and your skill level and will choose a method that's comfortable and safe. We recommend that you watch our YouTube videos on these topics as well as any other instructional videos that may suit your situation.

ATTACHING COMPONENTS

If you've built the stations carefully, checked them for symmetry and attached them to the strongback using squares and string, you should have a solid base to build a "true" boat frame but there are a couple of ways to check as you're attaching the keelson, outer gunwales and stringers.

The first method is to look at the shape of the boat as you lay them out. Platt describes it as "Eyeballing your work-boat builders learn right from the beginning that one of the most important things you must do is to stand back and look at your work. You have to sight it from all angles and see that everything lies in fair lines and has symmetry in spacing." Simply put, be honest with yourself while looking at the boat and if something doesn't look exactly right, make small adjustments until it does.

This "eyeballing" technique starts with the first step, attaching the keelson, and will be used throughout the build. Once the stringers are laid out on the stations, there are ways to confirm the symmetry that will be discussed in that section.

At this point, the stems (or transom) should already be attached to the cleats on the strongback and now the keelson gets mounted. It's extremely important that the stems are centered on and perpendicular to the strongback.

SECTION THREE: Double Ended Boats

NOTE: All of the wood components in this section should be sanded smooth before installation. This is more of a finish issue than a fit issue and the amount of sanding needed will be determined by how well your saw cuts the pieces and how smooth you want the finish. We don't recommend chamfering or rounding the **outside** edges of the stringers and gunwales at this point, as the amount of rounding needed is much easier to see once they're installed. The inside faces can be sanded for aesthetics.

INSTALL THE KEELSON

The keelson is laid down the length of the stations (unattached) and will rest on the stems at the bow and stern, overhanging each. The keelson must now be mounted to the stems, ensuring that the mounting surface of the stems is flush with the keelson, exactly centered on the keelson and parallel with the length of it. This isn't as difficult as it sounds.

Carefully measure and draw a line down the center of the keelson where it mounts to each stem. These will be used for screws that attach the keelson to the stem.

Drill 2 perpendicular pilot holes through the keelson on the center line you've just drawn. Depending on your confidence in your drilling ability, they can be drilled in place or taken to a drill press. The pilot holes should be about 1/16" diameter.

All boats are different, but you want to "eyeball" the curve of the stem at the keelson and make sure the pilot holes are far enough back so that they don't interfere when you trim the keelson to the shape of the stem.

The next step is to mount the keelson to the ***stations***. Remember, this is a temporary mount since the stations will eventually be removed. There are many different ways to make this mount. Platt recommended wiring the longitudinal members to the stations and while this will work, we recommend using **thin zip ties** run through a 3/8" hole drilled through the station about 1" below where the keelson contacts the station. They're cheap, easy to find and work well. Longer zip ties (about 10" or 11") can be used to make a very secure "X" but shorter ones can simply be looped around the piece and pulled tight. You can see both zip tie methods on our YouTube video about mounting ribs.

Temporarily clamp the keelson to the stems, aligning it closely on the center of the stems and then look down the keelson. It should be very straight but if it isn't, gently tap it until it is. Make marks on each station on both sides of the keelson and then pull the zip ties as tight as possible.

Once the keelson is correctly located, it can be permanently attached to the stems. We recommend a combination of chemical (glue) and mechanical (screws or pegs through the keelson into the bottom of the stem) to make this connection.

Keep the keelson aligned and centered on the stem. There are many complicated ways to do this, but we use a couple of spring clamps attached to the stem just below the keelson as a visual guide. You can judge the center based on how much of the clamp shows on either side. With a very sharp pencil, mark through the pilot holes onto the stem. You may need to make larger pilot holes, large enough to accommodate the screws without forcing them. Depending on the boat, these are usually #4 or #6 stainless screws, ¾" to 1". The pencil marks should be on the exact center of the stem. Even though the keelson is mounted to the stations, you can slide it out of the way to drill the pilot holes into the stem. You could easily split the stem when installing the screw so

make the pilot holes large enough to allow the threads to catch easily. If you are going to keep the screws, make sure they are located far enough toward the center of the boat that they won't interfere with the curve of the boat when you fair the keelson into the stem. If you plan to replace them with glued pegs, this isn't an issue, just remove the screws, drill for the pegs and install with epoxy.

