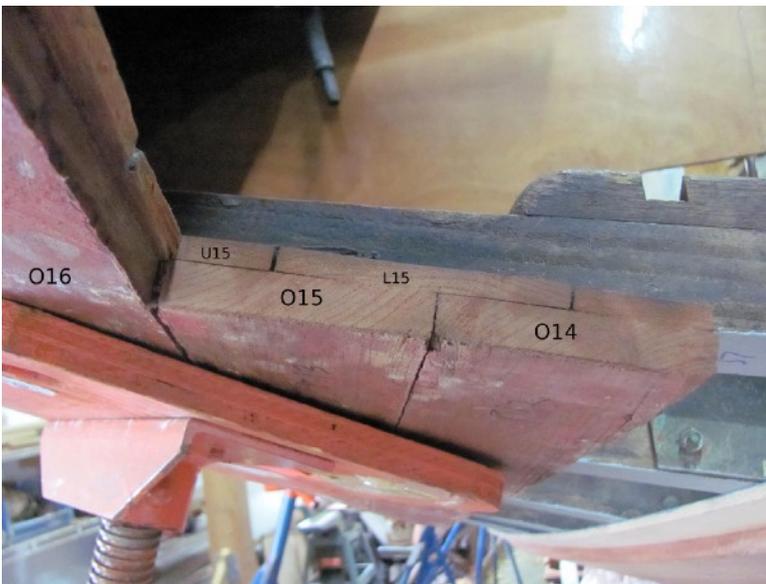


Double Planking (top down)

Double planking consists of an outer plank O overlapping two inner planks – an upper U and a lower L. Referring to the picture below, if n represents the number of the plank being replaced, then O_n overlaps U_n and L_n . The outer plank below O_n is O_{n-1} . Note that $L_n = U_{n-1}$.



To simplify the discussion, let us consider the case when $n = 15$. The pic below illustrates this particular case.



Preconditions: Since we are replacing planks top down, we assume that O_{16} and U_{15} have already been replaced. To accomplish this O_{15} and the top half of L_{15} would have already been removed. O_{14} and the lower half of L_{15} would still be in place to provide something to wedge against during the replacement of plank 16.

The pic below shows O16 (brown) being clamped in place, with the lower half of L16 (tan) showing below it. O14 is the (green) plank below the clamps.



Preliminary steps:

- Record the width of O15 at each frame and at the hood ends. The approach is not to measure O15 directly, but to measure the gap left by the removal of O15, where the distance is measured square to the bottom edge of O16. This gives a measure of the width of O15, which is slightly different than the width of the original O15, because O16 is typically an imperfect replacement. If portions of O14 have already been removed, measure the old plank O15 to fill in the gaps. So it's a good idea to save the old plank until it's been replaced.
- I used to fair this width data using Rhino, but I no longer think this is necessary. Fairing width data doesn't necessarily produce a fair plank edge since it depends on the fairness of the top edge. Instead the plank width should be transcribed to the plank during reverse spiling and then the bottom edge should be faired with a fairing batten. We should strive to maintain the old plank width as is reasonable; otherwise, accumulated errors may result in significant differences between new and old.
- Record the width of O14 at each frame and at the hood ends (measuring the plank directly). Again measure square to an edge. This data will be used to compute the location of bottom edge of L15.
- Remove old O14 to make room for O15. The top half of L14 and the remains of U14 will also be removed.
 - Remove bungs and frame fasteners
 - Remove hull strap fasteners



- Remove butt-block fasteners
- Use putty knife to split inner plank
- If necessary, saw O14 in half at convenient locations (makes it easier to split inner plank)
- Cleanup frames
 - Remove broken fasteners. Note, some fasteners might be “locked in” due to other fasteners in the frame (bilge stingers, bulkheads, etc.)
 - Remove old nails
 - Enlarge fastener holes to .24” diameter; depth equal to thread length of screws (1.25”).
 - Make 6mm plugs (H. Mahogany) with tabs for easier handling



- Plug holes
 - Wet out holes with 105/206 and pipe cleaner
 - Plug using G/flex (keep plug tabs clear of frame)
 - After cure, trim plugs with chisel/scrapper/plane
- Clean frame face – scrape, alcohol, sand, vacuum, paint (2 coats Primocon)
- Mark frames for bottom edge of L15.
 - Lower edge measured from bottom of O16 as width of O15 + $\frac{1}{2}$ *width of O14. This puts the bottom edge of L15 at the mid-width of the next outer plank O14. Use previously collected data on O15 and O14 and then use Rhino to fair the curve. (Again, fairing at this point may be superfluous.)
 - Use dividers to scratch arc onto painted frames. (Note: the pic below shows this process when working bottom-up, but the principle is the same.)



