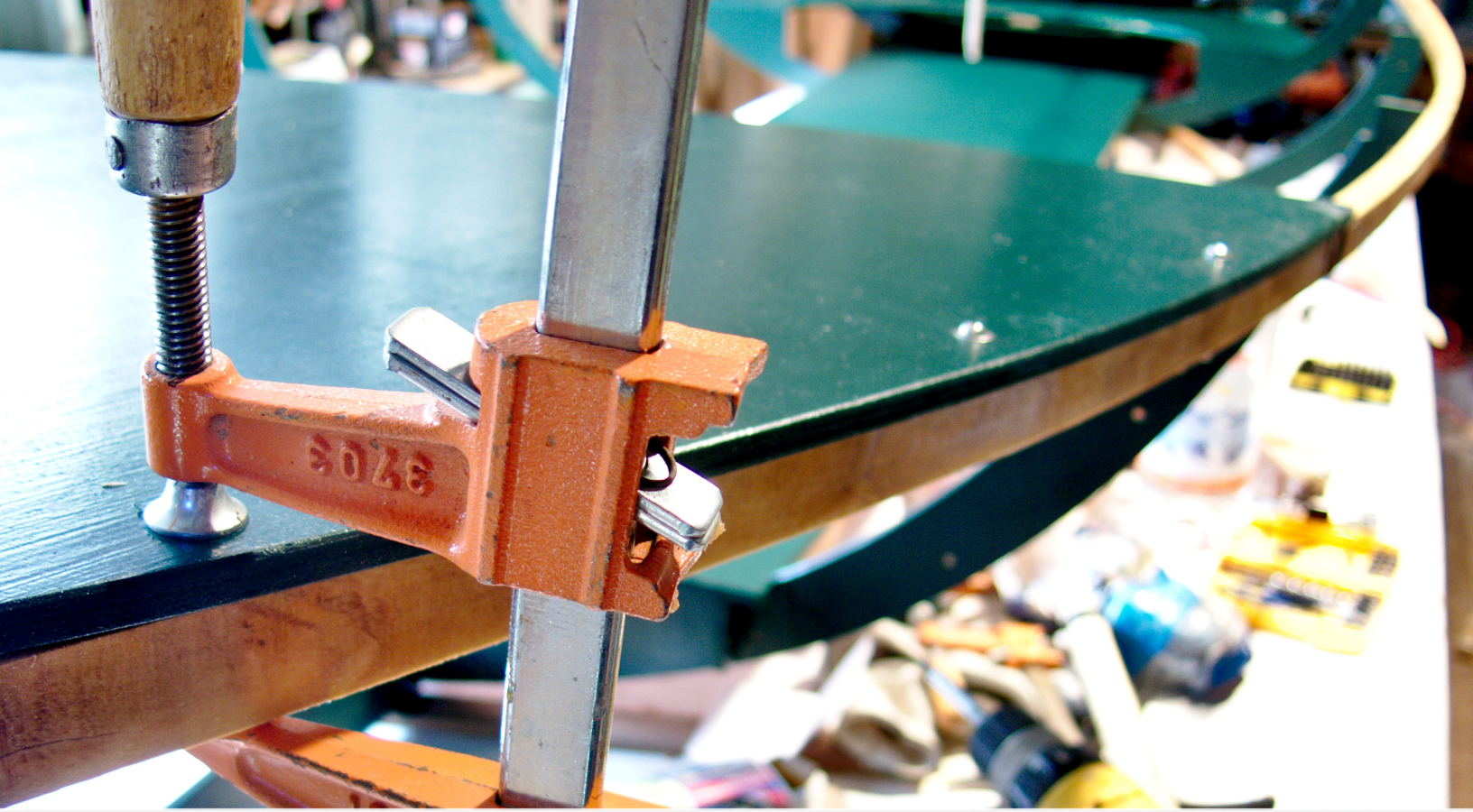
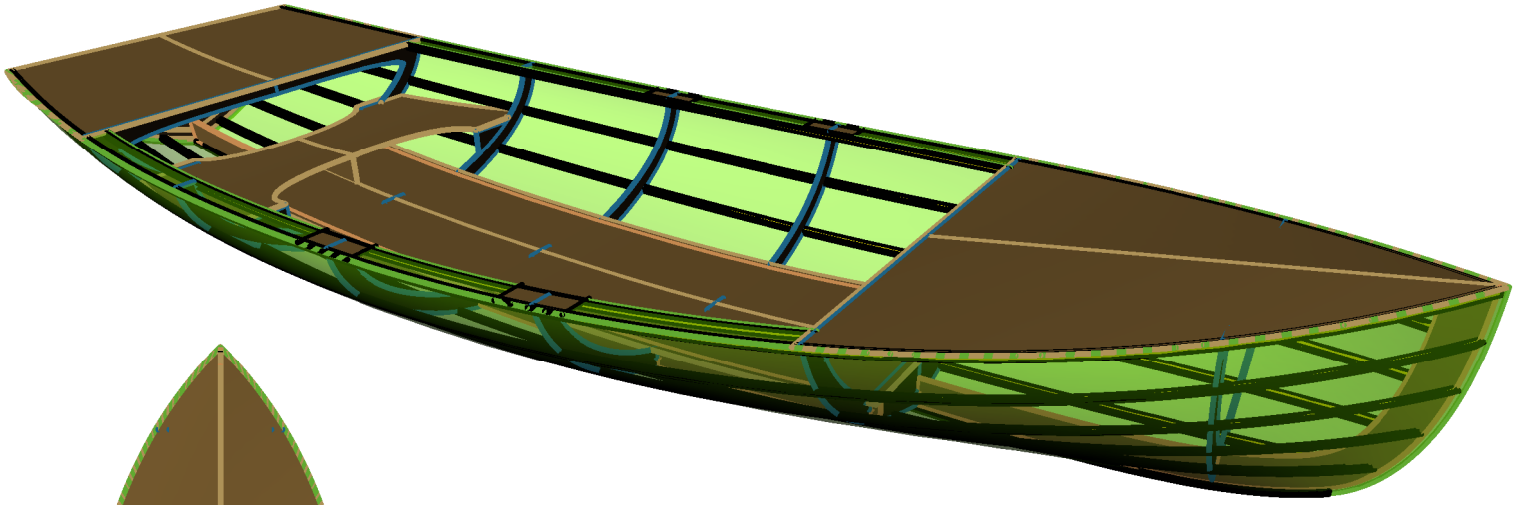


Building the Pacific Loon

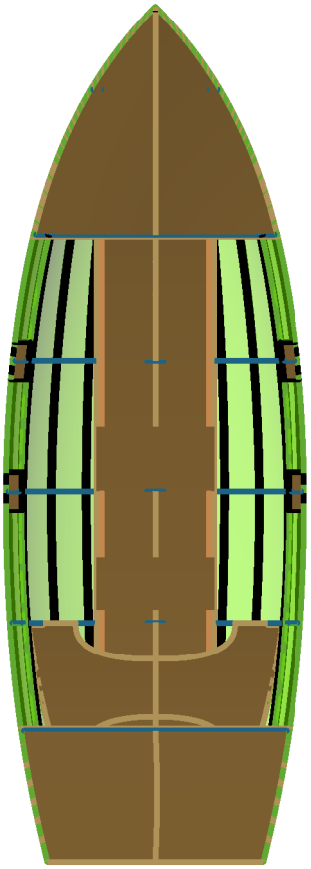
A guide to assembling a 13' 4" camping rowboat

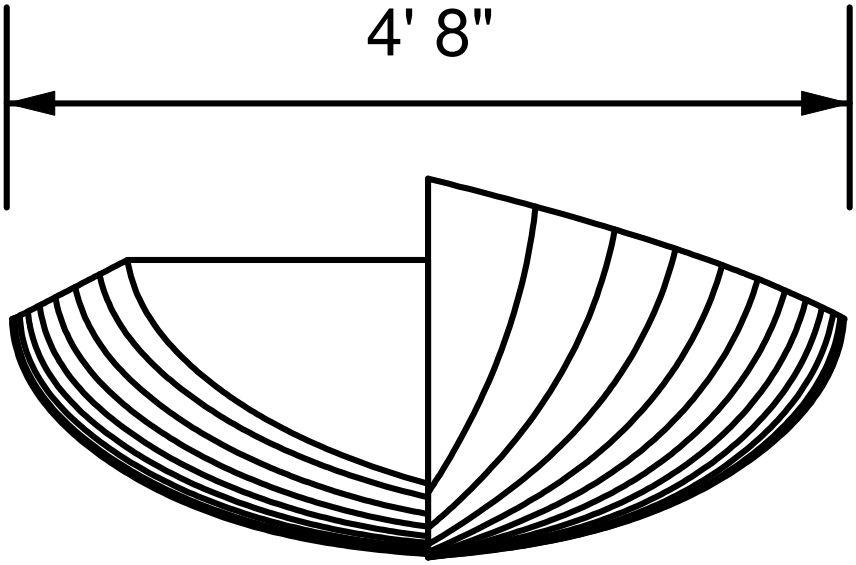
Hermit Cove Boats

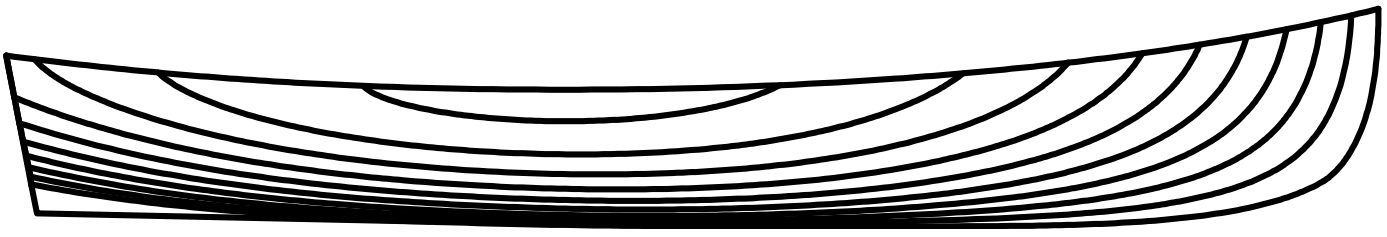
http://www.hermitcoveboats.com

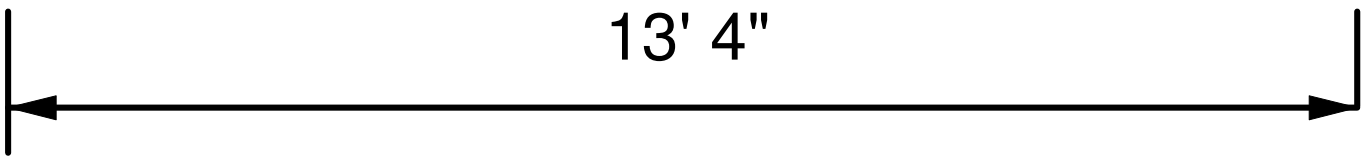


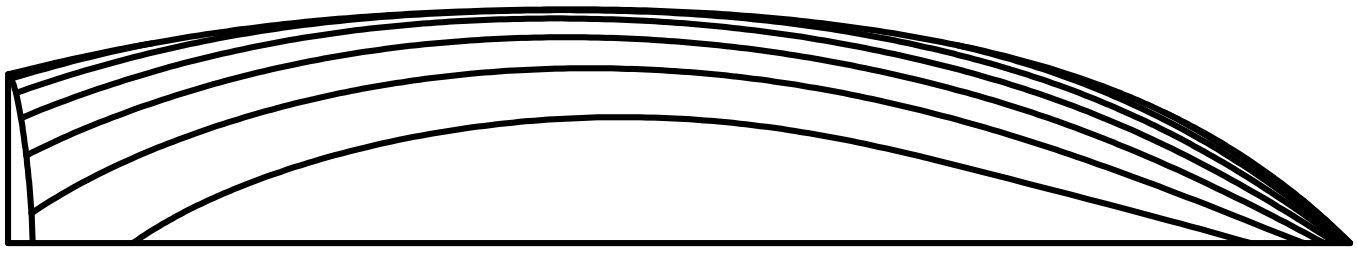
The Pacific Loon











Contents

1. Introduction

We are going to build a skin on frame rowboat. Unlike traditional boats where the hull is both structure and waterproofing, this style of boat uses a flexible fabric of some kind stretched over a frame. The fabric keeps the water out and the frame gives the fabric the correct shape. This is a very quick and simple way to build a boat, but you have many choices along the way. This guide walks you through those choices step by step, but requires your active participation. This is not a Lego kit, where following each step precisely will lead you to the desired end. Instead, this is a process where you build your own boat, so you must take steps to be sure that it is the boat that you want.

You can either buy the full sized plans, or you can trace the shapes onto plywood using the pdf somehow (see appendix A). Once you have the plywood parts in hand, the construction process is divided into a few big steps:

1. Assemble the plywood frame. This is done in 3 stages. At the end of this step you will have a frame that is upright and resembles the boat, but requires external support. Add the bow and stern cleats at this time, to aid the external support
2. Sand and paint the top half of the frame
3. Attach the gunwales to the frame, using both bolts and lashings
4. Turn frame over and sand and paint the bottom half
5. Lash the stringers to the frame
6. Stretch and staple the skin to the frame
7. Coat the skin
8. Attach the gunwale pads and oarlock sockets

9. Go for a row

The first step hides the most complexity. There is no mold or strongback to hold the boat together in its partially built state. This saves time, and reduces complexity overall, but you must manage the incomplete frame carefully. It is best to work in three stages, assembling the middle of the frame, then the stern, and finally the bow. Until the gunwales are in place, the bow and stern sections will need extra support. I like to already have the cleats in place, so that I can tie lines fore and aft to support the ends.

Figure 1.1. Plywood parts

Between each round of assembly, there is an enforced waiting period as the epoxy hardens, or the paint dies, or the coated skin cures. The construction time for the Pacific Loon is determined by drying time more than it is by human labor. “How many hours does it take to build?” “Well that depends. How hot and dry is your work space?” It is possible to finish in 6 days; but working at a reasonable pace it should not take more than 4 weekends.

