

## Replacing Double Planking

This document describes replacing one course of double planking on Alita. Double planking consists of a 3/8" thick inner plank and a 5/8" outer plank with a sealant between the planks. The pic below shows two outer planks labeled O12 and O13. Both outer planks overlap the inner plank I12-13. About 1/2 of two other inner planks are visible in the picture (I14-13 and I11-12).



In the original construction (shown above), both the inner and outer planks were made from Spanish Cedar with shellac as the sealant. Due to cost and availability considerations, I'm replacing the inner planks with Alaskan Yellow Cedar and the outer planks with Wana, a South American medium density hardwood. I'm using Sikaflex 291 LOT as the sealant instead of shellac because 291 is more flexible. As the outer planks contract when drying out, there will be less likelihood of splitting the inner planks, which is what has happened with the original construction.

For the purpose of discussion, let's assume that we are about to replace outer plank O12. We assume that the outer plank below it (O11) has already been replaced as well as the inner plank I11-12. This situation is depicted in the picture below.



The cream colored wood represents I11-12 and the brown wood below is outer plank O11. Note that O12 and I12-13 have already been removed as well as O13 and part of I14-13, to make room for the new planking.

It's best to remove only as much old planking as necessary for clearance, so that the remaining planks can be used for "wedging down" the new plank. (An example of wedging down to help tighten the seams is shown in the pic below.)



In this case the goal is to replace O12, but O13 must be removed to make room to fit O12. But, O12 and O13 overlap I12-13, so we must also remove I12-13. In removing O13 about ½ of I14-13 will come with it. This represents the minimum. It's possible to remove one more course than the minimum. The remaining planks would still be close enough to wedge against, and removing the extra plank provides more room to work. With just the minimum, you can't get your hand between I12-13 and O14 to install clamps.

So to replace O12 we must (1) remove old planking, (2) make and install I12-113, and (3) make and install O12.

### **Remove Old Planking:**

Removing the old planking is fairly easy if we are not trying to save the inner planks.

- a. Remove the (#12 x 2") fasteners holding the plank to the frames. Removing the bungs is easy with double planking since they are set very shallow. Just an awl will do.
- b. Remove any fasteners holding the hull strapping to the plank (from inside the boat). See pic below.



- c. Remove any butt blocks. In some cases, butt blocks are installed in two steps. Before the outer plank is installed, the butt block is held in position by small screws through the inner plank. Then, after the outer plank is in place 10 screws are driven through the outer plank, through the inner plank, into the block. Since it's very difficult to separate the outer plank from the inner, after removing the 10 main fasteners, you may have to pry the butt block loose from the inner plank.
- d. Pull the plank away from the hull, splitting the inner plank at the seam. You might have to initiate the splitting with a chisel.
- e. Use a chisel to remove any remnants of the inner plank protruding below the outer plank. Otherwise the remains could interfere with clamping/wedging.

### **Clean Up the Frames:**

After removing the planking, the exposed frames will need some attention.

- a. Pull the ring nails that held the inner plank to the frame. Vise-grips and a pry bar might be necessary.
- b. Remove any broken screws using a 7/32" Unscrew-um in a drill running in reverse. Running the drill at high RPMs heats the screw, which can help. A few firm taps with a drift also helps. The pic below shows a collection of tools that are useful in removing old screws. From left to right ... impact screw driver, modified screw for removing bungs, Unsrew-um, another form of screw extractor, modified screw driver for deepening the slot in screws, awl.



- c. Wiped down the frame faces with alcohol.
- d. Make 6 mm x 1" Mahogany plugs using a special cutter.



- e. Drill out the old fastener holes to .24".
- f. Coat the inside of the holes with 106/205 West epoxy using a pipe cleaner.
- g. Coat the plugs with G/flex, and tap the plugs into place. I don't worry about aligning the grain of the plugs with the grain of the frames. G/flex provides sufficient tolerance to differences in shrinkage (probably overkill).

- h. After cure, trim all the plugs flush with the frame with a sharp chisel. As you can see in the pic above, the plugs are cylindrical about 1" long with a small square cap. It's important to keep the cap clear of the frame. Otherwise, the cap becomes bonded to the frame, making trimming more difficult (need to saw them off with a flush-cutting saw). So, either do away with the cap (makes gluing messier), or make sure the cylinder is longer than the hole is deep.
- i. Sand the face of the frames by hand. Power sanded the bronze straps. Vacuum and tack.
- j. Paint with Primocon (2 coats; first coat thinned 10-15% with xylene). Avoid painting the rabbet, since we will be applying sealant in that area.