Loosely screw the keelson to the stem and recheck the alignment down the boat and at the keelson/stem connection. If it's OK, remove the screws, glue the keelson to the stem and reinstall the screws.

Repeat the process for the other end of the boat, let the glue dry and then trim the keelson so that it doesn't overhang and interfere with working around the boat. Don't fair the keelson at this point.

This may sound complicated but most of it is basic woodworking; keep things square, plumb and true.

INSTALL THE OUTER GUNWALE

The outer gunwales are some of the largest components on the boat and are subjected to the most bend so it's important to avoid "fighting the grain". This is a little hard to describe but these long, thin strips seem to have a preference in which way they bend. To test this:

1. Place a gunwale on the floor, on edge (use this process for the inner gunwales also)
2. Gently grab the gunwale in the middle and slowly lift
3. Notice how far you lift the middle before the ends come up
4. Turn the gunwale over on the other edge and repeat the lift
5. Compare the behavior of the ends. If you're lifting "with the grain" the ends will tend to sag more. If lifting "against the grain" the ends will come off the ground quicker and want to move left or right. It may only be a little bit, but every little advantage helps the build process.
6. You want "with the grain" properties to work with you on your boat. The gunwales will be installed so the extra sag in the middle of the gunwales works toward the water (or away from the strongback) as the boat is being built.

Another way to be sure is to clamp the gunwale to the stations and then see how it falls on the stem. Turn the gunwale over and repeat. Normally, one of those two mounts will allow the gunwale to fall more flush on the stem.

Installing the gunwales is pretty simple. Their location should be clearly marked on the stations and holes drilled for the zip ties.

Loosely zip tie the gunwale to the middle stations, making sure that the scarf joints are as far from the middle of the boat as possible. Attach the gunwale to the other stations with loose zip ties and clamp to the stems. Repeat for the other side of the boat, making sure the keelson doesn't shift.

The gunwale can be trimmed now but leave a couple inches at each end for "corrections" as you learn to fair the ends of the boat.

At this point, both outer gunwales are in place, loosely zip tied to the stations and clamped to the stem. A rubber band around the ends of the gunwales will also work. Time to move on to the stringers.

INSTALL THE STRINGERS

The process for installing the stringers is identical to installing the outer gunwales. Checking the grain isn't as important but it only takes a couple minutes.

If you have scarf joints in your stringers, alternate the scarf joints from bow to stern and use the extra length of the stringer to ensure they don't fall directly under each other.

FAIRING THE ENDS

With the outer gunwales and stringers loosely attached and the keelson permanently mounted to the stems, it's time to fair the ends of the boat. We recommend watching our YouTube video How to trim and fair the ends of your SOF boat about fairing the ends of the boat since it's much easier to show the process than to describe it.

The most important thing to know is that the stringers will not lay flat on the stems. The gunwales and the stringers closest to the gunwales will almost be flat but as you get closer to the keelson each stringer will have a pronounced twist. This twist is normal and does not need to be taken out.

Rather than twisting the stringers to get them to lie flat, the stringers should be trimmed to allow their natural curve to lay flush on the stems.

NOTE: The stringers should be tightly attached to all stations using zip ties for this process.