There are many choices for skin and coating, and every possible choice is the correct one for some use. Therefore the purpose of the boat must be considered. For more detail on those choices, see appendix B. That said, I strongly recommend ballistic nylon, 12 oz weight or greater, and the two part urethane sold by Corey

Freedman of the Skin Boat School in Anacortes, WA. These are incredibly tough and easy to work with materials.

2. Gathering tools and materials

The first step in construction is to cut out all of the plywood parts, either using the full sized plans, or by using the electronic plans and lofting or projecting the lines onto the plywood. You can use any sort of plywood, I suppose, but I strongly recommend ⅜" (9mm) marine grade plywood. In any case, be certain to use plywood with a waterproof glue binding the various layers. The plans include notches where the plywood slots together. If your plywood is not exactly ⅜", you will want to use a sample from the plywood to trace the notches over the plans. A tight fit for the notches is desirable.

In addition to the plywood parts, you will also need:

1. Stringers (see below for dimension information)
2. Lashing twine
3. Curved needles for sewing
4. Skin (synthetic fabric)
5. Coating for the skin
6. Paint for the plywood frame
7. Glue (two part epoxy)
8. Staples (monel)
9. Clamps
10. Staple gun
11. Drill
12. Japanese pull saw, or equivalent

13. Hardware for attaching the gunwales to the deck
14. Hardware for attaching the gunwale pads to the gunwales
15. Hot knife for cutting the skin

The pull saw will cut the extra parts of the stringers that hang past the bow and stern. A Japanese pull saw is ideal for this purpose. The staple gun is for monel staples, which are only available in Arrow size "T50", so be sure to have the correct staple gun. The drill will be used to make holes in the gunwale braces for screws and oarlock[1] sockets. The hot knife will cut the edges of the skin so that the fabric won't unravel. There are some really nice hot knives out there, but I found the little 40 watt kind used for burning patterns into wood carvings to be perfectly adequate.

You might also want copper tacks for a nice finish on the decks where the staples remain visible.

2.1. Stringers

The hull shape is formed by the parts that run fore and aft called stringers. Stringers must bend easily, but also be stiff enough to keep their shape over the unsupported span between frames. Because the stringers are lashed to the frames, and not constrained in a notch or channel, any diameter and cross sectional shape can work. Wood is ideal for stringers with its combination of strength, weight, bendability, and low cost. But feel free to experiment: PVC is quite bendable, but may be too weak to span the frames rigidly. Aluminum rods are very bendable and strong, but expensive. Also consider bamboo or ocean spray[2] branches for an uneven but very strong and light alternative. The gunwale stringers must be a material that takes staples, or you must have some plan of your own for stretching and attaching the skin without staples.

For an excellent choice, I recommend sticks ¾ inches on one side, ½ inches on the other, cut from boards of clear vertical grain yellow or red cedar. For the gunwales, which have a harder life (you tend to lift the boat using them, and they support the

[1] The oarlocks (called rowlocks in the UK) connect the oars to the boat. The oarlock either surrounds the oar or supports the oar, and inserts into the oarlock socket. The oarlock turning in the oarlock socket provides the leverage and smooth motion needed for rowing.

[2] A bush with very straight branches, used in making arrow shafts, for instance

oarlocks), use a larger sized stick. ⅝ by 1 inches is large enough to take the gunwale pad bolts, but not so stout that bending becomes impossible. Red cedar looks the best varnished and costs less, but you need a very high grade (sometimes called "boat grade") of red cedar. Nothing beats yellow cedar for pliability and even grain. Both are rot resistant and the stringers have an easy life with great ventilation, so it is unlikely that the wood will develop rot unless severely neglected. Douglas fir is a great wood, but it has big grain so choose your boards carefully. Any other type of wood that will take the bend will likely be good enough. Varnish is optional, but know that it will be very difficult to keep the finish looking sharp, so choose a durable varnish.

For the gunwales, you will need a pair of sticks at least 8' 6" feet long, and another pair at least 11 feet long. For the rest of the stringers you will want nine sticks at least 14 feet long. If you are trying to get away with shorter boards, the shortest stringer is the keel stringer, at roughly 13 feet. The stringers get longer as you move towards the gunwales. But it is much easier to cut all stringers to the same length and not have to sort through them. You will also want an external rub strip, called a bilge runner, to go on the outside of the hull along the keel. I use the same wood as for the stringers, bringing the total needed to ten.

Part	Ideal Dimension	Quantity
Inside gunwale	8'6" x 1" x ⅝"	2
Outside gunwale	11' x 1" x ⅝"	2
Hull stringers	14' x ¾" x ½"	9
Keel bilge runner	14' x ¾" x ½"	1

Table 2.1. Summary of lumber requirements

The lumber you need will not be available off the shelf. If you have a table saw, you can use larger boards and rip them down to size, or pay your local lumber yard to do the cutting for you. Ideally, you can find boards that are already ¾ or ½ inches in one dimension, and then rip the boards to the other width. This way you minimize waste, and produce the least sawdust. Using a narrow blade also helps reduce waste (I used a blade from a battery powered circular saw in my table saw. A tiny little blade, but then the stringers aren't so big either).

2.2. Skin and glue, hardware

You will need epoxy and a thickener for gluing the plywood parts together. For thickener, I use fine sawdust, though a wide variety of commercial thickeners are available.

You will need twine for lashing the stringers to the plywood frame, and also for sewing the skin together if you are working with two parts of fabric. Twine is sold in a wide variety of confusing designations, sometimes given three or four different designations all at once. You will want something waxed or tarred, so that it will hold tension well. I suggest “artificial sinew”, which in a land of numerous size designations is sold without any dimension to describe it at all. The lashing material you want is small enough to allow many turns while remaining compact, but not so small that it will cut into your skin as you pull on it.

You will need staples to hold the skin in place once you have stretched it. You might later opt to use copper tacks instead, hammering them in place and then removing the staples. But if any staples remain on the boat, they must be monel, a metal alloy that does not rust. Ordinary staples won’t last a year, and the word “stainless” is misleading at best.

You will need nuts and bolts to hold the outside gunwale to the fore and aft decks. These should be thick enough to go through your chosen gunwale dimensions, plus the plywood of the deck. Use three per side in the front, and two per side in the back, for a total of 10 nut/bolt sets. These spots will be hard to reach once the boat is skinned, so use nylock nuts or lock washers to make sure they stay put. Ideally, you will use bronze hardware here, but it is not a critical part of the boat in the long term, so stainless or galvanized hardware will work well enough.

You will need skin material, likely nylon or dacron, and an appropriate coating for that skin type. I strongly suggest you choose nylon (12oz is a good weight) and Corey’s two part urethane coating. For more materials recommendations, and a discussion of skin material and coatings, see appendix B. For materials sources, see appendix D.

3. Gluing the plywood parts

One never has enough clamps, so go out and buy some more now, no matter how many you already have. I'll wait.

3.1. Working with epoxy

Got more clamps? Good.

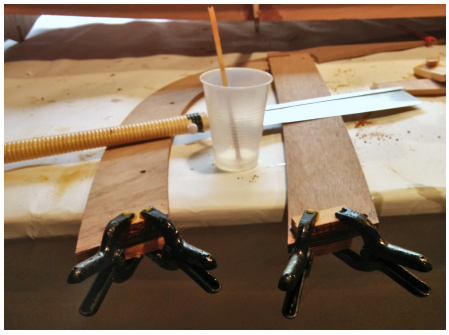
I strongly recommend epoxy for gluing parts. The core strength of this boat comes from the glue joint that runs along the cockpit sole. You can use any waterproof glue and not be called insane, but be aware that good coverage of the plywood contact points is critical, and some glues like Titebond shrink as they dry. Epoxy gives you a limited working time before it hardens, so it is important to already have practiced the assembly steps (dry fit) to prevent surprises. Those surprises may take some time to address, and you don't want the epoxy to harden while you puzzle it out.

If you've never worked with epoxy, there are some things to keep in mind. For one, different kinds cure at different rates. If you are working in a hot condition, you may want to use a slow hardener to give yourself more time. Also, larger batches cure faster than smaller batches, because the heat of the reaction is greater in larger containers. I suggest using epoxy on some test subject first, to get a feel for how it flows, how long you can work with a batch, and so on. Practice thickening a small amount as well, so you know how to reach the correct thickness. For more information on how to work with epoxy, refer to appendix D, under "West System Epoxy User Manual".

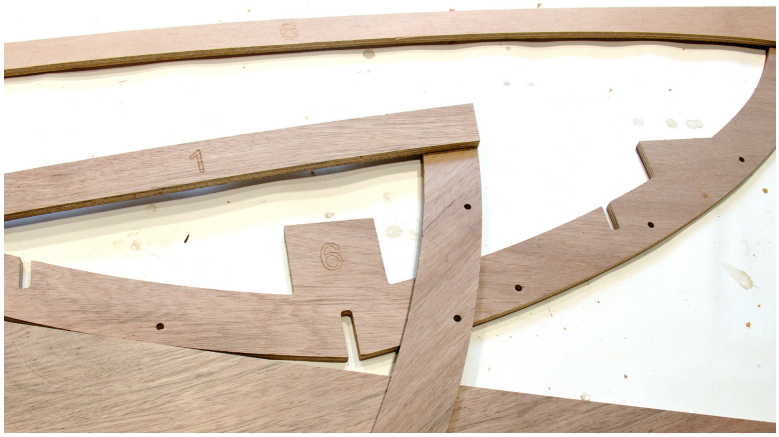
3.2. Assemble two part frames and transom first

Some elements of the boat are drawn in the plans as two parts though they are logically a single part. This is done to save plywood. To make the dry fit process

(a) Clamping frame 1



(b) Front and back keel parts with sticks to increase width



(c) Frames 1 and 6, ready to be clamped

Figure 3.1. Preparing plywood parts made from two peices

simpler, glue and clamp these ahead of time. The pieces that are made from two parts are the transom and frames 1, 2, and 6. See figure 3.1a.

The transom has two parts, one is the most substatial while the other part acts as a smaller border for the larger part. Each has holes drilled for lashing the stringers, and they should line up. When they are assembled, the two parts form a notch on the inside of the hull for the stringers to fit into, and a ledge on the outside for stapling the skin. This outside ledge also acts as a cutting and gluing guide for when you finish and waterproof the skin.

For the frames, there is the larger U-shaped part and then a cross piece. On frame 1, you just need to glue the two parts together. On frames 2 and 6, the inside gunwhale is meant to fit snugly into a notch. That notch is drawn on the plans as a dotted line because it should exactly match your gunwale dimensions. Before

gluing the second part across the tops of frames 2 and 6, use your gunwale to trace the correct notch onto the frame, and cut that notch out. This way you get a notch in the frame, but not in the cross piece. This notch will hold the inside gunwale securely.

You should also address the bow and stern keel plywood parts at this time. These parts meet the bow and stern decks at right angles, so the edge of the plywood must glue to the surface of the plywood decks. This alone will not yield a strong enough joint. To solve this problem, take some offcuts (you will probably have plenty from your stringers) and glue them to the ends of the bow and stern keel parts, so that they align with the edge of the plywood and provide a wider surface. See figure 3.1b.

3.3. Dry fitting the middle section

Now that you have assembled the two-part frames and transom, you can temporarily put the parts of the middle section together to be sure of how they fit.

The cockpit sole[1] runs front to back, and the two spines[2] run along its length. Five of the six frames[3] slot into the spines, where they define the shape of the middle of the boat. Later, the bow and stern will connect with this middle section to complete the boats shape. Because the bottom of the boat is curved, you will want to use spacers (anything at hand, a box, offcut lumber) under the sole. This way it will take on the correct bend more naturally. You can see the spines and frames propped up this way in fig 3.2.

The order of the frames is important and they look very similar. To help you, they are numbered 1-6, with 1 being closest to the bow and 6 closest to the stern. The direction of the spines is also important, so the notches on the spines are labelled 1 in the front and 6 in the back. The cockpit sole is the same on both ends, but you will want the guide lines facing down towards the spines. Frames 2 and 6 have a notch that is backed by plywood. This notch should face inwards so that

[1] The floor of a boat, often the interior space or where your feet rest, as distinct from the deck, which is often higher up.

[2] The spines are the parts that connect the frames and the sole together. The resulting box section gives the boat stiffness. I am using the term spine here by choice, it has no special meaning in boat construction

[3] The transverse structure that gives a boat its cross-sectional shape

Figure 3.2. Test fitting the frames and spine for the middle of the boat

later the inside gunwale can slot into the notch. This means that frame 6 should have the notch facing forwards and frame 2 should have the notch facing aft.

Once all of the parts are in place, check that everything is lined up, that the cockpit sole is centered on the spines, and that the spines meet the frames at right angles. Once everything looks lined up, try using your clamps to keep the loose parts correctly placed. Use clamps to keep the cockpit sole in contact with the spines over the whole length. It is important to be sure how you will use your clamps ahead of time, because when you start working with the epoxy, you will have limited time before it hardens. You must make sure all of the epoxied parts are in firm contact when that happens.

The underside of the cockpit sole is marked where the spine meets it. These guide lines will help you apply the epoxy to the correct spot, and to line up the spines when you clamp them together.

3.4. Gluing the middle section

Before you start work, make sure you have extra epoxy and thickener handy. First, apply glue to the cockpit sole where the spines will set. This process is called "wetting out". By putting glue on both sides of the joint, the hope is that when they are clamped together, there is an excess of epoxy between the two and no dry spots remain. Use the lines on the cockpit sole to apply epoxy in the right place. Then wet out the tops of the spines, one at a time. After each is wetted out, set them on the wetted line along the bottom of the seat. Carefully use clamps to hold each spine in place. The spines are under some pressure to hold the thwart in a curve. It can help to prevent the spine buckling and twisting if you already have the frames (or at least one frame) in place. Once both long spines are clamped down, slot all the remaining frames into position.