- Circle middle of arc with contrasting marker. This is not accurate, especially when the planking does not run perpendicular to the frames. We measured the plank widths perpendicular to the plank edges, but we're laying off this distance along the centerline of the frame. So if the planking is not perpendicular to the frames the mark on the frame will be short. If I try to stay perpendicular to the bottom edge of O16, the mark in some cases will not lay on the frame. We want the edges of the inner planks to lie at about the centerline of the outer planks so that we can accurately install the back-fasteners from inside the boat where we can't see the outer plank seams. To correct for this error, we need to adjust the length to account for the angle ϕ between plank edge perpendicular and the centerline of the frame. $\text{Adj. length} = \text{length of perpendicular} / \sin \phi$.
- Spile for L15
 - Separate spiling batten into sections
 - Modify hood-end templates to fit. Accurate hood-end templates are not required. Normal spiling is usually accurate enough. The fitting cycles will correct any errors. I've found that the best way to capture the shape of the hood ends (when the edges are approximately straight) is to shape the end of the spiling batten to roughly approximate the shape of the hood end, but with significant clearance. Then using a straight edge, transfer the shape of the hood end to the spiling batten. Reverse spiling is done with the same straight edge and a combination square to transfer the edge of the straight edge to the planking stock. For curved edges, a flexible batten can be used in place of the straight edge.
 - Clamp spiling-batten sections to boat, adjusting lengths as needed (Note: When clamping, clamp in the middle and then add clamps left & right to smoothly lay batten against frames. This is insurance against edge set. This continues to be a problem. It's very easy to introduce edge set in the spiling batten and as little a

1/8" can make fitting more difficult. I now think that the trick is to clamp the batten in the middle and smoothly lay the batten to the frames, endeavoring to support the weight of the batten as you go. As you go, mark the frames where the batten intersects them. Then clamp the batten to the frames at the marks. Otherwise installing clamps as you go can inadvertently shift the batten (usually downward). I've had very good first fits using this technique. I've also had luck with this method using spiling battens almost 16' long without having to splice them on the boat.

- Sand sections where butt block will go. Just wipe down rest of section with alcohol. If not too dirty just a wipe down with a tack cloth is enough.
- Paint spiling-batten sections with white house paint
- Clamp sections to boat. Clamping can be difficult when the bilge stringers are in the way. Use square steel tubing fastened at the middle fastener hole in the plank below. It's best just to remove all the middle fasteners since you will need to eventually.
- Make and install butt blocks (2.5" x 3") 1/4" plywood with grain of outside plies oriented along the length of the batten.
- Spile for top and bottom of L15. The data point for the top edge is measured perpendicular to the bottom edge of O16 at the middle of the frame. Use a scale to draw a line on the batten to indicate the correct direction. Label the line with the frame number. The bottom edge is measured from the circled arc on the frame along the centerline of the frame. (Maybe better along the same line as top edge. If that misses the frame, just move the line slightly.)
- Lower batten to floor using ropes. It's fragile at the butt blocks. It's a lot easier handling three 16' overlapping spiling battens than one full length one. Also less chance of edge set. Down side is some loss in flexibility choosing the scarf locations.
- I now just use two 15' spiling battens. One for the aft section and the other for the forward section. I then use one of these two battens for the middle section (using a different color markings). If a batten isn't long enough for the plank section that I'm making, I can just extend the spiling using data from the other batten.
- Prepare the AYC stock for L15. (I now have lumber resawn at Signature Door for \$8 per cut. Very smooth cut with 1/16" kerf.)
 - Thickness plane both surfaces of the 1" AYC lumber to clean them up. Just enough to evaluate any cupping and to provide a finished surface against the bandsaw fence. The thickness after this clean up should be at least 1.07" (1.1" is better) to allow for clean up after resawing.
 - Plane both edges square to face (shooting board method).