With the frames reconditioned, the next step is to make the inner plank, but first some preliminary work.

### **Mark Frames for Top Edge of Inner Plank:**

The top edge of inner plank I12-13 lies at the (approximate) centerline of the next outer plank O13. We need to mark the location of this top edge at each frame and at the hood ends. To do so, measure the width of O12 (old plank) and the width of O13 (old plank) and compute  $D_f = \text{width of O12} + \frac{1}{2} \text{width of O13}$ . Using a compass or dividers, make a mark on each frame a distance  $D_f$  from the top of O11. Then using a fairing batten extrapolate the marks on the frames to the hood ends. The pic below illustrates this process. The cream colored plank is I11-12 and the light brown plank is O11.



### **Prepare Scrubbing Templates:**

If the frames have significant curvature (convex), the planking must be hollowed out (called scrubbing) to fit the frame. Because the inner planking is only 3/8" thick, it can flex enough to conform to small amounts of curvature. In that case no scrubbing is

needed. For the outer planks, which are thicker and stiffer, scrubbing is needed for even small amounts of curvature (say 1/16" or greater). Also, unlike Carvel planking, which can be scrubbed just at the frames, the outer plank must be scrubbed for its entire length to conform to the inner planking below it.

To capture the curvature, we make a pair of scrubbing templates at each frame. An example is shown in the pic below. (See "Planking a Carvel Planked Boat" for details on making these templates.)



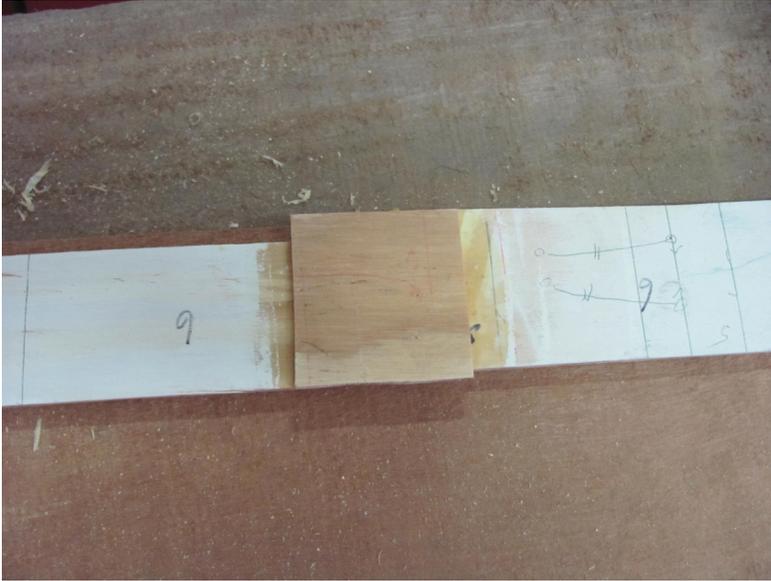
### **Measure and Record Bevel Angles:**

We must measure the bevel angles for the bottom edge of both the inner and outer planks. Measurements are taken at each frame location and recorded on a bevel board (seen below).