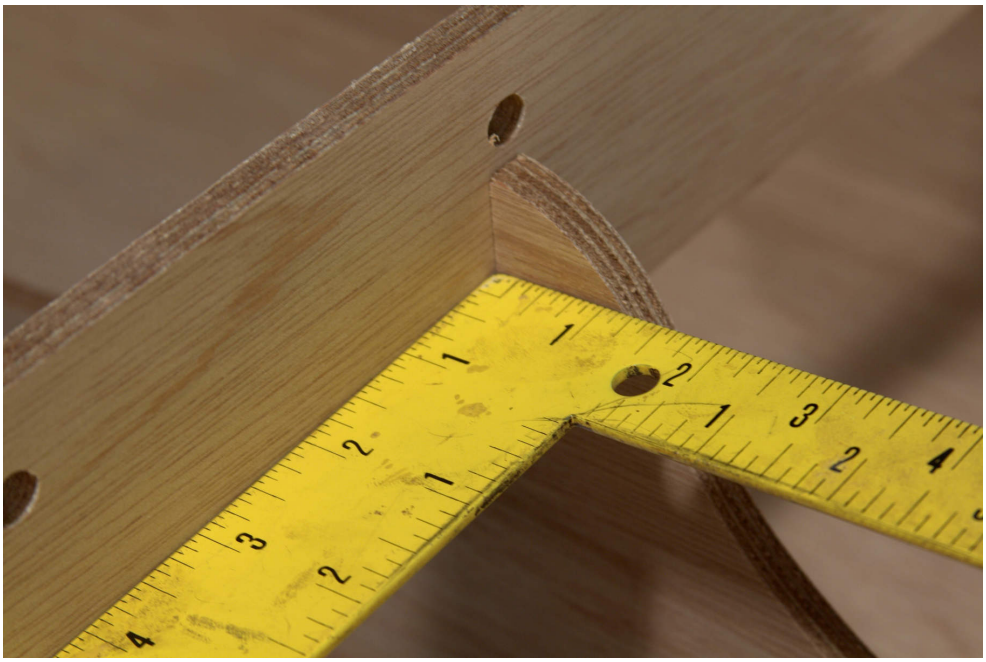
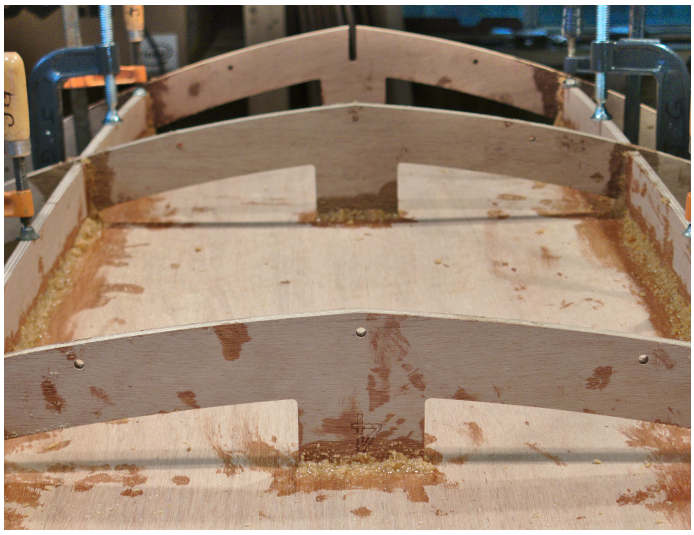


Figure 3.3. Checking frame alignment

Now that you have gotten the spines placed and glued to the thwart, you need to glue the frames meet the spines. Take one frame out at a time and wet out the slot on the spine and the slot on the frame so that when you put them together, the surfaces where the two parts touch are nicely coated. Repeat until all are coated. Now that the parts are about to be permanently secured, make doubly sure that

everything is even, that the thwart is centered over the spine, and that the frames are square with the spine (fig. 3.3).

(a) Applying epoxy



(b) Clamping the parts after applying epoxy

Figure 3.4.

Next, add thickener to the epoxy until you get a peanut butter consistency. Use it to coat the wetted joints. Apply it like toothpaste and smooth it with a stick or gloved finger to get a nice smooth line. This extra epoxy creates a ”fillet” and adds a lot of strength to the joint between thwart and spines. It is easy to make a mess in this step. Keep in mind that whatever mess you make will later be rock hard, and you will need to clean it up with sandpaper. A little extra care and neatness here can save a lot of time later. Now we wait for the glue to dry. If your clamps are numerous indeed and well placed, you might be able to skip ahead without waiting for the epoxy to cure. Usually it is best to wait a full day for the epoxy to cure.

3.5. Cleats

At this point, you may elect to install bow and stern cleats. These will be of critical importance when using the boat, a place to tie to the dock, a place to tie your anchor, a place to tighten your tent down against the weather. It is also a handy place to grab the boat when carrying it around. But for now, the cleats will be

handy in the next step to provide tension (see fig. 4.3). Don't be tempted by small cleats, and don't bother with heavy duty metal ones either. Look for large plastic cleats. To make the cleat attachment to the deck stronger, use a backing plate (see fig 3.5). The backing plate can be made of the same plywood as the rest of the boat, and acts to double the thickness of the wood. Use bolts to attach the cleat with big washers and nylock or locking washers. The backing plate helps to reinforce the bolts, and the washers help to spread the load over more area. When placing the cleats avoid the spot where the frames and bow keel parts intersect the deck. An inch or so back from the stern, and four or five inches back from the bow should be good.

Figure 3.5. Backing plate

3.6. Gluing the stern section

To glue the middle section, it was most convenient to work with the boat upside down. Now that we are addressing the stern, it is most convenient to have the boat right side up. Turn it over, and repeat the dry-fitting step as before. This time, we must dry fit the aft-most keel part into frame 6, clamp the transom to the wider end of the aft-most keel part, and then clamp the aft deck to the transom and the top of frame 6. Also, the aft seat can be installed at this time. I found it

simpler to do this in 2 steps, first just gluing the aft-most keel part to the transom (see fig 3.6a), then proceeding to place the aft seat, mount the transom to frame 6, and clamping the aft deck into place. The aft deck will fit at an angle to frame 6 and the transom. Because the plywood parts have square edges but meet at an angle, there will be a gap between them. This void will be filled with thickened epoxy, ultimately creating a stronger bond than would be present if the plywood parts mated more exactly (see fig 3.6b). They will be harder to clamp into place than the middle section, however. If your clamps have a hard time reaching where they need to be, consider using off cuts from 2x4s or other handy items to build up areas that are too recessed for clamps to reach.

(a) Gluing transom to the keel

(b) Getting the clamps right for the aft deck and seat

Figure 3.6.

The little aft most keel part will be more than strong enough when it is working in tandem with the stringers and the skin, but at this stage it will be strained by holding up the aft deck part. This will be especially true if you are working in a shop with some space limitations, and the stern is hanging over your table. Take care to reinforce the frame at this time so that the glue can dry without any unnatural twist or sag. I used long blocks support the stern as it overhung my table, and to raise it so the stern could be supported at its higher level. Another approach (see fig 3.7) is to support the stern from above using ropes.

Once you have a good clamping system, remove the clamps and repeat the

(a) Supporting the stern with boards

(b) Supporting the stern (and bow) with ropes

Figure 3.7.

wetting-out and thickened epoxy filleting from the previous step. Let the epoxy dry if you think you will have trouble continuing without moving the boat.

3.7. Gluing the bow section

The bow section is much like the stern, in that it must be supported and clamping must be carefully considered. But it adds one more complexity: you need to create a bit of a curve for the bow to meet the front most keel-part, and frames 1 and 2 in the correct place. But until they are in place, there is nothing to enforce that bend.

One approach is to begin by getting the bow deck clamped to frames 1 and 2. Then, attach a clamp with a long shaft to the bow, and tie it back, thereby bending the bow deck into the correct bend. You will also need to clamp the bow deck to the front most keel part, where the extra sticks have been glued to increase surface area. See fig 3.8b.

Another approach is to run a few extra boards underneath frames 1 and 2, such that two run fore and aft, and two run underneath them abeam[4]. Then pinch the bow deck part down using clamps that span between the deck and the boards running abeam. See fig 3.8a.

The bow deck section wants to meet frames 1 and 2 as they rise out of their notches directly, without allowing them to bend fore or aft to reach the deck. But

[4]Arranged from left to right in the boat, rather than front to back

if you do this without bending the bow deck, it will then not meet the front most keel part at the correct angle. If you use the above techniques you will get your bend, but you must be aware of one more challenge: the force placed on the front most keel part by the bend will be translated back to frame 2 where the keel part ends, and the force can bend the frame slightly out of shape. To counteract this, relieve some of the bending pressure use ropes to lift the bow end, or by using a rope to connect the bow and stern under tension, creating a bend the other way. If you have placed the cleats already, this is a handy place to attach the rope.

Once you have a good clamping system (a little bit harder here in the bow!), remove the clamps and repeat the wetting-out and thickened epoxy filleting from the first step.

Excellent work!

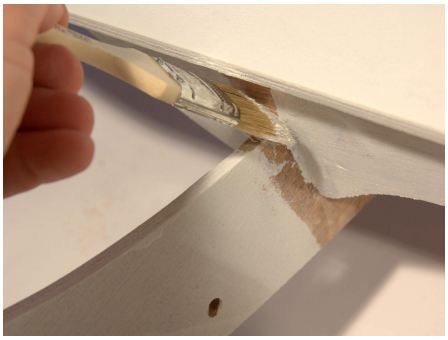
(a) Creating a bend using external boards and clamps

(b) Creating a bend using clamps and rope

Figure 3.8.

4. Sanding and painting the frame

Now that the glue has dried, you can sand the frame. The frame won't be easy to turn over until the gunwales are attached, so you should sand and paint the surfaces that are easily reached, move on to the next chapter for instructions on attaching the gunwales, flip the boat over, and then repeat the sanding and painting process for the underside of the boat. The sanding and painting is mostly to acheive a nice finished look, so you can go easy on the underside of the cockpit sole. Start with a medium grit paper like 80, and then finish with something finer like 200 grit. I used an orbital sander. A tiny sander (for instance the Black and Decker "Mouse") would be helpful for reaching nooks and crannies around the frames and spines.



(a) Painting the nooks

(b) Rolling the edges

Figure 4.1.

Marine plywood uses waterproof glue, but if the wood becomes very wet it may swell to the point where it pulls itself apart. A very thorough person would epoxy the edges of the plywood where most water is absorbed. But even a person in a big rush should at least paint the frame. The paint provides some protection for the plywood. The color you paint the frame may depend on the type of skin coating

you use. See appendix B for more information. Some paints are very thin, and if you don't want the plywood edges to show through, you will need to sand carefully and use a thick primer first. The edges of the plywood, unless sealed earlier with epoxy, will drink the most paint. You can skimp on the paint under the cockpit sole, but be sure to get as much paint as you can on the bottom of the frames.

Surface preparation is the key to a good paint job. You can use a fairing compound[1] to cover any big blemishes. Sand thoroughly to smooth out wood grain, plywood edge texture, and areas that have fairing compound. Also, when painting, use a high build primer so that the first coat of paint also helps to cover unwanted texture.

The best technique for painting is called "rolling and tipping". You start with a roller to apply paint to a small area. Then you follow up with a brush, holding it at a shallow angle to knock down the knap left by the roller. The brush itself collects paint rather than applying it. For a uniform finish, work methodically, rolling and tipping one area, and then overlapping that area with the next while the previous area is still wet. You can find good guides on "rolling and tipping" online, links in appendix D under "Rolling and Tipping".

Figure 4.2. Plywood frame, the top sanded and painted

At the same time as you are sanding and painting the frame, it is a good idea to also sand and paint the gunwale braces, so you don't have to wait for paint to dry

[1] Similar to thickened epoxy, this is glue with some material in it. The glue is chosen to be a little softer than epoxy, and the material chosen to be easy to sand. You can build up a damaged area with the fairing compound, and then sand it all back to level again.

twice. Also, if you choose to varnish your stringers, this might be a good time to varnish them as well. Its best to combine as many “wait to dry” steps as possible.

Let the paint dry. Usually 10 or more hours.

Nice job!

Figure 4.3. Plywood frame, preparing to paint the underside

5. Attaching the gunwales and stringers

After painting the top, you should have your boat right side up, painted, and its delicate ends supported by various contraptions. It is time to make the boat strong enough to be turned over. Attaching the gunwales will do just that.

5.1. Gunwales

This is an important moment for the boat. The final sheer and length will be decided once the gunwales are attached and bolted to the bow and stern decks. Attach the gunwales correctly, and the boat will be shaped correctly. Attach them incorrectly, and the boat will never take on the correct shape.

Fortunately this important step is also a relatively easy one. The procedure is:

1. **Bolt the outside gunwale to the aft deck** Using one of the longer gunwale sticks, clamp it to the stern deck, so that it passes through the notch in frame 6. The stick will extend straight out away from the boat at this point, and will not be stable on its own in this position. Use a temporary lashing to frame 5 to help hold it, or several clamps on the stern deck. The gunwale should extend back under the deck for about 12 inches. It should be slightly inset from the decks edge, unless you have chosen a large gunwale width. Drill a hole through the deck and the gunwale near the inside edge of the deck. Use as small a bit as possible to make a hole your bolt will fit through. We don't want to unduly weaken the gunwale stick. Drive your bolt down from the top deck and secure it with a nylock nut or nut and lock washer. Now repeat the process near the end of the gunwale stick. Once these two bolts are in place, the clamps will no longer be needed.