- Draw a line on both edges midway between the two faces as a guide for sawing. Draw a double line on the end grain separated by about .1" as a guide for starting the cut. It's vital to get this right because you don't have a lot of thickness to play with. Saw the end square first.
- The 10" wide x 1" stock is heavy the thus makes feeding the stock into the resaw difficult. I found that if I could suspend the plank on either end with a roller, it feeds more easily. Also fastening a clamp to the stock and pushing on the clamp is less tiresome than holding on to the stock. (not necessary with proper rollers)
- Don't let the motor stall or slow down – burns out starting capacitor.
- Don't feed too hard; I've broken the blade twice now in two days (this was the carbide blade, which is brittle). The first may have been due to a frozen guide bearing and loose guide blocks. No explanation for the second failure, but the blade broke below the work piece so I suspect too much feed was the culprit. Could be that the blade is too thick (.035") for the wheel diameter. Ordered a .025" resaw blade from Highland Woodworking. New blade works fine. Cuts about as fast as the carbide blade but with narrower kerf. Yes but it didn't last very long – got dull and wouldn't make a straight cut. (I now believe that the carbide blade wanders off line causing a sharp flexing at the bottom of the cut. I could see this with the narrower blade, which is flexible enough not to break.) I now have a Lennox 2 TPI carbon blade (.035) . The bigger gullets help. I've been able to make two very straight cuts with this blade. Kerf is .1", which is somewhat problematic with marginally thick stock. Still takes about 1.5 hrs for a 15' x 10" board.
- After resawing, cleanup the boards with planer just enough to layout the planks.
- Layout L15 on AYC planking stock. The plank consists of three sections scarfed together. You can only get one section (well maybe 2) out of one (15' x 8-10") board.
 - Try to stagger the scarf joints for adjacent planks.
 - Avoid scarfs at points of high frame curvature. The plank will be forced to conform to the curvature of the frame. The scarf is probably less flexible than the rest of the plank.
 - Provide a 2-3 frame overlap (2 is enough) at scarf joints to help with aligning the plank sections.
 - Reverse spile plank sections. Label each point with the frame number.
 - Use fairing batten to interpolate spiling points
 - Cut top edge close to the line; cut bottom edge ½" outside line. With the extra ½" at the bottom, small movement due to stress relief will be corrected during fitting. Leave hood ends full until fitting.
- Fit plank sections

- Plane top edge square and to the line (shooting board method)
- Cut hood ends to size (can't wait until after planing because you'd lose your cut line); account for bevel angles
- Thickness plane sections to 3/8" (transfer frame labels to edge so we don't lose them); run the planks through the planer hood end first so that hood ends aren't snipped. Flip the planks longitudinally for the last two passes to balance out planer taper. (Not a problem now that I've tuned the planer.)
- Fit plank sections individually, starting with forward and aft planks. It's best to fit the hood ends without also having to match the middle section. (I really doesn't matter what order the fitting is done.) Once the ends are fixed, and reference marks made, the middle section can be fitted.
- Clamping can be problematic if bilge stringers are in the way. In that case, clamps cannot be positioned at the frame. Instead the clamping is to the inner plank above. This ultimately makes marks on the inside face of the inner plank. A weak alternative is to clamp a bar to the planking below and drive a wedge between the bar and the plank. Both methods are shown in the pic below. (I now have another method of clamping using the center fastener of the plank above.)
- During fitting, make sure plank is flush against the frames, otherwise the twist of the plank will not be correct and fit won't be right. This might not be possible with bilge stringers in the way.
- Make reference marks at three frame locations (doesn't have to be right at a frame) to register adjacent plank sections. Also draw the frame outline on the plank. Label with frame number. Also make a reference mark near middle of middle section as a guide when installing the full plank.



- Redefine bottom edge of the sections by measuring the distance from the bottom of U15 to the mark on the frame and transferring this mark to the L15. Distance measured along centerline of frame. This transfer is accurate since we have the frame outline on the plank for reference. (Well not quite ... The measurement is sensitive to where on the frame (fore/aft) that you place the divider point.)
- Overlay the plank ends and decide where to cut the scarf. Make sure bottom edge curves of adjacent plank sections are consistent in the scarf area. Don't need to worry about this if you defer trimming in this area until after glue up.
- Cut and plane bottom edge of all sections (square to the plank face). Defer trimming of scarf area until after glue up.
- Build full plank
 - Scarf sections together making sure reference marks line up.
 - 4" scarfs with resorcinol
 - Paint inside face of plank with 2 coats Primocon (avoid ends where sealant will go) (note that Primocon literature says to wait about 8hrs before overcoating at 50 degF; it's 3 hrs at 90 degF); use foam brush. Bristle brush tends to deposit paint on the edges. Foam will swell due to solvent but will last for the full coat.
 - Clamp and fasten plank using #14 x 1" boat nails (counterbore with Forstner bit; .080" pilot hole) with Sikaflex sealant under hood ends. I've also tried heating the plank with a heat gun before forcing the plank to conform to the curvature of the frame – not sure it helps. Note that the edges of the plank between frames tend to buckle due to the added compression at the edges due to the frame curvature. In effect you're trying to force a planar object to conform to a compound curve (e.g., a sphere). This is not a developable surface. The back fasteners should mitigate this problem – best if they could be applied before the sealant sets up. When installing nails, do the upper ones first (adjacent to previous plank). Then clamp the bottom snug against the frame. Starting at amidships, remove a clamp, drill, and hammer nail flush. Then replace the clamp and finish the nail with a drift.
 - Fair transition from previous inner plank to this one (trim transition from U15 to L15).