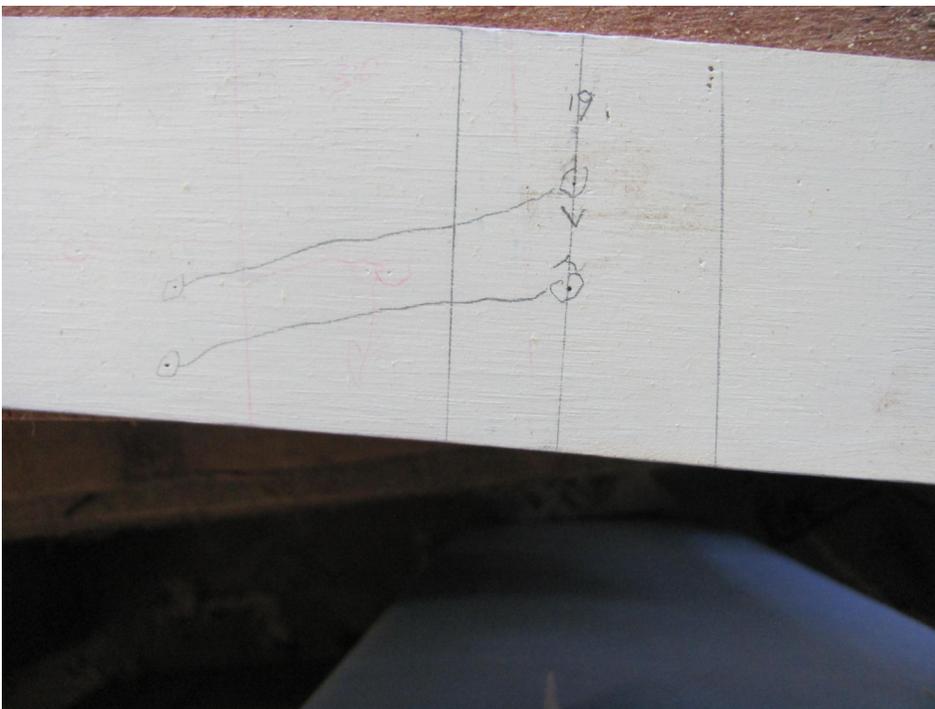


When dealing with battens of this length it's important to limit the amount of edge set. I make my spiling battens out 1/4" plywood in 8' (or shorter) sections. I clamp the sections to the frames and then use glued butt blocks to connect the sections (see pic below). The butt blocks are positioned on top of the batten sections and between frames so as not to interfere with spiling. For flexure strength, be sure to orient the grain of the butt block's outer plies in the direction of the batten.



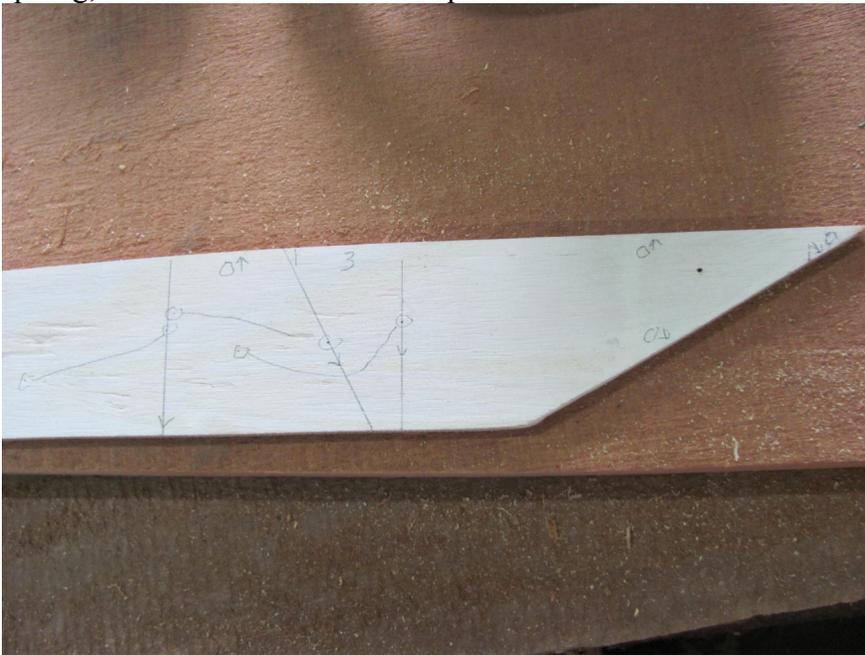
I make reference marks at intervals on the frames and batten so that I can reposition the batten on the boat if necessary.

With the batten in place, I spile for the lower edge of I12-13 by recording the distance from batten to the top edge of I11-12. I also spile for the top edge of I12-13 at the same time. See pic below. Note that the outline of the frames is also recorded on the batten and will later be transferred to the plank.



Spiling is performed at every frame location. At the hood ends, templates are used to capture the shape of the plank, and the templates are attached to the batten (see pic below). The shape of the template is found by a series of cut/fit cycles, with the bottom edge defined by the top edge of I11-12, the leading edge by the shape of the rabbet, and the top edge by a line representing the top edge of I12-13 (constructed during our preliminary steps). The template doesn't have to be precise. Any errors in fit are marked on the template and corrected during reverse spiling.