2. **Clamp the outside gunwale to the forward deck** The process is much the same for the forward deck. This time though, the deck is more curved, so more clamps and a more careful application of force will be needed. Cut the gunwale so that it extends under the forward deck until it nearly reaches frame 1. When you place the first clamp, it defines the distance that will exist between the fore and aft decks, and therefore the total length of the boat, and the degree of sheer that will be present. The bend should be such that almost no pressure is placed on the middle frames (frames 3-5). To be sure you have the right length, once you have placed one clamp, measure the straight distance between the outside edges of the bow and stern decks. This should be 92 ¼", but if it is slightly off that is OK. It is most important that you find the same measurement on both sides. Have someone help you if you need to trap a lot of tension between the deck and gunwale to get the correct measurement. If you haven't already, consider tying a line between the bow and stern cleats to create tension between them.

3. **Bolt the outside gunwale to the forward deck** Drill holes for three bolts, attaching each bolt before drilling the next hole. Put one hole near the edge of the deck, one near the middle of the gunwale-deck overlap, and one near the end. Use clamps to trap the gunwale in a bend that matches the curvature of the deck. At the end of the gunwale, if the wood will allow the extra bend, try to bend it even further under the deck. Do this because if the gunwale is close to the edge of the deck here, it will protrude as the skin curves inward. If you can't move the gunwale in far enough that it doesn't interfere with the boats lines, you will want to shave it down with a chisel or draw knife.

4. **Repeat** Now do this same thing on the other side. This time pay extra attention to your measurements, so that the decks are equally far apart on each side.

Excellent! The boat should already be much more rigid. Now we move to the shorter gunwales, placing them on the inside. These need to be cut to a precise length, and then settled into the notch between the frames and the decks. Take one end of the inside gunwale stick and set it into the notch on one end of the boat. Then bend the gunwale into the approximate shape that it will take when it is set into the other notch. Mark where it will set with a pencil. It will be tricky to mark this point because it is flush not with the top deck, but with the upper part of the

Figure 5.1. Check for the correct length before bolting the gunwales

frame, which is inset from the deck by the width of the plywood. You can estimate, as long as you estimate by cutting too long. This is a good policy in any case, as it is difficult to estimate length when the wood will bend into place. Once you've

cut the gunwale, attempt to bend it into place, mark a new line, cut again. Do this until you get a slightly snug fit.

5.2. Lashing technique

There are several different kinds of junctions to lash on the Pacific Loon. There are the intersections between the frames and the stringers. There are the intersections between the frames and the gunwales. There are the intersections between the bow keel part and the stringers at the bow. And there are the ends of the stringers at the transom. Slightly different lashing techniqes are appropriate in each case. But they are made up from the same building blocks: a bowline knot to attach the twine to something, wrapping turns around the two things to be lashed, wrapping turns around the lashing itself to tighten it, and hitches to finish the lashing and keep it from unraveling. Don't get caught up trying to follow the directions perfectly: if you are able to get the parts to hold together tightly, you've done it correctly.

First lets consider the most frequent lashing type, where a stringer intersects a frame. To start lashing, tie your line using a bowline to a hole in the frame (fig 5.2). Then loop around one side of the stringer, back through the hole, and then around the other side of the stringer. Leaving it loose at first and passing through a few times means that as you tighten the lashing and bend the stringer into place, you can rely on the friction of the lashing to easily hold tension while you rest (fig 5.3). Finish the lashing by tightly wrapping a few turns around the other way, between stringer and frame like a belt around the waist of the previous turns, and then finish tying it off with a few hitches and a rolling hitch (fig 5.4). See appendix D for how to tie these knots. Be careful that while lashing the stringers into place, you don't force any twist into the plywood frames. They bend out of shape easily until lashed in place. The lashing should be tight enough that once the stringer is lashed to the frame, they can't move back and forth.

Next, consider lashing the stringers at the transoms. This is a little bit different than at the frames, because you can't go around both sides of the stringer to get a nice strong purchase. Instead, tie your bowline onto the stringer itself, go through the hole transom hole, but then take a turn around the stringer before going back through the hole. This gives more friction for the lashing to pull with, and keeps the lashing from falling off of the sides of the stringer.

Next, consider the gunwales. Here and inside and outside gunwales share the

Figure 5.2. Start by tying a bowline through the hole

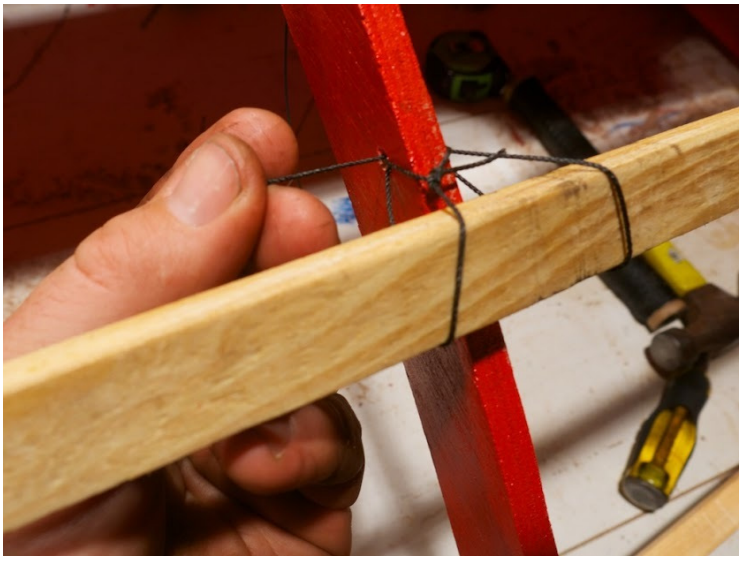


Figure 5.3. Several loops, then tighten

same hole, and must be pulled down tight into notches. The only real difference in lashing here is that you must pull down and in to make the stringer sit in its notch. When you have pulled down and in hard enough, wrap the lashing around the stringer several times to help keep the stringer in place before trying to run the lashing through the hole in the frame again.

Finally consider the bow. Here both stringers (port and starboard) share the

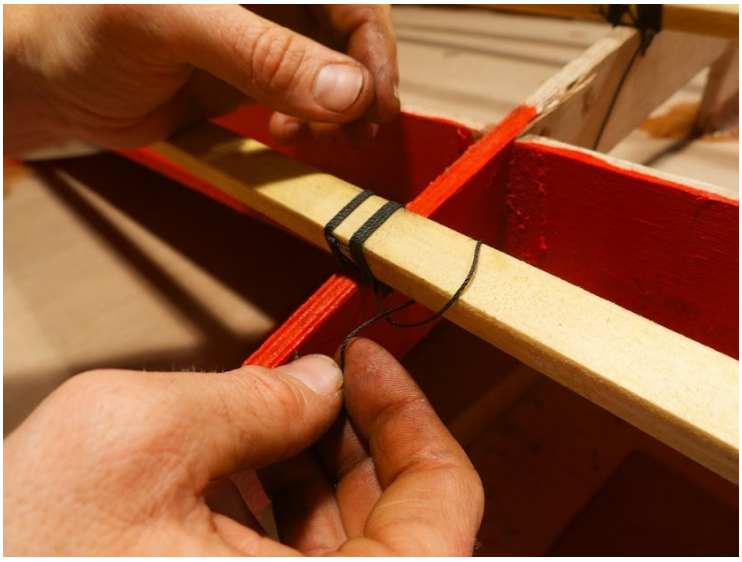


Figure 5.4. More loops to lock in the tension, then finish with several hitches

same hole, as with the gunwales. But you have an advantage in the bow because you can lash the stringers to one another, and then pull on both equally as you tighten the lashing.

5.3. Lashing the gunwales

Now you should have both gunwales in place on each side, and a boat that is even on both sides. It is time to finish the gunwales by lashing them to the frames. Be sure that you do not bend the frames out of place when lashing the gunwales to them, it is easy to do at this stage when they are not lashed to anything else. You might accidentally move the frame out of true front-to-back, or you might bend the frame in or out when bringing it together with the gunwales.

The general lashing technique is covered below (see section 5.2). The lashing for the gunwales has to hold the gunwales in place in the notches provided. The lashing must then pull downward and inward for frames 3, 4, and 5, and must just pull inward at the ends, for frames 2 and 6.

5.4. Lashing the stringers

In this step, each stringer is lashed to each frame as well as to the transom. The lashings are tight, and once they are in place there will be no movement between the stringers and frames. If you have nice, knot free vertical grain wood, this step will be a joy. If not, you may break a few stringers in the effort. Its good to have a few spares.

Once the stringers are lashed to the frame, it will be very difficult to paint or varnish them. So before lashing, make sure the stringers are finished to your satisfaction. When the finish wears off, it will be hard to replace, so choose a durable coating, or leave the wood natural. On some boats I've used "Natural Teak" Cetol, which is a durable product, and on others left the wood natural. If the wood is kept dry most of the time, by simply turning the boat over for storage, its life should be very long indeed. The stringers get enviable ventilation.

The shape of the hull is dependent on the placement of the stringers. If you lash them evenly, not trapping any twist or bend in the plywood frame, then the final boat shape will be correct. That said, don't get hung up on exact placement. It is most important that you be consistent, using the same kind of stringer, and the same lashing pattern, for each point. You will be trapping a lot of tension into each stringer at first, as you bend them from frame to frame. In the end, the tensions will even out and the wood will relax into its new shape. However at first the bends are difficult to achieve. Keep these tips in mind to make the process easier:

1. **Work slowly** If the wood complains or is hard to bend into place, try lashing it into a partial bend, and take a break. Forcing a bend quickly will break wood that would happily move into place if given time. Even if the wood is agreeable, your hands will get tired. Again, use the lashing to help you, letting it take the strain while you rest.

2. **Start from the keel stringer** The frames are loose until lashed to the stringers, so you must be careful not to lash them in a bent shape. The bottom most stringer attaches to the frames where they are most rigid, under the thwart. By starting here and moving port and starboard out from the keel, you arrive at the gunwales with frames that are already well reinforced. The keel stringer is different from the others, which meet their pair at a lashing point on the front most plywood keel. Instead, you lash the keel stringer along

Figure 5.5. Lashing the stringers to the bow

the bow into a bend that matches the bow. The bend is a big one, and will be easier if the board is thinner. For the last two feet of the keel stringer, consider planing the end down from ½" thick to ¼" thick.

3. **Cut the stringers to meet at the bow first, then work backwards** The bow angle is very sharp, with an angled cut that could run for severl inches down the stringer. Trying to cut these as the last step invites disaster: cutting them too short! Instead, cut them first, making the angle the same for both. Then lash them loosely to frame 2, loosely enough that you can shift them back and forth. Once they are lashed to frame 2, they will stay in place well enough that you can lash them at the bow. Each pair of stringers gets one hole in the bow keel part. Tie a bowline around one, then run the lashing through the hole, then around the other stringer, then back again. Do this again, so that several loops go around each stringer, and then bring the stringers together while tightening the lashings. Once they are pretty tight, tie the lashing off with a few half hitches. You wont get them perfectly tight on the first attempt, especially for the bottom-most pair (which are a very tight bend). Now take a new length of twine and lash the two stringers together behind the bow keel. Here you will have more leverage to bring the two stringers together. The first lashing will keep the stringers in the right place, and this lashing will get

them nice and tight. Revist the first lashing now, taking some turns around the existing lashings to remove the newly created slack.

4. **Lash frames 1 - 5, but leave 6 until the stringer is cut to length** Once all but the last frame is lashed, you will need to bend the stringer into place at the stern, mark the angle, and then cut it too long. You want to cut it too long because cutting it too short means starting over again with new wood. If you try to cut it close to the correct angle from the start, you will be surprised at how wrong you are. Better to slowly nibble at the length until it is correct. You leave frame 6 unlashed because you need enough wiggle room to bend the wood into place in the notch. If frame 6 were lashed, the bend would be too dramatic and break the stringer. After the correct length is cut and the stringer lashed into place at the stern, you can lash frame 6. If the stringer is the correct length, it should more or less rest flush on frame 3. If it is bowed away from the frame, the stringer is too long and must be cut slightly shorter. If you cut the stringer too long and force it into place, you risk trapping twist into the frame, or bending the transoms outward. A tight fit is ok, and a loose fit is ok, but try to get the same fit for all stringers.

Figure 5.6. The finished frame

Now that all the stringers are on the boat, you can look for alignment issues. Alignment isn't critical, but especially with the bottom most stringer (which should run in a straight line fore and aft), small variations from straight and true are easily noticed. You can usually pull a little on the already tightened lashings to get the stringer to line up. For the other stringers, just look for any obvious problems.

The gradually curving lines help to hide tiny imperfections. Measure from bow corner to stern corner. Both sides should be the same. If they aren't, try tying a line from one corner to the opposite corner, tensioning the line to correct the twist. This isn't critical. You will be changing the tension again when you skin the boat. But keeping things even throughout the process is a good idea.

Before you move on to the next step: covering the boat with a skin, you should consult the instructions for installing the skeg (see section 7.3). You will probably want to use keel bolts for the skeg and it will be easier to prepare the stringer and aft-most keel part for the bolts before the skin is in the way. But then again you may just use long screws and glue, and not need to do anything at this time.

Nice work!

6. Skinning the frame

> There are a 1000 ways to skin a cat. There is only one way to skin a Loon.
>
> *Jon Garrison*

This step may seem daunting, but it is really just slow, steady work. If you find it isn't going well, you can back up, pull some staples and try again. There is a knack to it, and if you have worked with fabric before, you will have an advantage. The idea is to drape the skin evenly over the frame, and then stretch it in one direction, lock the tension in place with staples, and then move on to another direction. Doing it all as evenly and methodically as possible will help. At its widest point, the Pacific Loon will need a fabric about 79 inches wide. Only a few available fabrics will stretch over the whole hull. See appendix D for fabric sources. At the time of this writing, George Dyson is selling an 82 inch wide 8oz nylon fabric that is wide enough. Allow for an extra foot of overlap on the bow and the stern when ordering.