To trim the stringers:

1. Hold each stringer on the stem at the pre-marked location from the plans, leaving most of the excess stringer length at the other end of the boat while you are tightening the zip ties
2. With a pencil, draw the approximate curve of the stem on the stringer at that location
3. From above, draw a line parallel to the flat surface of the stem on the inside of the stringer. This line and the curve from Step 2 are the rough outline of how the stringer attaches to the stem.
4. Carefully cut the stringer about 1/16" longer than the point it falls on the stem, roughly following the curve of the stem from Step 2
5. Using a sharp hand tool (plane, rasp, chisel, utility knife, etc.), begin to trim the underside of the stringer where it contacts the stem until a flat surface is created to mate with the stem
6. Continue to refine the stringer surface, checking the fit regularly until at least half the width of the stringer has been cut away. The stringer doesn't have to come to a point. That will be done later but the end of the stringer should be close to flush with the outside curve of the stem.
7. As you fit the stringers, you'll notice those closest to the gunwales will lie pretty flat with a minimum of cutting but the ones closest to the keelson will require a good bit of trimming along the edge to create a gluing surface.
    i. NOTE: There aren't any exact angles or lengths provided to fair the stringers, but you should start with the ones closest to the gunwales. They are the easiest to fit and will help you get more comfortable with the process as you work toward the more difficult ones. Alternate sides to keep the stem perpendicular and square during the process.
8. If you make a mistake, just pull a little bit of the stringer forward (you may have to loosen or remove/replace the zip ties) and re-shape the end, making sure you leave enough at the other end.

9. Once you have the stringers at one end trimmed and fit, the next step is to fair them. Do this before beginning the fitting process at the other end because if you make a mistake, you have some extra length to recover with.
10. Fairing the stringers is another place where “eyeballing” comes into play. You want to taper the end of the stringer so that it flows smoothly into the outside curve of the stem. There’s no set formula for fairing the stringers because everyone may cut and fit them a little differently.
11. A quick way to test the accuracy of your fairing work is using a cloth tape or something similar to check your work both horizontally (around the stem) and vertically (around the keelson). By wrapping the tape around the stem, you’ll be able to see gaps or bulges where the stringer tapers into the stem and can adjust them.

FAIRING THE KEELSON

At this point you can begin to fair the keelson into the stem. Again, this isn’t complicated, but the keelson is already glued so take your time and get it right. There are two fairing processes on the keelson: into the curve of the stem and into the width of the stem.

To fair the keelson into the curve of the stem:

1. Get on the side of the boat and use a pencil to draw an arc on the side of the uncut keelson that follows the curve of the stem at that point. It doesn’t have to be exact.
2. Cut the keelson at an angle that roughly follows the arc, leaving a little extra.
3. Use the sharp hand tool of your choice and begin to whittle down the keelson until it forms a continuous curve with the curve of the stem but don’t finish it yet.
4. Move now to the bottom of the keelson (facing up) and begin to taper the sides of the keelson so they flow cleanly into the width of the stem. Most of the double ended boats have a narrow keelson and this taper will begin about 5” to 6” back from the curve. Some of the larger canoes have a wide keelson and the taper starts much further back, as shown on your plans.
5. As you are tapering the keelson into the width of the stem, you’ll also “round off” the keelson so the Dacron will have a smooth edge to transition into the ends of the boat.
6. To see if the width is tapered correctly, use the cloth tape used to check the stringers. Wrap it from gunwale to gunwale at the stem where it is attached to the keelson. This will ensure that the keelson is narrow enough at that point to allow the Dacron to contact all of the stringers with no voids. If the tape fails to contact the stringer closest to the keelson, continue to taper the keelson until it does.

One end of the boat is now fit and faired and can be glued in place. For extra strength at these critical joints and to hold the components in place while the glue dries, a #6 x ¾ brass screw can be ***carefully*** run through the stringers and gunwales into the stem.

Don’t start the other end of the boat until the first end is securely attached. If not, you may accidentally pull the stringer or gunwale to the other end. Yes, this is experience talking!

Learn from your mistakes on the first end of the boat!! On the other end, you won’t have the luxury of pulling a little more forward to make corrections. But don’t worry, thousands of these boats have been built and after fitting the first end, you’ll know exactly how to fit the other end.

Be sure to check out our YouTube video How to trim and fair the ends of your SOF boat on trimming and fairing the ends of your boat.

INSTALLING RIBS

By the time you reach this step, you should have designed and built your steam box and cut your ribs (plus a few extra). The rib locations should be marked in pencil on the keelson and the gunwales according to your plans.