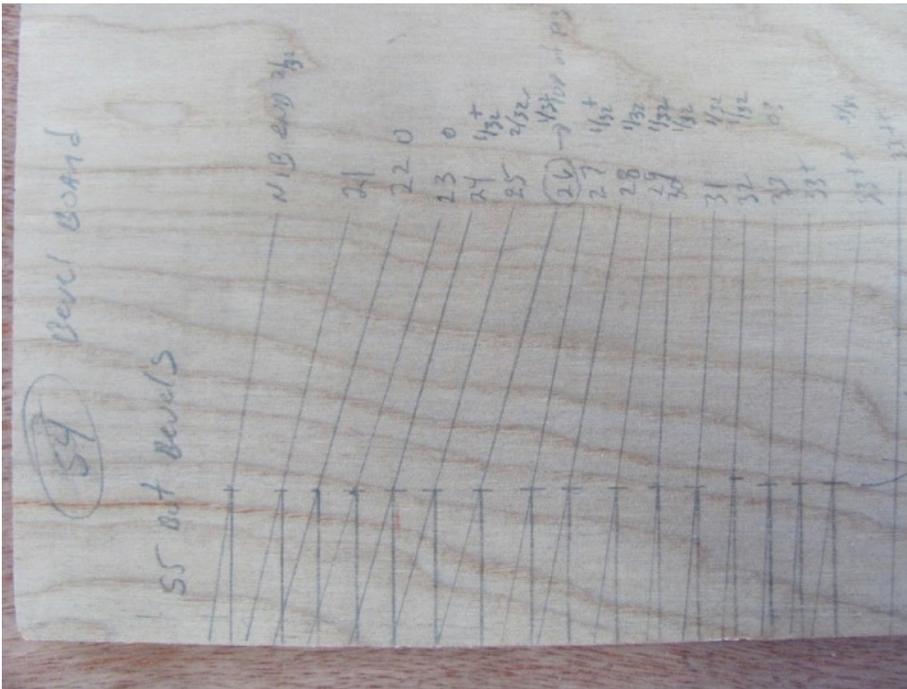
Outer Plank O15:

- Mark the approximate location of the bottom edge of O15 onto L15.
 - a. This provides a reference for the scrubbing templates and bevels. This is most easily done using the width of O15 collected earlier. At each frame, set dividers to the width of O15, and transfer that width from the bottom of O16 onto L15 (on a line square to bottom edge of O16).
- Make scrubbing templates. (3 x 5 AYC scrap make good template stock)

- b. A contour gage is convenient for capturing the shape of each frame. We then trace this shape onto a piece of template stock. Two templates are made at each frame, one concave and the other convex. The convex template is used to scrub the inside face of the plank, whereas the concave version is for shaping the outside face (rough estimate; actual curvature will be somewhat less). You can make both templates in one operation if you saw carefully. (Use a bandsaw with 3/4" blade. It follows the line better than a narrow blade.)
- c. The templates capture the shape of the frame from the bottom of O16 to the mark on L15 indicating the location of the bottom edge of O15. Often one template covers a sequence of frames, so one template can have numerous marks.



- d. Locate the template with the maximum curvature. Measure the cord depth. This will be the added thickness of the plank to account for scrubbing.
- Record the bevel angle of the bottom edge of O16 at each frame.
 - a. This angle is relative to the face of the new plank O15. This is most easily done using the concave scrubbing template. We position the template on the boat and trace the bevel angle onto the template using a small parallel. (the parallel should be very light so that you can hold it against the plank edge and the template against the inner plank with one hand.) We also indicate the location of the bottom edge of O15. Remove the template from the boat and place a parallel along the concave edge of the template with the end at the bottom edge mark. Using a bevel gage capture the bevel angle and record it on a bevel board. If a template is used for multiple frames, be sure to distinguish which bevels/marks go with which frames. (To avoid confusion, I now erase the bevel mark once the bevel is recorded.) If the plank face is fairly flat such that a scrubbing template is not needed, the bevel angle can be measured directly using a small bevel gage.