I prefer to use heavier fabric than 8oz. That weight is based on the weight of the fabric by square yard. The Pacific Loon skin is about 7.8 square yards. Without coatings the fabric weighs about 4 lbs in 8 oz, and 6 lbs in 12 oz fabric. Adding the coating, those numbers probably a little more than double, but the heavier fabric still only adds a few pounds, and the fabric is the thing that keeps the boat afloat, after all. So I suggest picking a heavier fabric and then skinning the boat in two halves. The directions below assume you are working in two halves. If you are working with one sheet of fabric, the process will be a little easier. You still want to stretch the main section of the boat, and leave the bow for last. I will provide some tips for how to handle one sheet of fabric when you reach the bow.

Start with the boat upside down, draping the skin over the frame. Arrange it fore and aft, covering one half completely with a little overlap on the other half as well.

Figure 6.1. Draping the skin over the frame

Make sure that you leave enough to curve around the gunwales and tuck under, but also leave a few inches at least over the midline. See figure 6.1. Use clamps to hold it in place, so that the skin will stay put when you begin the stretching process.

If your fabric is way too long, you can trim the excess length, but be sure to leave

plenty of extra. It is easier to grab the fabric and pull it tight if you have something to grab.

Any cuts you make in the fabric should be done with a hot knife (fig 6.7d). Using scissors or a normal knife will be difficult, and will allow the edge to fray. The hot knife cuts and seals the edge at the same time.

Figure 6.2. Damp skin draped over the hull

If you are using nylon, try to work in a cold and wet environment. The fabric sags most when cold and wet, so you can get it tighter over the frame that way. If its hot and dry where you are, try wetting the fabric with icewater. I hosed my fabric down to get it evenly wet. If it is not evenly wet, streaks may result, as sediment in the fabric will run and not be evenly distributed.

When you staple to the transom, use the outer part as a ledge, and staple to the inside edge. This allows a clean finish, and gives the staple extra holding power.

6.1. Stapling the skin to the frame

You will attach the halves of the skin along the middle stringer. To make room for both rows of staples, you will need to be good at lining them up. Run one row of staples on one half of the stringer, just a little of off the middle line. Then when you move onto the other half you will have room for that row of staples. Put three or four staples in a line near the bow, at the end of the keel stringer. These will anchor the skin so we can tighten it at the stern. The curved part of the bow willbe tightened in a different step. Move to the stern, and pull the skin as tight as you

can. Staple it three or four times at the stern. The skin should be puckered from the tension along the whole length of the boat. Move along the keel stringer with the staple gun, putting a staple in every 3 or 4 inches. These staples will hold the skin in place so that you can pull it tight abeam.

(a) Stapling to the transom notch

(b) Staples along the gunwale edge

Now change directions and tighten the skin abeam. Pick the widest point, pull it tight, and staple it to the outside of the gunwale. The staples in the outside of the gunwale will be pulled out later. It is much easier to pull tight if you are pulling straight down, and this allows you to work with the boat upside down the whole time. If you have non-monel staples, you can use them here, because they will later be removed. Once you've stapled the skin on one side, move to the other side of the boat, and pull the skin as tight as you can manage, and then staple it down on the other side.

You should now have the skin tightened in two directions (fore and aft, and abeam). Now repeat the process, tightening the stern just to one side of the last staple point, and then tighten the skin abeam again, forward of the previous staple, then aft. Then again to the stern, and then again abeam. Move a few inches each time, moving enough to make progress, but not so far that the skin can pucker between the staples. As you move towards the bow and stern, you will start to pull both down and forward on the skin. With enough finesse, there should be no wrinkles in the skin.

As you work your way aft, you reach the aft deck. That this point, pull the skin around the corner tighly and then staple to the deck. You won't be able to see the deck with the boat upside down, so just staple at a random point, and you can clean this up once the boat is turned over. As you work your way forward, you will similarly encounter the fore deck. Do the same thing here, but be aware that as you reach the bow, you will get to a place where there are no staples to resist a

Figure 6.4. Moving on to the second half

sideways pull, and you need to only be pulling forward to provide tension.

Now that you've done it once, you just need to do it again with the other half. To give a clear view of the keel stringer, fold the extra skin from the finished half out of the way. Repeat the steps again for this side (see fig 6.4).

6.2. Tightening the bow

Now that the skin is stretched tight over most of the frame, you can turn your attention to the bow. Here we don't have the keel stringer to hold our staples in, and yet we want to be able to tighten here more firmly than anywhere else on the skin. The answer it to stitch up the two halves of the skin at the bow, much like a pair of Chuck Taylor High Tops. Just lace them up! See figure 5.4.

To start the stitch, take a length of waxed twine (artificial sinew is a good choice here), and tie a stopper knot in one end. Run the needle from the inside to the outside of one half of the skin, exiting an ½" or so from the mid-line. Then loop around the outside to the opposite side, an equal distance from the mid-line, and then run the needle through. Then cross over to the other side, repeating the process. The exact distance from the mid-line will be determined by how much

(a) Stitching bow

(b) Trimming edges

(c) Finished bow

Figure 6.5. Bow stitching

slack you need to pull up. As you thread the needle, pull the slack in hard. If it is too hard to pull the slack in and sew, you can take a few turns around through the skin in one place, locking in the tension you have managed to create up to that point. Continue up the bow to the top deck, making sure that you evenly and completely tension along the way. Finish the stitch with several half hitches, and cut the thread.

6.3. Trimming and finishing the skin

Now that the skin is tight everywhere, turn the boat over. You can now finish stapling the skin underneath the gunwales. Once the skin is stapled to the inside of the gunwales, you can remove the staples from the outside of the gunwales.

First we must cut away the excess skin. The extra skin hanging underneath the gunwhales is the first to go. Try to cut the skin even with the inside gunwale stringer, so that the bottom of the stringer is covered by skin. Where the gunwales

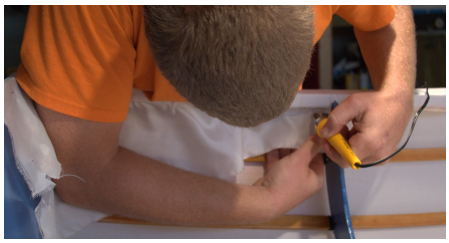
meet the forward and aft decks, cut the skin to the same width as the gunwales. You could cut the skin closer, but its visually pleasing to continue this line. At the aft end where the deck meets the transom, the skin will bunch up in the corner. Cut the skin on a line from the gunwale width section on the deck down to the transom inside width section on the stern. Fold this like the corners of a wrapped present, and anchor it down.

Figure 6.6. Trimming the excess

Some people will like the utilitarian appearance of staples. Others will want a nicer finish level. One easy compromise is to use copper tacks, which do the some job as staples but look great at the same time. Tacks are not as easy to apply while keeping the skin under tension. In order to get good tension with copper tacks, you need to start with staples, and then replace them with tacks one by one. The first staples in the top decks were applied while the boat was turned over, so they will not be nicely lined up. If you don't replace them with copper tacks, you may still want to replace them with staples that are arranged in a more pleasing way. If the rough edge and staples or tacks are not neat enough for your tastes, you can

use wood trim to mask some or all of the skin along the top decks. There is no reason to add trim here except for looks. The trim may even trap water and lead to trouble later. Also, time spent adding trim is time not spent on the water. You decide.

(a) Stapling skin to underside of the gunwales



(b) Trimming the gunwales

(c) Cutting around the frames

(d) Trimming the transom

Figure 6.7. Finishing steps

Now you can trim the skin along the transom. You will want to cut a nice attractive line here, following the inside edge of the notch formed by the two transom parts. Make sure there are enough staples holding the skin into the edge of the plywood here that you can cut pretty close the inside edge and not worry about the skin pulling free. You want a nice close cut here for more than just good looks, you will want to seal this edge with caulk, and the more even the cut, and the closer the cut to the the inside edge of the notch, the easier it will be to seal. See figure 6.11.

6.4. Finish stitching the two halves

Along the length of the two halves, from bow to stern, you will want to cut the junction between the two parts so that each overlaps the other. You will stitch these two halves using the “blind hem” stitch. For this stitch you want both halves of the skin to overlap each other. One side should be twice as tall as the other side, so that it can fold down over the other half, and then the two parts fold down one more time flat against the hull. See figure 6.8 for an example of this two-tiered cut, and refer to figure 6.7d for the view at the transom and figure 6.5b for the view at the bow.

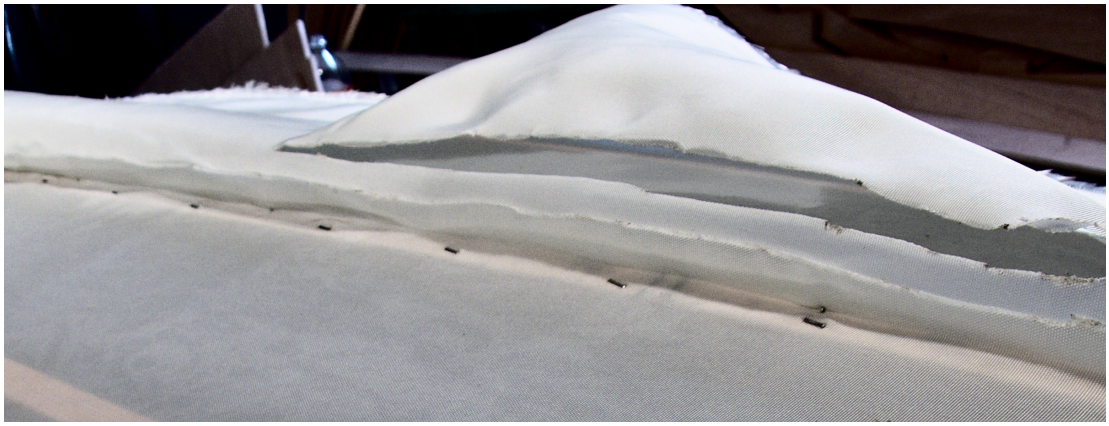


Figure 6.8. Trimming the two halves to prepare for stitching

The smaller the overlap, the smaller the final stitch, but it is difficult to cut the skin perfectly, so I suggest a healthy amount of overlap, about ½” for the smaller half and an inch for the taller of the two edges. Fold the taller half down over the shorter of the two edges, and then fold the whole bundle flat against the hull. Having done that, you use the blind hem stitch to keep it flat. This stitch consists of a length of twine traveling ¼” on the inside of the hull, poking up through the hull into the double-folded bundle of skin, running for ¼” inside the fold, poking out, and then diving at that same spot through the hull for another run. This is a good stitch for this purpose because if you are careful to enter and exit from the same point, hardly any thread will be visible on the outside of the hull.

Start with a 3 or 4 foot long length of artificial sinew or twine, tie a stopper knot, and run a blind hem stitch from the stern transom ledge where the fabric starts, all the way to the bow where it meets the deck. When you use up your twine, take

Figure 6.9. Sewing the halves

a short break, and start with a new stopper knot where you left off. For a helpful video on this process, refer to appendix D. I found it helpful to keep the bundle of fabric (hem) together using clamps. See figure 6.9.

6.5. Tightening the skin

You can shrink nylon skin with an iron or heat gun, just not very much. You must be careful not to overheat the fabric, you can melt it, and then it loses all stretch. Having the skin a little moist helps to avoid overheating. If you are using a heat gun, keep moving, don't heat one area too much. You will get some tightening, but not a lot.

If you are using Dacron, **do not use a heat gun**. It is too easy to melt the dacron. Use a household iron on a medium setting, and keep the iron moving. You should get a noticable amount of tightening. If you don't notice any tightening, use more heat and move a little slower until you get the desired result. Don't rush it.

If you have one area that is sagging, and the iron isn't taking up the slack, try using the iron over a larger area. Getting the skin tighter in one area tighens it everywhere else as well. If you still can't get the wrinkle out, consider sewing up the excess. You can stitch a fold into the skin, taking out the slack. It ends up looking a little like Frankenstein's neck, but not in a bad way.

The cut edge of the skin is not far from the water line, and when the boat is loaded, the edge may be well under water. **The staples alone do not make a**

Figure 6.10. Taking up the slack with a stitch

Figure 6.11. Sealing the transom

waterproof connection. Some coatings join the skin so well to the bow and stern that the resulting joint is waterproof (Corey's Goop, for instance). But this is too important to leave to chance. This is a boat after all, and it must float. To be sure, use a polyether caulk like "3M 4000", and lay in a healthy bead of caulk in the notch between the two transom parts. Try to capture the cut edge of the skin in the caulk, and smooth it out to an attractive fillet. It will be a challenge to be neat here, but neatness counts, especially if you are using a translucent finish. White caulk will leave a more attractive mess if you fail to be perfectly neat. Once enough

caulk is in place, press the skin firmly down against the plywood, to make sure a waterproof bond is formed. You can clean up the mess with rags and rubbing alcohol.

Figure 6.12. Finished skin

The skin is now finished and ready for coating. Good work!