One of our most common questions is: ***Can I build the ribs larger than the plans?*** *Certainly, you can, but be aware that making them even a tiny bit thicker greatly increases the difficulty of steaming and installing them. Also, if they don't bend easily to cleanly follow the lines of the hull and contact the stringers properly, your thicker ribs will actually result in a weaker boat. If you choose to modify the rib structure, we strongly recommend a much simpler, stronger option. Make the ribs a little wider but no thicker and space them closer together on the boat. For example, on a Snowshoe 14, the ribs are ¼" thick by ½" wide, spaced 8" apart. To beef up the structure, make the ribs ¼" thick by 9/16" wide and space them every 7 inches. This modification is not necessary; your boat as designed has plenty of strength. It is only offered to answer a very common question and to prevent the frustration of trying to bend and fit ribs that are too thick.*

On all of our prototype boats, the ribs are cut (using a thin kerf blade) from 1x stock to slightly more than 3/16" thick and 5/8" wide. The 1x board is cut to 5/8" and then the ¾" dimension of the 5/8" strip has two-1/16" cuts, resulting in three ribs that are evenly cut from the remaining width. They will each be slightly thicker than 3/16" and 5/8" wide. The amount of wood in each rib is actually more than the original ¼" x ½" from the plans but is easier to steam and install.

To steam your ribs (see our YouTube video Installing Ribs on steaming and bending):

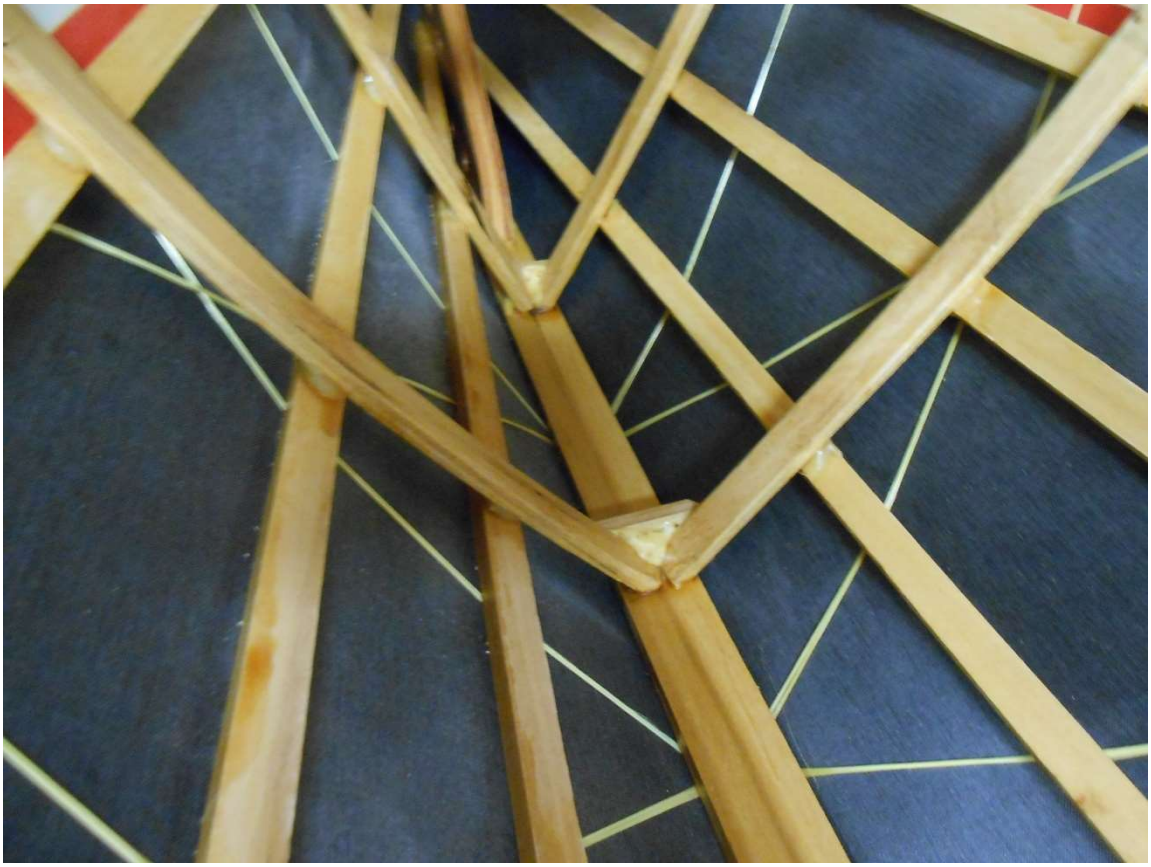
1. If possible, pre-soak them for at least 5 hours. This isn't always necessary, but wood is a very inconsistent medium and this soak will help the ribs bend more consistently.
2. Don't steam all of your ribs at once. The last ribs to come out would have been steaming for well over an hour if they were all put in at the same time. Make two or three batches.
3. The amount of time your ribs spend in the steamer varies significantly and depends on many factors. As a general rule, leave them in the steamer for at least 25 minutes after the steam first comes out of the safety vents on the steamer.
4. At that point, pull out one rib and see how it bends around the outside of the stringers. If it bends easily and follows the curve properly, you are ready to start bending and installing. If not, put it back in the steamer and test again in a few minutes.