More details can be found in the article "Spiling Update." Note in particular, the two lines below the numeral 3. These lines capture the location of the apex of the inner plank; i.e., where the rabbet meets the top edge of the inner plank below. One line is perpendicular to the rabbet and the other perpendicular to the lower edge. On reverse spiling, these two lines locate the apex.



### **Stock Selection and Preparation:**

Planking stock longer than about 17' is hard to acquire and hard to handle. Also, due to the inherent curvature of the planks, long stock needs to be quite wide to be of any use. Even with wide stock, to avoid a lot of waste you end up working with shorter stock after cutting out the first piece. If your stock is 17' long you need a width of about 10" to accommodate the worst of the plank curvature. All in all then it seems that 17' x 10" stock is preferable. The question is how to get a 30-40' plank out of 17' x 10" stock?

Clearly the plank must be made up in sections. The traditional approach is to connect the sections on the boat with butt blocks. With planking that is receptive to gluing, scarfing the sections together with resorcinol or epoxy is an option. Then the question is whether

you scarf the stock to get the required length (making the scarfs at an angle to accommodate plank curvature; the pic below is an example), or do you make and fit the sections first (with some overlap) and then scarf the sections together?



Scarfig the stock has the advantage of minimizing section overlap thus minimizing waste. But scarfig stock is more work than scarfig finished plank sections (stock is wider and typically thicker). Also you end up having to reverse spile, cut, and fit a very large piece of wood.

Life is much easier making shorter plank sections. There is more waste, however, since you need at least a 3-frame overlap between sections to assure accurate continuity.

I prefer to make individual plank sections that are fitted independently and then scarfed at the end. On occasion, I will scarf together stock if I need to lengthen the stock a bit, or if the stock is not wide enough for the required curvature (then I scarf two pieces at an angle; which also reduces grain run out).

The rough sawn Alaskan Yellow Cedar planking stock is a nominal 1" and 17' long. This must be resawn into two boards slightly less than 1/2" thick. One should save the thicker boards for those inner planks that will need scrubbing. In preparation for resawing, both faces and one edge should be planed smooth so that the board runs smoothly through the resaw. Just take off the minimum or your plank may end up undersize. At this point we could plane the stock to final 3/8" thickness (plus any scrubbing allowance), but there are some advantages to doing this after the plank sections have been fitted. Working with thicker stock is easier when planing the edges (more bearing surfaces), and the extra thickness provides a level of protection against plank damage during handling. So the rule of thumb is to plane as little as possible until the end. In fact, one could wait until the plank sections have been scarfed together. The one down side is the difficulty in running

a 30 ft. plank though the planar. Note that if scrubbing is required, you have to plane to final thickness before scrubbing, or the planing will remove the scrubbing!

Once spiling is complete, the spiling batten is removed from the boat and used to select suitable planking stock. Since my stock is only 17' long, the plank must be made up of overlapping sections. The overlap is needed to insure that the plank edge remains fair from one section to the next.

I've discovered that it's best to work with two sections. If the stock isn't long enough, you just lengthen it by scarfing an extension onto the stock before spiling. It's easy to do and doesn't require great accuracy. Note that you could carry this one step further and create 30' stock using extensions, but then you would have to fit both hood ends simultaneously, which I find more difficult than scarfing together two sections.

Unfortunately, planks made up of two sections end up with scarf joints all falling in the same area. You can avoid this problem by making the plank out of three sections.

After selecting and preparing (lengthening via scarfing if necessary) the stock, we're ready to reverse spile.

## **Reverse Spiling:**

For each section, perform the following steps:

1. Lay the spiling batten on the stock.
2. Lay weights on one end of the batten to keep it from moving.
3. Carefully lift the other end of the batten and lay it back down striving to minimize edge set.
4. Weight the middle and the other end of the batten to prevent it from moving (or tack them with small nails).
5. Make reference marks (3 minimum) so that the batten can later be returned to its position.
6. Using dividers, reverse spile the data points for the top and bottom edges. Only every third point needs to be developed at this time since the first cut is rough.
7. Develop the shape of the hood ends from the templates.
8. Draw a fair curve 1/2" outside the lower-edge data points. Do the same for the top edge. A 1/2" wide fairing batten does the job nicely.
9. Using a circular saw cut to split the lines. This rough cut is done to relieve any residual stresses in the stock. Cutting out the plank is done outside with a circular saw with the plank resting on pieces of foam insulation board. This is a handy arrangement and keeps much of the dust out of the shop. These exotic woods are good against rot and insects for a reason. You don't want to be breathing too much dust!
10. Return the batten to its position on the stock.
11. Repeat the respiling (bottom edge only), and then make any adjustments to account for obtuse bevel angles. (See "Planking a Carvel Planked Boat for details.)