6.6. Painting the skin

The technique for painting the skin will vary depending on your choice of coating (detailed in appendix B). The process is very similar to painting anything else,

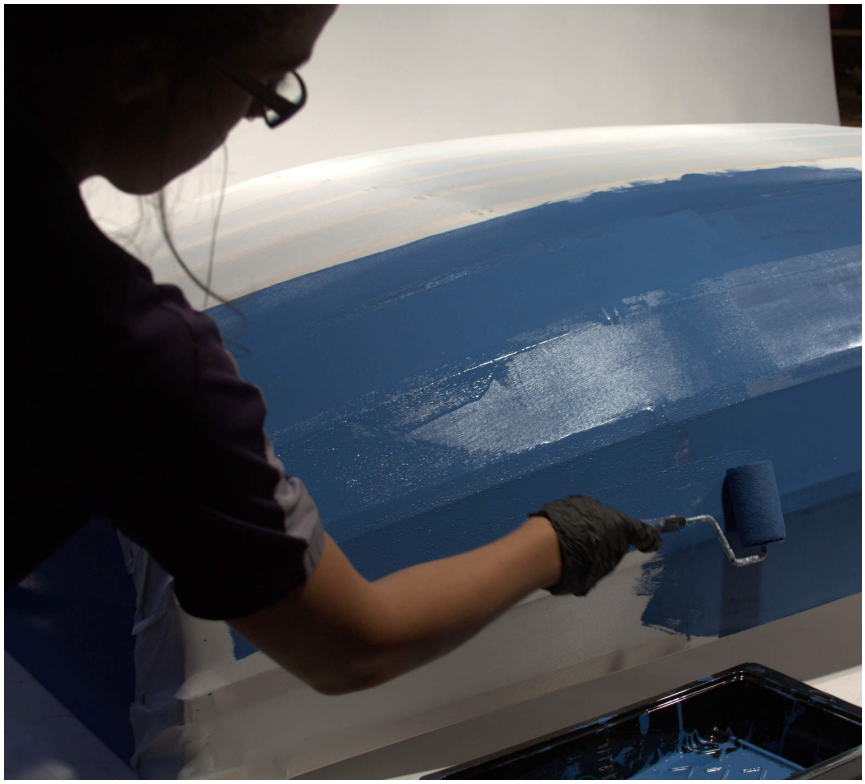


Figure 6.13. Painting the skin

except that you will use a lot more coating to soak the skin than you would to cover an equivalent area of wood. I strongly recommend using “Corey’s Goop”. It is durable, easy to apply, and you can use his excellent tutorial, listed in appendix D, under “The Skin Boat School and Store”. If you go with anything else, I suggest rolling and tipping, just like when you painted the frame.

Especially when using fancy yacht coatings, be sure not to coat too thickly. Some paints will take weeks to cure if put on too thickly. Better to apply the paint in several coats instead. If you are working in a warm condition, you may get away with several coats a day. “Corey’s Goop” can cover a boat completely in one day. With others, it may take some time to reach the desired thickness.

You are technically done as soon as the skin is watertight, but you should aim to fill the weave of the skin so that the surface is smooth. This will reduce drag and make rowing easier.

7. Gunwale braces, oar sockets, skeg and runners

You've got a boat now, or at least once the coating dries you will. But you won't get far without a means of propulsion. Outboard engines are out of the question, their weight would make a boat this light pop a wheelie and sink. Adding a lead acid battery would mean lots of weight, just what we'd like to avoid. There are some electric motors with advanced battery packs that would work, like the "Electric Paddle" (see appendix D). But you will want oars in any case. And to use oars, you will want oarlock sockets.

You will need sturdy mounting points to take all the force of rowing. The 4 small plywood rectangles (2 per side) will be screwed to the gunwales to provide this support. They will also stiffen the boat in general, locking the gunwale stringers together near each frame. If you have your rowing hardware, (oarlock sockets, thole pin holes, etc) install them in the blocks before attaching the blocks to the frame.

The blocks are labeled so you can identify which belongs where. The exact placement of the blocks will depend on how you want to load the boat, but you won't really know where you want the them until you've used the boat for a while. A very good starting point is to put the blocks just aft, or slightly over frame 4 (you don't want the oarlock socket to run into the frame, so don't line it up perfectly over the middle) for the single rowing postion and just aft of frame 3 for the rowing position when you have a passenger. Once you've lined the blocks up where you want them, use the hot knife to cut holes in the skin where the oarlock hardware will pass through.

Use skinny bronze bolts to attach the blocks to the gunwales. Using a narrow bolt weakens the gunwales the least. Pre-drill holes for the mounting hardware. If the inside and outside gunwales line up with the blocks, great. If not, you'll need to force some overlap.

I use 8 foot oars, but oar length will also be a personal preference, somewhere between 7 ½' and 8 ½'.

7.1. Deck molding

The decks are angled in towards the cockpit. Any waves or rain you take will be directed into the boat. This is no good. To avoid this, use the same sort of wood that you used for the stringers to put a barrier up. Cut a length the exact width of the forward deck where it meets the cockpit, liberally caulk the wood on one side, and clamp it down. Repeat this step for the aft deck. Now any water that wants to get in will have to jump over this barrier.

7.2. Runners

Your boat will no doubt be run up on beaches and dragged over gravel. The more carefully handled, the longer the skin will last, but using wooden runners[1] to take the punishment will significantly increase the life of the skin. Put at least one runner down the moid-line, matching the lowest stringer but on the outside of the skin. Start at the aft end, and run it up the bow as far as you can manage. As with the keel stringer, you will find the stick much easier to bend at the end if you shave it down so that it tapers down to about ¼".

Start with the middle runner. Be sure to line it up with the stringer on the inside of the skin, so that you will have something to screw into when attaching the runner. Use bronze wood screws, not too thick, and not so long that they could protrude on the inside. You should predrill and countersink these holes, so that the runner doesn't split, and so the screw heads to not protrude. Drive the first screw through the runner and stringer amidships[2], where there is very little curve to the hull. Then work towards the ends, bending the runner into place and screwing it down, keeping it flush with the hull. Six or seven screws should be plenty. If you have extra length in the runner, leave it until after you glue it in place. For the side runners, keep the length short, two feet or so, so that there isn't much curve along their length. Three screws should be enough for these. Choose the location

[1] Runner, bilge runner, a strip that runs along the bottom of the hull. Its role can be to protect the hull, or to stiffen the hull.

[2] In the middle of the boat.

for these by lining them up with the stringer three over from the middle. Locate them fore and aft by resting the boat on its bottom and noting where it sits on a flat surface. Put the stringers there. Because they will end below the water line, the ends of these two stringers should be smoothly angled at the ends.

Now that you've screwed the runners down, you can unscrew them and use caulk (polyether caulk like "3M 4000") to thoroughly coat the area where the screws puncture the skin. Also apply some along the length of the runner. Carefully line the runners up with the screw holes again, and screw them down. You want a good coating of caulk along the length of the runner to keep debris out from between the runner and skin, and also a good coating where the screws go through the skin itself. Clean up the stuff that squishes out, using rubbing alcohol and paper towels. A credit card also makes a good scraper if you have a lot of extra goop.

7.3. Skeg

Adding a skeg[3] helps the boat track straight. Unless you put it on crooked, and then it does the opposite. There are two ways to add the skeg: one where it is fastened to the outside of the bilge runner, and is the outermost part of the bottom of the boat, and the other involved adding another runner to sandwich the skeg between two pieces of wood. The second way is more involved, but it protects the otherwise vulnerable leading edge of the skeg. You can always add the second runner later, so I suggest starting out with the skeg on the outside. You can wait until the end of the building process to cut and attach a skeg, but there are two reasons to consider doing it after the stringers are on but before the skin is attached:

1. It will be easier to trace the curved line onto a board using the keel stringer if the board can rest below the level of the skin

2. You can decide where you want the keel bolts to protrude below the skin, and pre-drill these holes. The plywood of the aft most keel part will block access to the keel bolts, so you will want to cut a small recess in the plywood where the keel bolts protrude. This will be difficult if the skin is already in place.

[3] From a Scandinavian word for beard, a deepening of the keel towards the stern. The extra depth then, usually in a fin like shape, helps the boat stay moving in a straight line.

Figure 7.1. Placing the skeg ahead of time, cutting recesses for keel bolts

The ideal shape for the skeg will carry the flat line of the middle of the boat all the way aft to the transom, yielding a long narrow right triangle with a curved hypotenuse. The height at the transom should be a few inches, not more than 4 inches or so. In order to get the right shape for the curved part, take the board from which the skeg will be cut and line it up with the middle runner, resting it on the hull. You can then trace the curve that you need to cut by running your pencil along the runner's length. This will be very close to the correct line, and variation will not be more than the inevitable errors that occur when cutting the shape.

Once you've cut your skeg shape, you can place it on the boat to check your work. It is a rare cut that works the first time, so prepare to make a few small cuts and sand down some high points before it rests nicely on the boat.

However you attach the skeg to the bilge runner, be it screw or keel bolt, the leverage the skeg will have over the stringer below will allow it to bend this way and that. The flexible skin and lashed stringers do not have the rigidity to keep it

(a) Tracing the curve of the hull

(b) Trace the desired final shape on the board

(c) Fine tune the shape to match the runner

Figure 7.2.

lined up. We don't want the skeg to move at all, so we must reinforce the skeg by running a board from the transom down to the skeg. The extends the rigidity of the transom down to the end of the skeg. It is possible to cut a skeg fits the transom

andlge and the hull curvature all in one part, but this is a difficult job better done in two parts.

The aft part of the skeg need only be a few inches thick. It extends from the bottom of the skeg until it overlaps the transom far enough to allow it to be securely fastened there, about 8 inches (see fig 7.3). The difficult part of of the cut is to line up the transom angle with the skeg angle. The shape aft of that doesn't matter, just make it look nice. I used an iterative approach where I got one angle correct, and then kept cutting the other angle and testing it until it fit. If you are a more thorough sort of person, you can make a template. See appendix D for information on how to template complex shapes.

Once you have the right shape cut out, use 3 bolts to connect it to the transom, and use wood screws to connect it to the rest of the skeg.

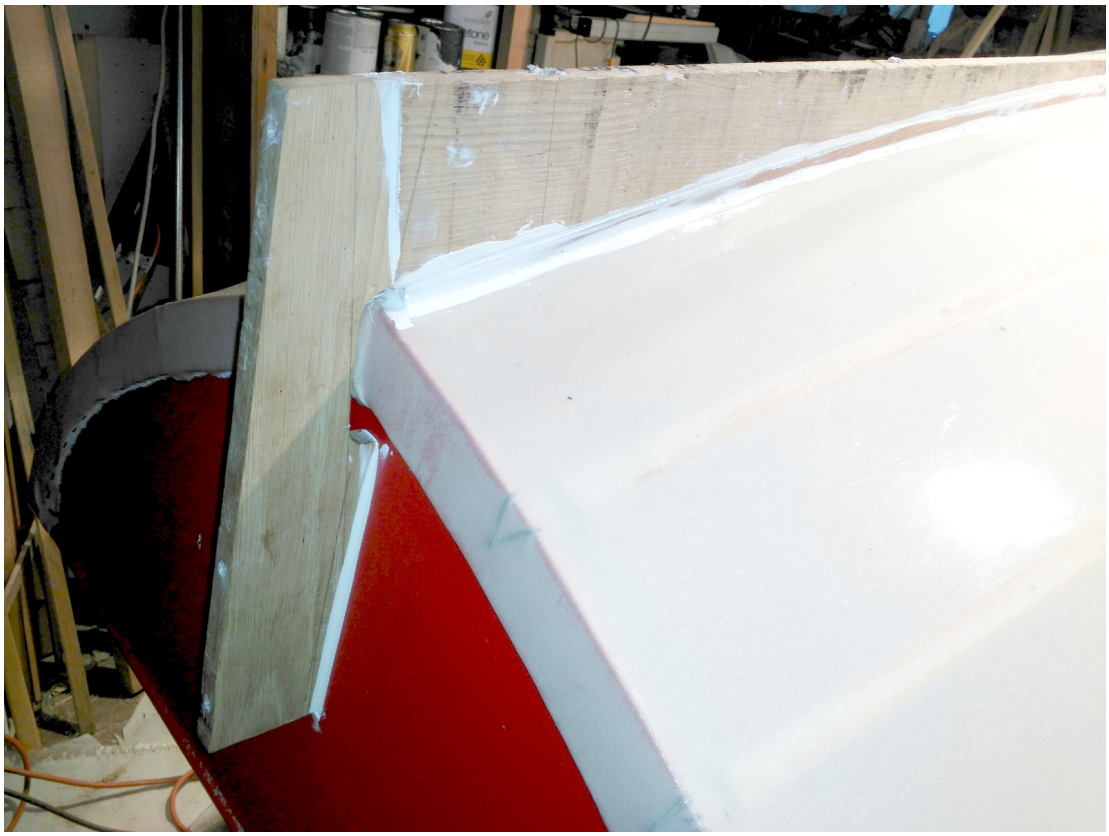


Figure 7.3. Finished skeg and reinforcement

Now that you have both parts, you can test fit them. If the skin is already in place, this will be an acurate test, but if not, you can still get a good idea of what

sort of fasteners you will need. At the thin end of the skeg, you should use wood screws. At the thick end, no bolts will be long enough to go all the way through, so you will need to drill a recessed hole on the skeg. As long as you are drilling a recessed hole, you have the choice of using a keel bolt or a long wood screw. I leave that to you, I think that with a properly reinforced transom part of the skeg, the keel bolts are not necessary. If you decide to use keel bolts, you'll need the longest and narrowest bolts you can find. Several inches, at least.

Use some 3m "4000" caulk to glue the skeg to the bilge runner. This will provide some strength, and also help to span any gaps created by an imperfect match between runner and skeg. Pay special attention when attaching the skeg that you don't put any twist in the wood, and that it lines up bow to stern. If this is out of alignment then your boat will always want to turn the wrong way!

Great work! Once the caulk dries, take it for a row!

Appendix A. Using plans to cut plywood

Included with this manual is a PDF plan showing the plywood parts fitting onto sheets of plywood. The PDF is a 2 page document, but the pages are 4 foot by 8 foot in size, which is probably larger than your printer can print. Also included is a PDF with smaller pages that will be easier to print, but will not match the best layout to cut from 4 foot by 8 foot plywood.

If you want to use these plans to cut the parts out yourself, the smooth curves and numerous lashing holes will not make the job easy. If a few hours spent working slowly with a jigsaw sounds unpleasant, I suggest getting the kit, which includes these difficult parts cut by machine. But maybe shipping is prohibitive to you, or you are just cheap and want to save a few bucks using ACX plywood from the hardware store. More power to you.

I know of two techniques to use this PDF to make your parts: print the plans out really big and then glue them to plywood, or shine a projection of the plans onto the plywood and trace the lines.

Using a full size paper will give good results, but such a large print will be expensive. The only errors will be cutting errors when the jigsaw strays from the line. To save money, you can also glue several smaller overlapping pages to the wood, in the extreme case doing it all with 8.5 x 11 pages (free if you print from work!). Send me a picture if you do it that way, you frugal overachiever. Use a weak spray glue like 3M Spray Artists Adhesive to glue the pages to the plywood.