To bend your ribs:

1. The ribs don't need to be installed in any particular sequence but start somewhere toward the middle of the boat with the longest ribs. There are two reasons for this. First, these are the easiest to bend and it will give you a chance to get comfortable with the process. Second, if you split one of these longer ribs, put it back in the steamer and you might be able to use it in another spot.
2. When you pull out a rib, check for grain run out. Even though you selected good straight grain stock for the ribs, there will be places where the grain curves and "runs off" the rib. This is the most likely place for the rib to split so you should try to place that rib, so the grain run out is

either outside the boat or on a flat part of the boat near the keelson where there isn't as much bend.

3. Remove a rib from the steamer, check for grain run out and position the rib at your chosen location inside the boat on the keelson. Clamp the rib to the keelson (you can pre-position some clamps on the boat frame to facilitate this process). Every rib will be clamped to the keelson and at least two and sometimes three stringers on each side.
4. With the rib clamped to the keelson, most of the ribs will not be near the stringers. It will be pushed straight out by the gunwales. Grab one end of the rib and gently push the end toward the strongback while pulling the rest of the middle of that side up toward the stringers. It should easily push into place. Take your time and be gentle. You have two or three minutes while it is still pliable.
5. There isn't a particular pattern for clamping the ribs into place on the stringers. It depends on your boat, the wood, how the wood was cut and how it was steamed. As you're bending the rib, you'll notice that it contacts some stringers easily and has to be gently forced to contact others. Clamps should be put on the stringers that are the hardest to fit.
6. Hold the rib on a stringer close to the keelson, clamp the rib to that stringer, push the rib back into place against the remaining stringers and put on another clamp close to the tightest curve of the hull. Re-fit the rib from the last clamp down to the gunwale and put another clamp somewhere near or on the gunwale.
7. With the rib secured, re-check it along the stringers, making sure it contacts all stringers. Push the rib and reset the clamps if necessary.
    a. NOTE: You have about 2 to 3 minutes to fit the ribs while they are still pliable enough to fit. If you don't have it clamped by then just put it back in the steamer for a few minutes and use another rib.
8. Continue to bend and fit the ribs, working from the middle of the boat toward each end. The last rib is almost always made in two pieces due to the extreme bend at the keelson. On many boats, the second to last rib may also need to be made in two pieces.



In this boat, you can see the last two ribs have been beveled to the keelson and to each other. They are then glued and reinforced with a small piece of ash from a cut rib. The second to last rib can normally be bent into this shape in a single piece. It may help to reduce the thickness of the rib in the middle where it contacts the keelson, which helps it to make the severe bend.