- With some modification we can reuse the spiling batten used to make the inner plank L15.
 - a. First we remove the butt blocks to separate the batten into sections.
 - b. We make any necessary adjustments to the hood-end templates and clamp them in place on the boat. (I no longer make accurate templates for the hood ends. I just spile and let the fitting process correct any errors.)
 - c. We then clamp the sections to the boat, adding or cutting as needed to get them to fit end to end.
 - d. Next we sand (alcohol wipe is good enough for paint area) and paint the sections white (No paint where the butt blocks will go). If the batten isn't too dirty, the alcohol wipe isn't need. Just remove the dust with a tack cloth.)

- e. After the paint dries, we clamp them in place on the boat. Glue on butt blocks (typ. 2.5 x 3") to make a full-length batten and mark location of the batten onto L15 (say a mark every 8'), in case we have to put the batten back on the boat. (I rarely do this now. Since I've never had occasion to put the batten back on the boat.
- f. A full-length batten is hard to handle, so I've tried using three shorter overlapping battens. Pros and Cons:
 - i. Shorter battens are easier to handle and less likely to introduce edge set during reverse spiling.
 - ii. The overlapping battens (as opposed to short sections with butt blocks fastened on the boat) are harder to position on the boat w/o introducing edge set. I've seen poorer first fits with this approach. I believe this has been corrected by positioning the batten by hand and marking the location on the frames before clamping.
 - iii. Shorter battens offer less flexibility in scarf position.
 - iv. I now think that I've resolved these difficulties. Here is what I think is best:
 1. Make three spiling battens (fore, middle, aft), where each batten is the length of the longest plank section – typically about 15'. Don't make them too long so that edge set and handling are problems. (I now have tried a 20' batten and it's about as long as one can reasonably handle alone. You still need the help of ropes to lift it into place.) You just need to make them long enough so that the fore/aft sections overlap the middle by 3 frames or so. In that way you can make a plank that spans two battens (described shortly).
 2. Clamp one of the battens to the boat at about its midpoint.
 3. Work aft frame by frame lifting the batten into position, making sure you are supporting the weight of the batten, allowing it to smoothly contact each frame. As you do so, make a pencil mark where the batten intersects the frame (about every other frame or every third frame should be good enough).
 4. Clamp the batten to the frame at the mark.
 5. Repeat this going forward
 6. Spile and reverse spile as usual. These shorter battens should be easy to avoid edge set on reverse spiling.
 7. If for some reason you need to create a plank that spans two spiling battens, this can be done without respiling using overlapping battens. Here is what you do ... Reverse spile the first batten as usual. Now lay the second batten on the stock so that the frame references match. Adjust the batten so that the spiling points from the first batten match the points from the second batten. Add the new spiling points and fair the curve as usual.
 8. To improve accuracy, it helps to make a reference mark on each frame and transfer this reference to each batten as you spile. This makes it easier to align the two battens if needed.

9. At this point (P17-P16), the middle batten is too straight, so I make the aft batten do double duty. I just spile with a different color.

- Spile for the top and bottom edges of O15. Indicate the spiling line, which is usually perpendicular to the bottom edge of O16. An alternative to spiling for the bottom edge is to use plank width data to plot the bottom edge data points during reverse spiling. These are plotted as a series of offsets from the top edge data points (along the spiling line). The first cuts will be rough so accuracy isn't important. (This a lot easier than fussing with the spiling batten to make all the bottom edge points visible.)
- Select Wana planking stock and use a power plane to clean up the surface exposing any defects or sap wood. (Even if I had a heavy duty planer, I'd loose to much wood running the entire board through the planer – too much warp and twist in the stock.) With my current stock of Wana, clear stock is rare. Most boards have either wild grain, many knots, or checks in the middle of the board - most of these are hard to detect until after planing.
- 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 some of the stock is almost 2' wide so we'll defer planing until after the plank is cut. New stock is only 12" wide.
- Reverse spile using every 3rd data point. Since the first cut will be rough, precision is not required. (May be useful to spile very point to get most out of a board)
- Draw a 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. The extra 1/2" margin is to allow for any stress relaxation. Don't trim the hood ends at this point – just let them be a bit long.
- Plane the sections to finish thickness. The plank is nominally 5/8" thick but we need to add some for scrubbing allowance (max cord depth from scrubbing templates; max is about 1/8"). 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! (Not strictly true – we could just plane the outside face of the plank, but this is probably not a good idea.)
- Reverse spile the top edge using every data point. You can use every 3rd data point for the bottom edge (It may be helpful to plot every point to be sure the plank avoids any defects). Be sure to adjust the top-edge data points for any obtuse bevels.
- Draw a curve through the top-edge data points. The shape of the top edge must match the bottom edge of O16 so accuracy takes precedence over fairness. Cut close to the curve using a circular saw with the plank laying of sheets of foam insulation.
- Draw a cutting curve 1/2" outside the marks for the bottom edge and cut to the line. The extra margin comes in handy if we need to remove substantial material during fitting. It might not be necessary to redraw and recut the bottom edge at this point. We do this after fitting.
- Plane the top edge to the line square to the face. The plank is clamped to a flat bench with a Formica top using shims to elevate the plank above the surface. A smooth plane is then pulled/pushed along the edge producing an edge square to the face. I call this the shooting board technique. (The sides of my smooth plane are not perpendicular to the sole, so I now use the smooth plane to remove the bulk of the material and finish up with a block plane. Now I just use the block plane)
- Layout and cut the bevels on the top edge. I use a bevel-limit line and also check the bevels with a bevel gage as I progress. Having multiple bevel gages is a time saver.