If you are using a projector, you will have two sources of error: tracing errors and cutting errors. You will not produce a perfect product, so give that idea up now. But! The nature of this plan, with its lashings and skin and gap filling epoxy, is such that many mistakes can be hidden. If you work carefully and make small mistakes in every direction, the end result will be very close to correct. Mistakes can cancel themselves out.

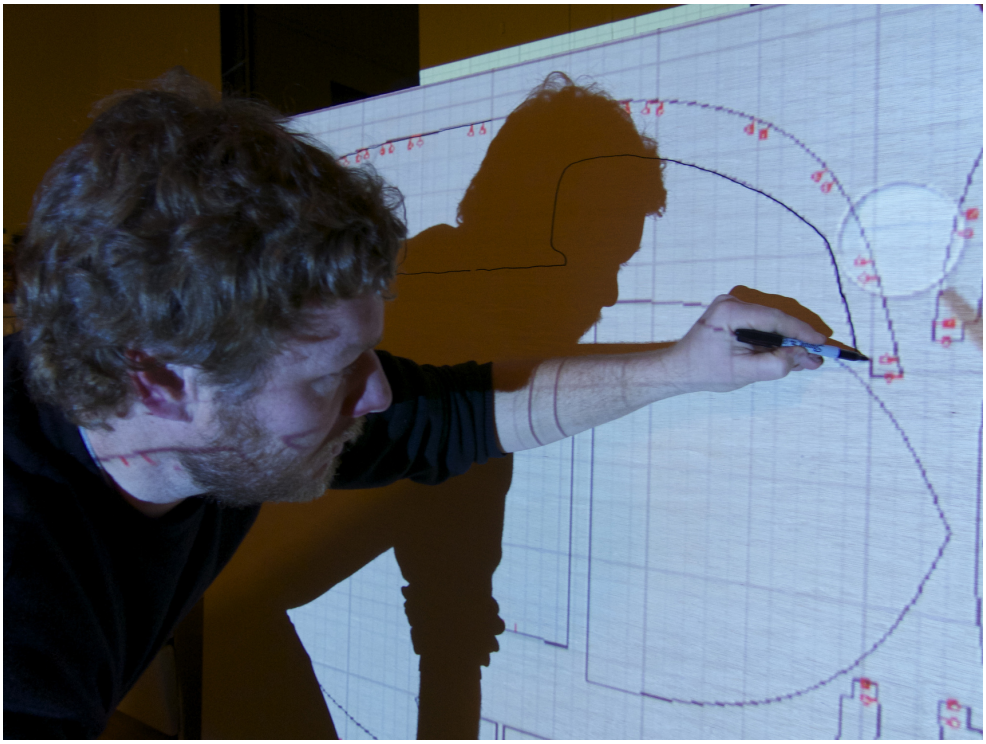


Figure A.1. Tracing plans using a computer projector

You will spend some time setting up the projector so that it casts the correct image onto the plywood surface. Choose an image viewing program like “Irfanview” (see appendix D) that allows a full screen view and zooming in and out, to help with image alignment. The plywood should be well supported from behind, so that the pressure of the pen tracing will not move it out of place. On the image are several calibrating lines, one in each corner. Measure these to confirm that the image is falling evenly over the whole surface of the plywood. When you encounter the notches, the places where the plywood slots together with itself, you need not trace each line. Instead, mark the start points of the notch, and the final depth of the notch. This is because in the next step you will use a scrap of plywood to trace the precise width of the plywood itself.

With either approach (printed or projected), you must now make sure that the notches are the correct width. They are meant to be exactly as wide as the plywood you are using. Cut a small piece of plywood and use it to trace the exact shape over the notches, lining up the piece on edge with the start of the notch, and ending it at the correct depth. Plywood varies in thickness even within the brand, so be sure

to check. If you used the projector method, you will probably have big errors in tracing which won't amount to much, but make sure that these notches are traced and cut very carefully.

Once the plans are in place, either glued or traced, get a jigsaw and a drill and get to work. Some long cuts will be easier using a circular saw, and a band saw can come in handy, but the real workhorse will be the jigsaw. There are a lot of cuts, so get a good jigsaw, or if you get a cheap one, keep the receipt.

Have fun!

Appendix B. Choosing materials

B.1. Skin

Historically, skin and frame boats were made with literal skin: seal skins. It took a great deal of skill to sew them into a continuous waterproof covering for a boat. We live in a lucky time; a wide range of materials are available in widths and lengths to allow covering an entire boat without the need to stitch. Although anything that can be considered fabric will work as a covering for a while, there are some "excellent" choices: canvas, polyester, and nylon. They all have their strengths and weaknesses, and the best choice depends on your needs.

First, let's consider canvas. It has one really nice trait: it shrinks when it gets wet. This means if you don't do a great job getting the skin tight on the frame initially, it will look better once you get out on the water. But of the three "excellent" choices, it is the weakest, pound for pound. Another nice trait of canvas is that it will take many different coatings. People report that oil based paint works well. But canvas is only marginally cheaper than polyester and nylon. Given that it is not particularly tough or affordable, make sure you know why you want to use canvas. Because you think it is really cool looking, for instance.

Second, let's consider nylon. Nylon is a term for a family of plastics, but when talking about skin for boats we mean "ballistic nylon". This term was coined by DuPont, who marketed a woven nylon product for bulletproof vests. Nylon is no longer used for bulletproof vests, but that it ever was should give the boat builder confidence. Ballistic nylon is almost hilariously tough. I offered a sample to a friend who is proud of his sharp knife. I stretched the sample out, and the tip of the knife would not go through. When finally, under great pressure, the tip broke through, it immediately stopped. The next cut would be as hard as the first. When my boat made of 12oz ballistic nylon hits barnacled rocks, it leaves behind murder and mayhem, a soup of ground up barnacles that never deserved such treatment, and the skin is unmarred. It is the toughest choice in any weight, and a great option

for skinning boats. But in it's toughness lies its drawbacks: the material stretches rather than tearing. It can stretch really well, much better than most coatings. Opaque paints can't stretch as well and gets torn off when the nylon it clings to stretches out of its grasp. Only a few coatings are able to stretch with it, and they are all translucent. Nylon stretches around curves nicely, and you should be able to get a nice tight frame using nylon. It will start nice and tight, that is, but then when it gets cold and wet it relaxes, stretching even more. It is rare to see a nylon skin and frame boat without a wrinkle.

Third, let's consider polyester. Polyester, like nylon, is a term for a family of plastics, but when talking about skin for boats we mean "Dacron", a trade name for the kind of polyester used to make sails for modern sailboats. It's a wonderful material. It shares canvas's affinity for many paints. With polyester, you can use opaque paints, and there is the whole rainbow to choose from. And you can choose to use cheap paint from the local hardware store, or the most expensive yacht coatings made. Polyester is also much stronger than canvas. Unlike canvas, once stretched over the frame, it doesn't shrink or grow, staying relatively stable. If you got a nice, tight fit when building the boat, it will stay that way. Polyester also heat shrinks well when moistened and ironed. So once you stretch the skin as tightly as you can over the frame, you can use an iron to hide your mistakes and tighten it further. Its a wonderful material. But because its so stable once finished, when it runs into sharp objects, it can't get out of the way. It is much more likely to puncture than nylon.

Which to choose? If you want a drum tight finish, and are OK with treating your boat with some care around rocks and beaches, consider Dacron. If you want a bright colorful finish, again, consider Dacron. If this is your first boat, or if you want a boat you can toss around without worry, go with ballistic nylon. Nylon can't be beat for toughness, and if you choose "Corey's Goop" to coat the boat, there are great guides online to help you coat the nylon.

What about pvc, or canvas, or transparent plastic, or old bed sheets, or… For your first boat, start with reliable options. If you want to try something else, remember that the skin material is not that expensive, and re-skinning your boat does not take that long. You will have time to experiment if you wish.

B.2. Coatings for skin

If you have chosen polyester or canvas skin, you can use any of the coatings listed below, and probably a lot more as well. Nylon, on the other hand, is capable of such stretch that it can stretch right away from most coatings. If you use nylon, choose only Corey's Goop, Coelan, or Dura-Tuff.

B.2.1. Opaque Paint

Boat builders report that affordable oil based exterior paints, like Rustoleum, work well. Because all yacht paint must be waterproof and UV resistant, consider using yacht paint though it is a more expensive option. Epifanes brand recommends their mono-urethane product, but probably their competitors' mono-urethanes will work equally well. When using yacht paints, consider applying thin coats and letting the coats dry completely before re-applying. It can take a very long time for Epifanes mono-urethane to dry if it is applied too thickly. You should use the "rolling and tipping" method for all opaque paints.

B.2.2. Corey's Goop (two part urethane)

For nylon skin, the most popular coating is "Coreys Goop", a two part urethane with excellent durability. It produces a white translucent coating that fades to yellow translucent quickly in the sun. Corey provides excellent support and documentation for applying the coating. The recipe is a secret, and Corey claims it is non-toxic. See more in appendix D, under "The Skin Boat School and Store".

B.2.3. Coelan

Some say that the best coating available is "Coelan Marine Coating", but it is expensive and hard to find, so first hand accounts are rare. Those who have used it rave that it is easy to put on, and very tough. Coelan claims to have UV protection. That could mean it will not yellow in the sun. Apply it by rolling and tipping as you would paint.

B.2.4. Dura-Tuff

Dura-Tuff is an exciting product. It can be applied by roller like Coelan, and also shows promise in toughness and UV resistance. With Corey's Goop, the yellowing happens in just a few months. In my testing, Dura-Tuff has lasted a year so far without yellowing. It is half the price of Coelan, however Dura-Tuff is toxic stuff and requires a mask. You should only apply it outdoors, or take extreme safety measures.

B.2.5. Exterior Oil-based Varnish (Zar, Varathane, Rustoleum, Etc)

Reportedly this product does not stick very well to nylon. But if you have chosen Dacron and want an affordable translucent finish that is easy to find locally, consider oil based varnish.

B.3. Coatings for plywood

How you coat the plywood frame is a matter of taste more than performance. You can varnish the plywood or paint it with an opaque color. If you are very lazy, leave it untreated, but it will not last as long.

For the stringers, which are not subject to delamination like plywood, paint or varnish will be a purely decorative choice. The wood can be left natural.

Taken together, the choice of coating for the skin, paint for the plywood, and finish for the stringers will have an enormous impact on the final look of your boat. Consider some of the possibilities:

1. **Opaque paint for the plywood, translucent skin, and untreated wood stringers** A classic choice would be a white frame, untreated yellow cedar stringers, and a translucent skin. The clear skin and untreated wood remind one of the aboriginal origins of the construction technique.

2. **Opaque paint for the plywood, translucent skin, and varnished red cedar stringers.** This can be considered the "high trim" level choice. Choose a bright yachty color for the frame, let the varnish show red cedar's lovely grain, and then let the translucent skin advertise the unusual nature of the boat.

3. **Opaque paint for the plywood, Dacron skin painted that same color, varnished stringers.** It is helpful to choose the same paint color for the frame

as for the skin, if the skin is going to be an opaque color. This is because you are bound to get paint on the frame when coating the skin, and no one will be able to tell if they are the same color.

4. **Opaque paint for the plywood, a different color for the skin, and untreated wood stringers.** This option will require great care at the bow and stern where skin meets plywood. You are urged to find some trim material to cover the boundary between colors, which will be imperfect. Your efforts will be rewarded by a striking combination of colors between outside and inside. For extra credit, consider painting the stringers as well. You seem to want to do something detail oriented and frustrating, after all.

The stringers will get some of the skin coating on them. The coating seeps through the skin, and the stringers are in contact with the skin. This is ok, because the part of the stringer that gets painted is hidden by the skin.

There are many other choices of course, but these are among the best. If you've chosen nylon for the skin, you have no choice but to also choose translucence. If you go with Dacron, translucence is still a good option. If you use "Corey's Goop" with a painted frame, remember to color match the eventual yellow color of the skin after UV exposure, not the initial clear hue. If you want to keep that initial white hue, choose the more expensive Dura-Tuff or Coelan coatings.

Appendix C. Tent, voyaging equipment

C.1. The tent

The Pacific Loon is designed to take a tent. Both decks extend well in towards the cockpit, giving ample room to attach a tent, and to shed water someplace besides on your bed. The cockpit sole is chosen to be wide and long enough to fit standard camping pads. The plans include a cutting pattern for fabric, which when sewn together should yield a tent like the one shown on the cover. This tent is shaped so that near the bow it is quite low, but it rises to its maximum height just before the aft seat. A pole around 8 feet long provides the archway here to keep the tent up. Another pole, sewn into the tent, provides shape for the aft end of the tent.

The tent is tensioned using the aft cleat, but does not button down to the aft deck. Ventilation is very important in such a small space. The low bow and high stern of the tent mean that when the wind is blowing, and you are anchored from the bow, the boat should blow the aft end downwind. This is a good thing for a few of reasons: it keeps the rain from blowing in the stern, of course, but it also presents the bow of the boat to the waves that the wind usually stirs up.

In addition to the two poles, I used snaps to attach the leading edge of the tent to the forward deck. I also used several snaps along the sides, to snap the tent to the outside of the gunwales. In the stern, I used a line attached to the middle of the pole to tension the whole thing once it was assembled. In order to give the aft pole its arched shape, I tied hooks to each end of the pole, and attached them to eyelets on the aft deck.

This arrangement of a well buttoned front, facing the weather, and an easily detached stern is very handy. If something goes bump in the night, I unhook and uncleated the stern pole, throw it over the arch, and quickly had a clear view and access to the majority of the boat.