12. Draw a fair curve through the data points. Keep in mind that the bottom edge must mate with the plank below, so fairness is secondary. Unless we've made a mistake in spiling the curve should run through all the data points. Cut to leave the line. The goal is to run the saw about 1/8" from the line. In that way when the saw starts to track off, you have time to correct the track before you cut on the wrong side of the line.
13. Plane the bottom edge to the line. Leave the top edge as is. It's best to defer finalizing the top edge until after fitting the bottom edge. If the fitting operation results in a significant change in plank orientation, the early marks for the top edge might no longer be fair. If we wait until the plank section has been fitted, we can verify the top-edge points using the scribe marks that we made on each frame. The pic below illustrates the process. We use the dividers to capture the distance from the top of I11-12 to the scribe mark on the frame (representing the top edge of I12-13), and then transfer that distance to I12-13.



### **Cutting the Bevels:**

Next we bevel the bottom edge using the data from our bevel board. Below the turn of the bilge where the curvature of the frames is small the bevel angles are slightly greater than 90 degrees. Here we can just leave the edge 90 degrees to the face. Since the bevels are slightly obtuse, this simplification causes the seam to be slightly open to the outside, but this is ok, since it will be covered by sealant and the outer plank.

Higher up on the boat where the curvature is greater, we cut the bevels using a "bevel limit" line. (see the document "Planking a Carvel-planked Boat" for more details about measuring and cutting bevels).

The final step before fitting the plank is to cut the hood ends to size. Up until now, the hood ends have been marked but not cut. This protects the feather ends from damage. In

most cases, the hood ends at the rabbet have significant obtuse bevels. This means that the outside face of the plank must be slightly longer than the inside face. The reason is that the template for the hood ends, being thinner than the plank, captures the shape of the plank at the bottom of the rabbet, but the bevel of the rabbet is greater than 90 degrees (obtuse) so the top of the plank must be longer than the bottom.

After adjusting for the added length, we cut the hood ends to size and cut the bevels.

Now we come to the question of a caulking bevel. Caulking bevels at the hood end of Carvel planked boats are covered in detail in the literature. Unfortunately, information on double planking is quite limited. The original planking for Alita employed no caulking bevel for the double planking. I see no evidence of any sealant, either. Current opinion is that a caulking bevel is a good idea, so I'm cutting a caulking bevel through the full thickness of the outer plank. In that way, the caulking will rest near the inner/outer plank interface. I'm also applying sealant between the inner plank and the rabbet to further deter leaks.

### **Fitting the Inner Plank:**

At this point, we fit each plank section to the boat. The section is clamped to the frames and feeler gages are used to locate the high spots – where the edges of I11-12 and I12-13 make contact. We plane down the high spots and repeat the cycle until the edges are flush (within .022"). This usually takes about 2-3 iterations. After each iteration, we make a reference mark on the top edge of the plank at a frame located about mid plank. When lifting the section to the boat, this reference mark allows us to use one clamp to properly locate the section. We then add clamps (loosely) at the extreme ends to seat the plank against the plank below it. We can then add clamps left and right of the center position until the entire section is in place. More details can be found in the article "Fitting a Plank."

When a section fits satisfactorily, we make reference marks on the bottom of the plank at each of the 3 frames that overlap with the adjacent section. The mark should extend from the new plank to the one below. Because adjacent sections have a 3-frame overlap, you can't position both sections on the boat at the same time. These reference marks provide registration from one section to the next.

When all the sections fit satisfactorily, we can begin work on the top edge.

### **Defining the Top Edge:**

Depending on how much wood was removed fitting the plank section, the data points defining the top edge might be too low (that's why we've waited until now to work on the top edge). Using dividers, check that the width of the plank at each frame defined by the scribe marks on the frames is consistent with the data points on the plank. Make corrections as necessary.