- Scrub the inner face at those stations that have measurable curvature. When checking the fit of the template while scrubbing, the top edge of the template should match the top edge of the plank. The lower reference is the bottom edge of the plank, which is marked on the template (but not on the plank, since the bottom edge is unfinished). The mark on the template should be flush with the inside face of the plank when the depth is correct. Be sure to check fit between frames. It's helpful to draw the cut line for the lower edge (use dial calipers to layout the data points from Rhino; no, the templates should do well enough for this) and then use a magic marker to make regular marks across the plank face. This provides a reference for planing. Note that during fitting, if a lot of material is removed, the cut line for the lower edge will move. Maybe a final check of the scrubbing would be good after fitting.
- The outer face needs scrubbing too unless the curvature is minor. This scrubbing must wait until after the plank sections have been glued up, otherwise scarfing becomes more difficult with both faces curved. Actually, you can do most of this scrubbing before glue up. Just avoid those areas where the scarfs will be.
- Cut the hood ends to size using a hand saw, making adjustments to the cut line to account for any obtuse bevel angles. If necessary, clean up the cut with a plane making the cut square to the face of the plank. Cut bevels at hood ends.
- Fit the sections independently
 - g. Mark gaps between new plank and the one above and plane the high spots.
 - i. Between marks 10> and <10; two planing passes. (.005" shaving per pass). Start the plane at the mark for both passes.
 - ii. Between marks 22> and <22; two planing passes. Start the first pass half way between the 22 mark and the 10 mark (if there is a 10 mark). Start the second pass at the 22 mark.
 - iii. Between marks <10 and 10> (seam not wide enough for .022" gage); treat it like (2)
 - iv. Between marks 30> and <30; two planing pass. Same for <22 and 22>
 - v. Between marks 48> and <48; three planing passes. Same for <30 and 30>. Start the passes at 1/3, 2/3, and 3/3 the distance to the 30 mark.
 - vi. Between marks 63> and <63; three planing passes. Same for <48 and 48>
 - vii. Between marks 85> and <85; four planing passes.
 - h. If fitting requires a lot of planing, be sure to occasionally check the bevel angles. Make sure blade is square to the sole.
 - i. Make a mark on the current plank and the one above at three frames (both ends for middle section) to provide a positional reference. Make sure that gap at the reference marks is <.010 to insure accurate alignment later.
- Reconstruct the points for the bottom edge. Cut and plane to line (except in the neighborhood of the scarf – leave rough cut).
 - a. Using the width data for O15 collected earlier, use dividers (dial calipers are quicker) to transfer this data to the plank at each frame. Draw a fair curve (fairness takes priority over intersecting the points). Cut and plane to the line, except where the sections overlap. Leave that area until after glue up.
 - b. When there is a significant bevel angle, the plank width depends on whether you measure the outside or inside face. When taking the plank width at each frame, it's the width at the inside face that you're measuring. When reconstructing the bottom edge, be sure to use the inside face of the plank to

define the data points; however, since the inside face has been scrubbed, you might want to make the cut with the outside face up, so you need to transfer the cut line to the outside face. No, this is not necessary. The circular saw has a wide base, so it rides on the edges.