For tent fabric, I suggest using similar skin material as you have for the boat. I used 8oz polyester. Lighter than the skin for the hull, but still quite tough. Once you've sewn it together (sewing is a skill that I lack, so I offer you no advice on this step as a kindness. I could only lead you astray), you can waterproof it using the same coating. This will produce a heavy tent, but conditions out on the water are much tougher than on land, and you will be glad for the toughness and relative quiet that heavy tent fabric affords.

There will be very little stretch for a tent coated this way, so it is important that you coat it in the shape that you want when it is dry. See figure C.1 for examples. I stapled mine to the floor to recreate the deck of the boat, and tightened the hoop using twine and three screws driven into the floor. These stood in for eyelets and cleats for the finished tent.

Refer to the diagram at the end of the appendix for a view of the tent arrangement.

C.2. Camping

Camping in a rowboat offers a delightful contrast to camping on land. For one, compared to hiking, you can carry much more stuff. Also, there is very little private land on the water. You are allowed to anchor just about anywhere. It may not be safe, but you are allowed to try. There are some new challenges to face, though. One obvious one: the bucket. Long a sailors friend, the bucket will bail you out when you are in trouble, and most importantly, allows you to relieve yourself when far from land. Choose your bucket with care, its the most important piece of equipment on the boat. Look for a smaller one, but a sturdy one. My trusty companion is a Rubbermaid Roughneck 12 quart bucket. When using the bucket as a toilet, fill it first with some water, and then rinse it with more water when you are done. You have plenty of water at your disposal, use it.

Cooking on a boat means finding a stable platform. The Pacific Loon is a stable platform, but if your stove isn't a low flat design, consider adding an appropriate hole in your cockpit sole for the base of the stove. The design layout already includes two holes for soda and beer, and one larger hole the correct size for those green 1 lb propane bottles. I use a burner that screws to the top of these bottles (Bottle Top Stove). It would be too unstable without the cockpit hole, but settled down into the hole. I have sauteed oysters and made coffee while underway.

(a) Sewing the tent parts

(b) Setting up the tent

(c) Another view of uncoated tent

(d) Coated tent

Figure C.1.

Because you can carry a bit more weight in a boat, consider using heavier, more household-grade pots and pans.

C.3. Anchoring, tides, voyaging skills

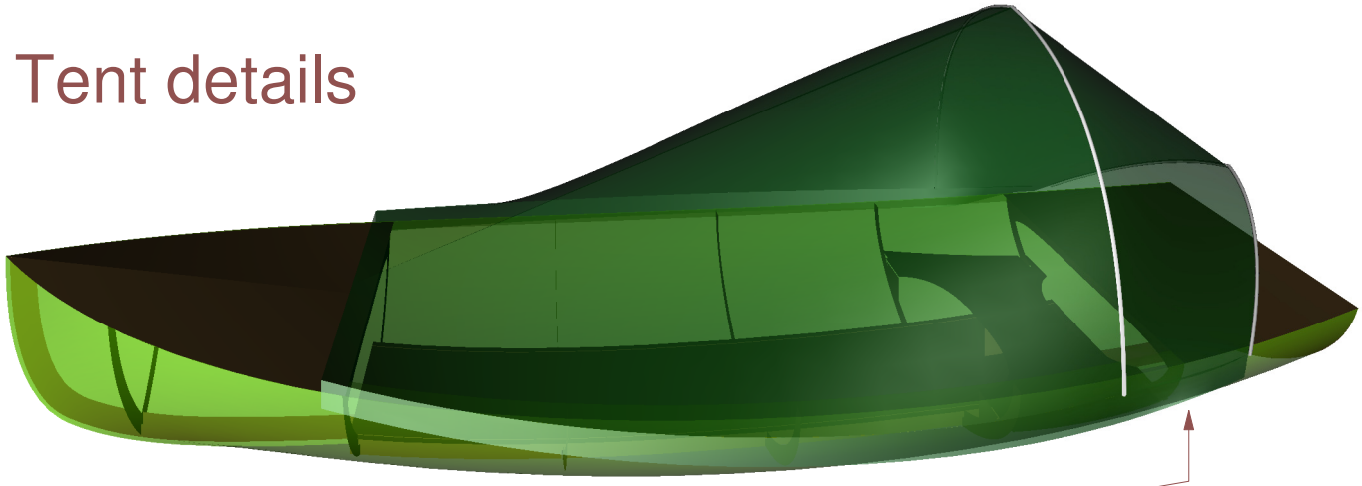
The Pacific Loon is techinically a little rowboat, but when decked out for voyaging its a big boat in disguise: bow and stern anchor, vhf, facilities for the galley, facilities for the head, charts, anchor light, everything you'd find on a bigger boat. And you will need the same skills to cruise the same waters. What is the weather forecast? What are the tides going to be like? The currents? Will your anchor hold in spot you've chosen? How much anchor rode must you let out to sleep safely through the night? At low tide, will that much rode be too much, so that you blow into other boats or the rocks? At high tide will that much rode still be enough to hold you?

These are big questions, and beyond the scope of this guide. But don't be daunted. They are great skills to have, and the Pacific Loon provides an ideal, low stakes platform from which to learn them. Be aware though: human power is limited. Don't pit yourself against adverse wind, waves, and tides. Be especially attentive to conditions where wind blows against the current. Paying close attention to the wind and tide before you go can make the difference between a cheery cruise and a forced march.

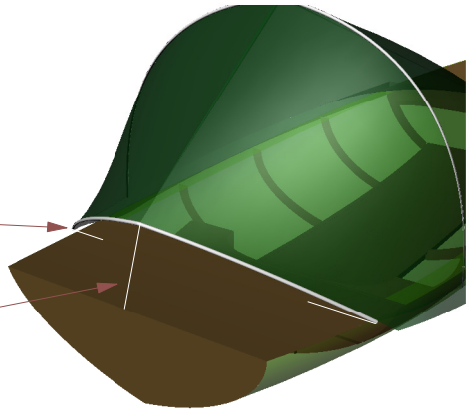
If you plan on anchoring in unusual spots, or rowing through the night, you should make a small mast to hold up an all-around white light. You can buy plastic mounting hardware for poles where a set-screw holds the pole in a plastic sleeve. These are nice because they let you raise the pole easily after the boat comes off the car roof. For the pole, a few feet of broom handle should be enough. On top of the broom handle, one of those solar garden lights will be good enough. The light need not be bright, it just needs to announce your presence.

While you are at it, why not put up a small flag? It will help with daytime visibilty. If you have a freak flag, this would be a good place to fly it.

Tent details

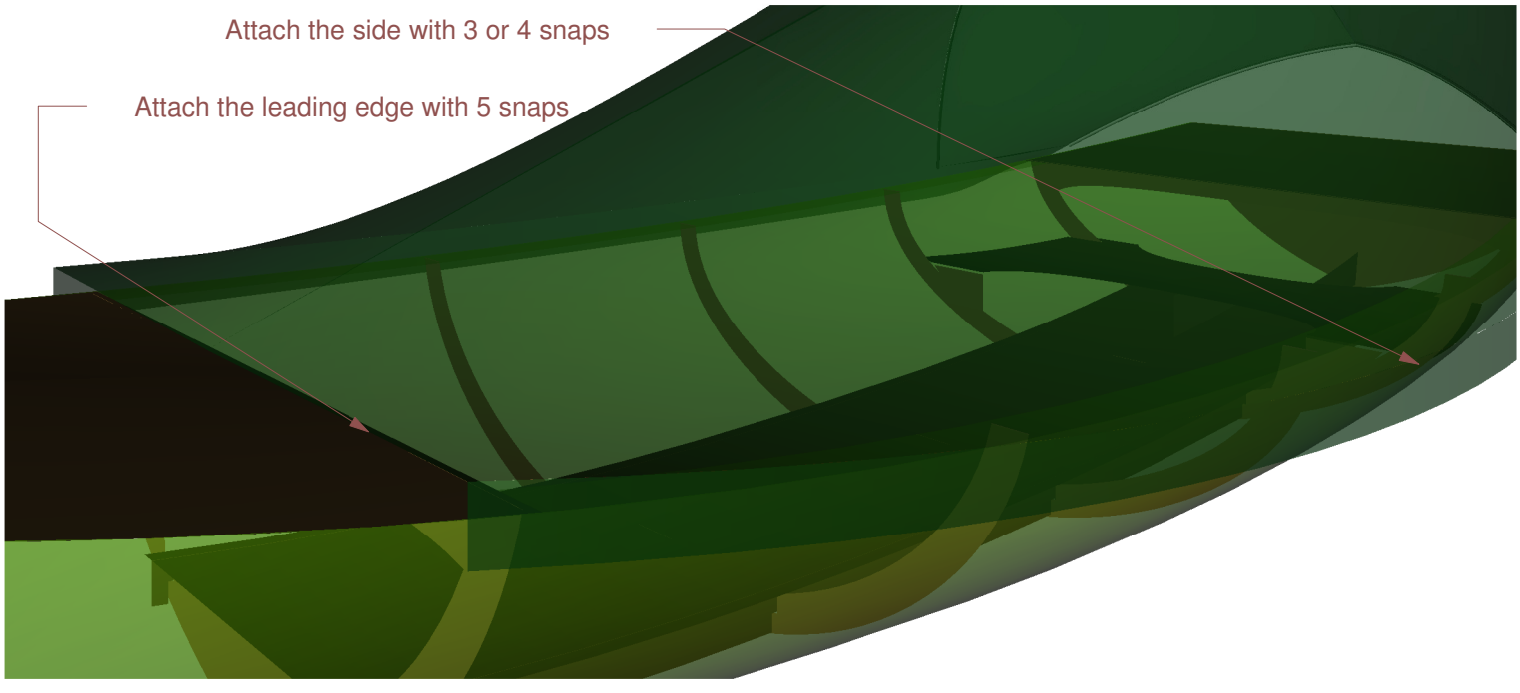


Two 1/2" PVC pipes. The main archway pipe is 8' long, the aft archway is 5' 2"



Two side lines hook into cleats or eyelets.
Use hooks for speed of attachment, the distance
should always be the same.

Central line is sewn into the tent,
and tightens the tent using the stern cleat.
If the tent is stiff and always tightens the
same amount, you can use a hook here as well.



Attach the side with 3 or 4 snaps

Attach the leading edge with 5 snaps

Figure C.2. Anchored on dry land

Appendix D. Resources

The internet! It knows everything! It doesn't agree with itself!

Skin on frame kayaks are far more popular than open skin on frame boats, but the issues involved are largely the same. For questions of skinning and coating your frame, consider these forums:

The Greenland Kayak Forums

Qajaq USA (Qajaq is an alternate spelling of Kayak)
`http://www.qajaqusa.org/default.html`
`http://www.qajaqusa.org/cgi-bin/GreenlandTechniqueForum_config.pl`

Wooden Boat Forum

The frame of a skin on frame boat is wood, so they are wooden boats. The discussion here is broad, but if you search well, you can find good information.
`http://forum.woodenboat.com/index.php`

Kayak Forum

Like the Greenland kayak forums, you can find lots of advice about how to skin and coat a frame here.
`http://www.kayakforum.com/`

DYSON, BAIDARKA & COMPANY

Order materials from a living legend. Who has no website for some reason.
`https://dl.dropboxusercontent.com/u/18771264/MaterialNotes.pdf`
435 WEST HOLLY ST., BELLINGHAM WA 98225
Telephone: 360-734-9226

The Skin Boat School and Store

An excellent source for all materials related to skinning and coating, the source for "Corey's Goop," a popular two-part urethane, and a source for excellent tutorials.

http://www.skinboats.org/

Especially useful is the urethane application manual:

http://www.skinboats.org/#!urethane-application-/c1xub

And this guide to the finish stitch for two pieces of fabric (Blind Hem Stitch):

https://www.youtube.com/watch?v=JSxDIx6pCSs

West System Epoxy User Manual

The West System user manual covers how to glue two pieces of wood together. Great stuff.

http://www.westsystem.com/ss/assets/HowTo-Publications/User%20Manual%202012%20Part1.pdf

Coelan Supplier

http://www.supplyground.com/

Dura-Tuff Supplier

http://www.creative-wholesale.com/Dura-Tuff.html

Geodesic Airolite Boats

If you want a light boat, and are willing to treat it carefully, it will be hard to beat the Geodesic Airolite Boats. They are light, and lovely as well. They are also very high labor to build.

http://www.gaboats.com/

http://www.gaboats.com/faq.html

Dave Gentry Boats

Dave Gentry Boats offers a wide variety of skin on frame designs. If Hermit Cove Boats are very easy to build, and Geodesic Airolite designs are difficult, then Dave Gentry boats must belong in the middle somewhere.

http://www.gentrycustomboats.com/

Kudzu Craft

Kudzu Craft has written a book on this type of boat construction. They offer kayak kits, and have good instructions as well.

http://kudzucraft.com/

http://kudzucraft.kudzupatch.com/articles/whichskin.php

Yost Werks

Interesting kayaks, including a folding kayak and an inflatable kayak. Also includes instructions on skinning a frame in PVC, a material something like a pre-coated Dacron skin.

`http://yostwerks.com/`

Knots

To lash the boat, you will need to know a few knots. But these are so useful, you should know them in any case:

Bowline: `http://www.animatedknots.com/bowline/`

Clove hitch: `http://www.animatedknots.com/clovehalfhitches/`

Rolling hitch: `http://www.animatedknots.com/rollinghitch/`

Knots, Splices and Rope Work

A free eBook, full of knots, lashings, and information for "Travellers, Campers, Yachtsmen, Boy Scouts"...

`http://www.gutenberg.org/files/13510/13510-h/13510-h.htm`

"Rolling and Tipping"

`https://www.youtube.com/watch?v=k-SGcSlNmoo`

Electric Paddle Outboard Motor

`http://www.electricpaddle.com/`

Making Complex Shapes, Templates and Spiling

`http://www.diy-wood-boat.com/spiling.html`

Irfanview

Image viewer for Windows, allows full screen viewing with smooth zooming in and out. A great help when lining up the projection of the plans with the plywood.

`http://www.irfanview.com/`