Draw a fair curve through the data points and saw to leave the line. Plane to the line except where the sections overlap. This area will be re-faired and planed after glue up.

### **Building the Full Plank:**

With reference marks in place, move the two adjacent plank sections to the bench and line up the reference marks (one section on top of the other). Also make sure that the bottom edges are flush along the overlap in the vicinity of the scarf. This is why it's important to have the sections overlap – so that the shape of the bottom edge of the two sections is the same near the scarf.

When satisfied with the alignment, decide where you want the scarf. With a 3-frame overlap, the natural choice is at the middle frame, but it can also lie between frames. Just choose a location where the bottom edges of the two sections coincide. Then clamp the two sections to the bench and make reference marks so that the sections can be precisely returned to their proper position. Note that after the scarf joint has been cut, we lose the 3-frame overlap making accurate alignment more difficult. The key is to make reference marks close to and as far as possible from the scarf to facilitate accurate alignment during glue up.

Layout and cut the scarf joint, and glue up the scarf with resorcinol. Clamp the sections to the bench as close to the scarf as possible to minimize any movement during glue up. Use  $\frac{3}{4}$ " plywood to distribute the clamping forces. Use wax paper as a release.

Here we see the 4" scarf partially cut. To make perfect matching scarfs, the scarf is cut on both sections simultaneously. Note the sacrificial piece of wood clamped to the front of the bench to support the feather edge as we complete the scarf.



Here the wider view reveals the clamping arrangement. You want enough clamps to keep the set up in place but not too close to the scarf to interfere with planing.

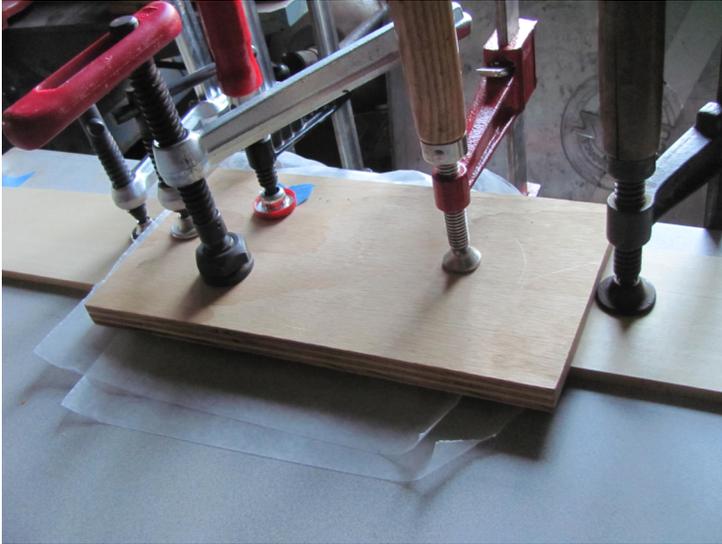


I've found that the joiner plane works best for cutting the scarfs. It lands on both scarf faces simultaneously and cuts a wide chip. I mark lines at regular intervals on each of the 2 sections and plane until I hit both lines simultaneously. This allows me to monitor progress.

If you hit the end line for both sections simultaneously, the angle will be correct; however, if one section is thinner than the other then it will reach a feather edge first. Just

stop when this happens. The scarf will still fit well at the joint but the thicker section will have a thicker feather edge that will have to be planed down after glue up. It's best for the thickness of both sections to be same. More detail can be found in "Cutting Scarf Joints."

Here we see the scarf joint being glued up.



Note that it's possible to glue up the scarf on the boat. An example is shown in the pic below. Alignment is easier, of course, due to the presence of the plank below; however, clamping is more difficult since the joint is typically at a curved section of the hull. A block of wood on either face helps distribute the clamping pressure.



## **Finishing the Top Edge:**

After the glue sets, the scarf joint is cleaned up with a small hand plane. Note that during the fitting process the line defining the top edge of the plank might not be fair in the vicinity of the scarf. That is why we left the top edge rough in this area. We can now use a fairing batten to correct any unfairness and plane the top edge to the line and square to the face of the plank. Note that the priority for the bottom edge of the plank is to match the top edge of the plank below – fairness is secondary. For the top edge, fairness is the top priority to make it easier to fit the next plank to it.