- c. Use a square to transfer data points to opposite side of plank. This works because the edge is square to the face (make sure that it is), but it's a good idea to check - make sure scale lies flush on the plank face.
- Scrub the outside face. Make a 5/8" reference line on both edges and plane to the line (Shoot for about .650" leaving the balance to be done when fairing the hull). Do the marking before glue up when the plank is in sections. Then scrub the outside face except in the area of the scarf (If you scrub the scarf area of one section, it's ok - just put that section on top when planing the scarf). When you clean up the scarf, you'll end up removing your marking, but just redraw it and finish scrubbing the scarf area. Be sure to transfer your reference marks to the plank edge so that you don't accidentally remove it when scrubbing. You should be avoiding that part of the plank anyway, but it doesn't hurt to be cautious.
- Layout and cut the scarf (strive for about 10:1 scarf; 7.5" for nominal 5/8 – 3/4" thick). Glue the scarf on the bench using the reference marks to position the sections correctly. Use resorcinol as the adhesive (about 15 grams). Cutting and gluing the scarf with a significant concave inner face is a bit problematic. Planing works better with bottom section concave up. Near the end, you may need to use the apron plane (smooth plane) against the grain to feather the ends. Clamping for gluing also works best concave up. You can't effectively clamp in the concavity but you can clean this up by some touch-up scrubbing after the glue cures. Scarfing would be easier if I had a plane with a fore sole longer than 7.5" so that the fore sole is in contact with both sections at the same time. I now have a #8 plane that has an 8" fore sole and it works fine. I now use a 7" scarf.
 - d. Longest of two sections should run toward back of garage with concave face up.
 - e. After cutting the scarf in the longer section, the face of the scarf should be up. This allows you to clamp the long section to the bench before applying the glue. Otherwise (scarf face down), you have to flip the section to apply the glue and then flip it back.
 - f. The shorter section has the scarf facing down but this section is easier to flip. Also bringing the joint together is easier with the shorter section scarf down.
 - g. Put scrap pieces of AYC under the planks; grain running lengthwise; extending just beyond the end of the scarf. Better support for plane sole at feather end.
 - h. While planing the scarf, the plane can tend to cut the lower section steeper than the upper. This becomes apparent when the thickness of the feather end of the lower is thinner than the feather end of the upper. It's a good idea to check the angle occasionally (about 5.7 deg) to insure that its same top and bottom. If not you can try some of the following:
 - i. Put plane in contact with bottom of upper scarf and top of lower scarf to correct the problem (untested).
 - ii. Use a low angle block plane to trim the top feather edge by (carefully, using a slicing motion) planing in the opposite direction.
 - iii. Often the planks are bowed and you can't get a clamp close enough to the end to hold them down. So if the top scarf bows upwards it provides too steep an angle for the bottom scarf. This might correct itself once the feather edge becomes more limber.

- iv. Try planing the top scarf further than the bottom (as long as the top scarf angle is correct). Once the top scarf is well established it should help bring the lower scarf in line.
 - v. Note that a power plane can be used to speed the process. You first need to hand plane until the scarf is well established - say 2" long - wide enough so that power plane sole is well supported (doesn't allow cutter to drop down as sole exits scarf). You can only plane one surface at a time (planer doesn't have long enough sole to plane both surfaces continuously). Plane until you have about 1.5" remaining, finishing up with the hand plane.
 - vi. If one of the plank sections has significant twist, you may have to plane the flat. Set the bevel gage for 5.7 degrees and check the gage frequently. Drawing the cut line on the edge of the plank is a good reference.
- Clean up the scarf, including blending in the bottom edge and scrubbing both faces. Repeat for the other two sections.
 - Check the fit and make a mark near mid-plank for alignment. Also mark location of frames and where fasteners will go to avoid bolts through frames.
 - Cut caulking bevels at hood ends (1/16"). Bevel extends the full thickness of the plank. I now do this when fitting the individual section while the plank is of manageable length.
 - Trace bottom edge of O15 onto L15 so that we know where to apply primer.
 - Apply sealant to O15 (primer first on both faying surfaces; 30 min to 24 hr drying time; <2 hrs is best)
 - Sikaflex 291 LOT (2-3mm (3/32") triangular notched spreader; about 3-4 hrs. open time; About 1+ tubes of 291 and ½ can of primer per plank.
 - Use pneumatic caulking gun (about 40 psi). (A manual one works fine with less of a tendency for squeeze out. Store 291 in house overnight to lower viscosity.)
 - Working left to right, apply ¼" bead in serpentine pattern for about 1 ft. Using 2-3mm triangular trowel, pull about 3" of sealant from right to left to cover wood. Then remove excess dragging trowel left to right. If the plank surface is concave, drag the trowel laterally. (It's probably best to use a new one each time, since the teeth tend to ware down.)
 - Better technique ... Run the bead just inside of the far edge. Then pull the bead toward the opposite edge with the trowel. Smear the excess on the far edge to fill the bare spot and the push the trowel away from you to complete the pass. The size of the bead depends on the width of the plank. About ¼-1/2" is about right.
 - Lift the plank into place and clamp.
 - Note: I've had trouble getting the midpoint marks to line up precisely. I can align them initially but somehow adding the clamps causes a shift. Usually the misalignment is 1/32" or less, which is tolerable. Anything more is not. You can shift the plank during a dry fit by clamping a block of wood to the plank and hitting it with a heavy hammer, but It's almost impossible to shift the plank this way once the plank has been seated against the sealant. If you encounter this problem, try this to shift the plank forward (shifting aft is similar) ... remove the clamps from frame 43 to about frame 30. Keep the clamp at the hood end aft and use wedges to shift the plank forward. The plank will bow outward to accommodate the shift. Now loosen the clamps from frame30 forward and start adding clamps from frame 43 forward. This will remove the bow, shifting the

plank forward. I now believe that the following steps help to resolve this problem:

- After the last fitting cycle, drill the middle fastener hole at mid-plank (about frame 24).
 - Cover the plank with sealant except for a small area at one end of the plank where you clamp a block of wood.
 - After lifting the plank into position, clamp and wedge at frames 23 and 25. If your careful, the alignment will be ok at this point and you won't need the block of wood.
 - Then align the reference marks by hammering on the block of wood.
 - With the marks aligned, insert an awl into the fastener hole to keep the plank in alignment.
 - Remove block of wood and apply sealant to space vacated by the clamp holding the block.
 - Add remaining clamps
- Have someone keep the plank away from the boat while I raise the plank using 3 ropes (frames 4-5, 15-16, 38-39). (or at about frame 10 instead of at 4-5) Once the plank is at the right height, clamp the plank (and wedge it; note a small block of wood can be clamped just below the reference line for the bottom edge of On to prevent the plank from shifting downward) at the alignment mark without making much of a mess. Then add a couple of clamps left and right to hold the plank in place. Then add clamps and wedges left the right until the remaining two ropes are in the way. Then starting forward, remove the rope the clamp (loosely with wedge) the plank end into position. Do the same aft. Now add clamps/wedges toward the ends.
 - Fasten with 2" bronze flathead wood screws coated with red lead; 3 per frame except at ends where the plank is narrower (omit middle of 3 fasteners until all stations have been fastened); counter sink screws about 3/16" (between 3/16 and 1/4; using a stop collar yields the right depth) (a little deeper if you have to do significant shaping of the outside face). Takes about 6 hours for a 40' plank (about 4 hrs. if you only install 2 fasteners per frame). What seems to work best with a limited supply of clamps is to start near the middle and work towards the ends. At each frame bay install a wedge and clamps at both frames (yes but you need to remove the clamp on the frame to install the screws). Install 2 screws, move the wedge and clamps one frame bay and repeat. (shank = .216"; root = .148"; use 7/16" counterbore/countersink on a #7 tapered drill (5/32"))(use stop collar to limit depth); followed by 5/32 (.156") straight drill as pilot; followed by #3 (.213") or 7/32" straight drill for shank clearance). Clean up Sikaflex squeeze out. Better after sealant sets up.
 - Plug with Wana bungs coated with red lead. Coat each hole. Hold bung with needle nose pliers and coat bottom sides of bung. Align grain with centerline of pliers. Tap home with plastic headed hammer. It's reasonable to install the middle frame fasteners, make bungs, and bung the holes in the same day.
 - Trim bungs with chisel and apron plane (can be done before red lead dries so that bung can be replaced if it breaks or below the surface of the plank).
- Back fasten the inner plank to the outer from inside the boat. Also fasten the bronze straps to the planking from the inside. (drilled with #8 Fuller tapered bit with countersink; bit extends 3/4" below start of countersink ; start screw with screwdriver; follow up with drill at #5 torque; and finish with screwdriver; made template to locate

holes but hole location changes with plank width. Pattern is 2 screws at $1/3$ & $2/3$ bay width and one screw $3/8''$ + and minus from centerline of inner plank. It helps that I am targeting the middle of the inner plank for my plank edges.) In some cases the plank edges don't lie at the middle of the inner plank, so it's best to measure up from the bottom edge of the inner plank to the outer plank bottom edge, record this dimension at each frame bay, and use this data when drilling for the back fasteners. Back fastening takes about 4 hrs. if you mark the hole locations ahead of time. Not practical to fasten the plank to the frames and back fasten in the same day.