Finally, we paint the inside face (2 coats of Primocon) and nail the plank to the frames and rabbet with small (#14 x 1”) ring nails. If we keep the nails near the edge of the plank and away from the center of the frame, we should be able to avoid hitting them when installing the fasteners for the outer planks.

## **Making the Outer Plank O12:**

Making the outer plank (O12) is similar to making I12-13. Here is a summary of the steps.

1. Mark the top edge of O12 onto I12-13. This provides a reference for the scrubbing templates and bevels. You can locate the marks by either measuring up from O11 by the width of the old O12 or measuring down from O14 by the width of O13. Extend the top edge of O12 to the hood ends using a fairing batten.
2. Make scrubbing templates and measure bevel angles. Bevel angles can best be taken from the scrubbing templates, unless the frame is fairly flat, in which case you don't need a scrubbing template. In that case, measure the angle directly using a small bevel gage (lay a scale on the plank edge to provide more bearing surface for the bevel gage).
3. With some modification we can reuse the spiling batten used to make I12-13. First we remove the butt blocks to separate the batten into sections. We make any necessary adjustments to the hood-end templates and clamp them in place on the boat. We then clamp the sections to the boat, adding or cutting as needed to get them to fit end to end. Next we sand and paint the sections white (except where the butt blocks will go). After the paint dries, we clamp them in place on the boat. Glue butt blocks to make a full-length batten and mark location of the batten on I12-13 (say a mark every 8').
4. Spile for the top and bottom edges of O12.
5. Lay the spiling batten onto the Wana planking stock and decide where the section break(s) will be. The planking stock is 1” thick that will eventually be planed to 5/8” but it's almost 2' wide so we'll defer planing until after the plank is cut.
6. Reverse spile using every 3<sup>rd</sup> data point. Since the first cut will be rough, precision is not required.
7. Draw cutting line 1/2” outside plank marks and cut to the lines using a circular saw with the plank laying of sheets of foam insulation. Don't trim the hood ends at this point – just let them be a bit long.

8. Plane the sections to finish thickness. The plank is nominally 5/8" thick but we need to add some for scrubbing allowance. Note that unlike the inner plank, we cannot defer planing to final thickness until after fitting, because the plank needs to be scrubbed for fitting. Planing after fitting would remove the scrubbing!
9. Repeat the reverse spiling process (now at every data point), cut the top and bottom edges using a circular saw. Plane the bottom edge to the line and square to the face. The top edge should be left full and trimmed after fitting and glue up.
10. Layout and cut the bevels on the bottom edge.
11. Cut the hood ends to size using a hand saw, making adjustments to the cut line to account for any obtuse bevel angles. Clean up the cut with a plane making the cut square to the face of the plank. Cut bevels at hood ends.
12. Scrub inner face at those stations that have significant curvature (cord depth 1/16" or more). The outer face needs scrubbing too unless the curvature is minor. In that case, scrubbing will be dealt with when fairing the hull.
13. Fit the sections independently.
14. If the fitting process resulted in a significant change to the bottom edge, reconstruct the curve for the top edge. Cut and plane to the line, except where the sections overlap. Leave that area until after glue up.
15. Cut caulking bevels at hood ends. Bevel extends the full thickness of the plank.
16. Layout and cut the scarf (strive for about 10:1 scarf). Glue the scarf on the bench (or maybe on the boat if alignment is a problem) using the reference marks to position the sections correctly. Use resorcinol as the adhesive. Use wax paper (2 mil) for release.
17. Finish up the top edge.
18. Trace top edge of O12 onto I12-13 so that we know where to apply primer.
19. Apply sealant to O12 (primer first on both faying surfaces)
  - a. Sikaflex 291 LOT (about 3-4 hrs. open time. About 1 tube of 291 and 1/2 can of primer per plank.
  - b. Use pneumatic caulking gun (about 40 psi).
  - c. Working left to right, apply 1/4" bead in serpentine pattern for about 1 ft. Using 2mm triangular trowel, pull about 3" of sealant from right to left to cover wood. Then remove excess dragging trowel left to right.
20. Fasten with 2" bronze flathead wood screws; 3 per frame except at ends where the plank is narrower; counter sink screws about 3/16". Plug with Wana bungs coated with red lead.
21. Back fasten the inner plank to the outer from inside the boat. Also fasten the bronze straps to the planking from the inside.