Plank #4 Port Side

The fourth plank on the port side (P4) has been the biggest challenge in planking thus far. Not only is the plank much longer than previous planks (about 12'), it has much more bow and twist. In addition, this is the last plank that I plan to replace, so it must fit well both to the plank below and the plank above.

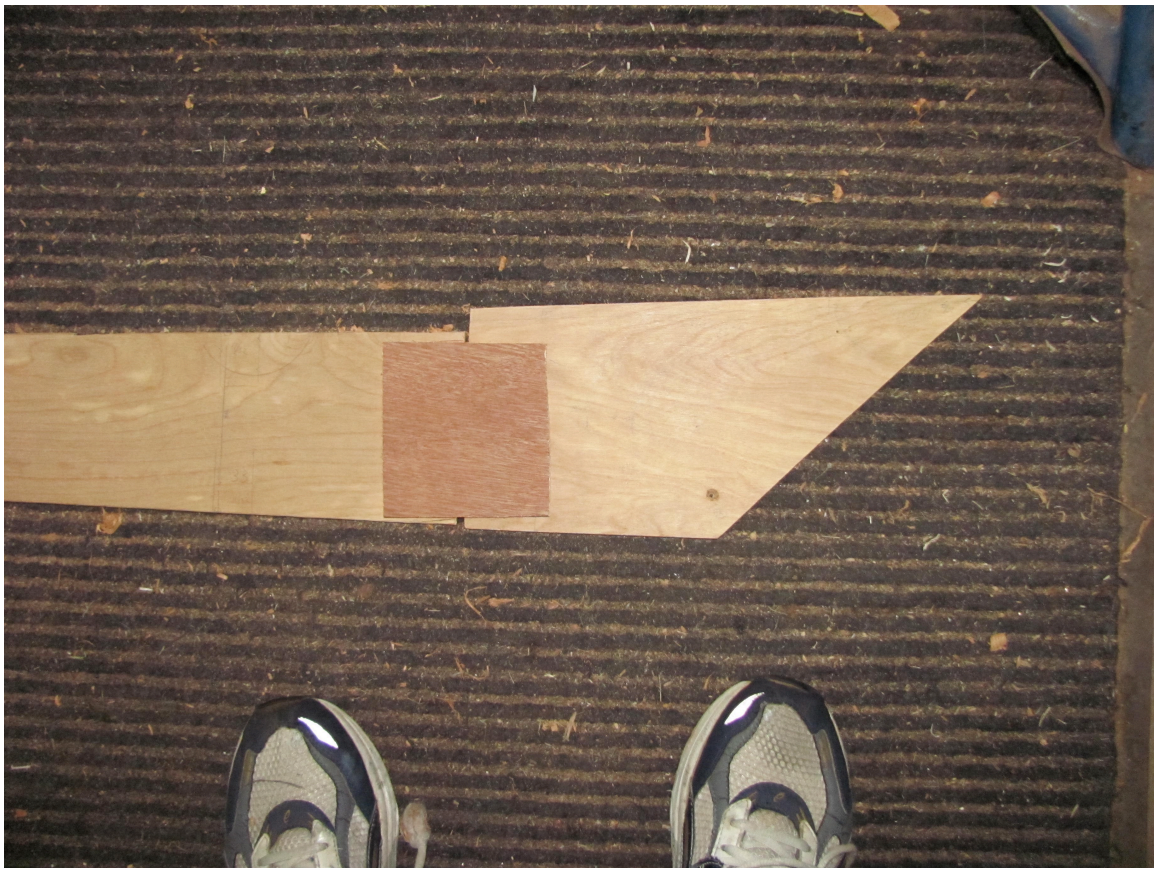
Although P4 fits between two existing planks, I am not installing it as a shutter plank, where you jam the plank in between two planks that are already on the boat, with little or no clamping possibilities. There is just too much twist and bow in this plank to install it without substantial clamping. Instead I've removed plank P5 and P6 so that I have room to clamp P4. I'll then make any repairs to P5 and install it. I'll work my way up to P8, which I believe is the original shutter plank and the start of the double planking. I'll then re-evaluate to determine how to continue.

The following pics show P5 being clamped in place on the boat. P5 was removed earlier as was the aft section of plank above it P6. I'm clamping it in place so that I can mark the location of the lower edge onto the frames. This will allow me to spile the top edge of plank P4 without P5 in the way. I suppose I should have done this before I removed P5, but it didn't occur to me at the time.

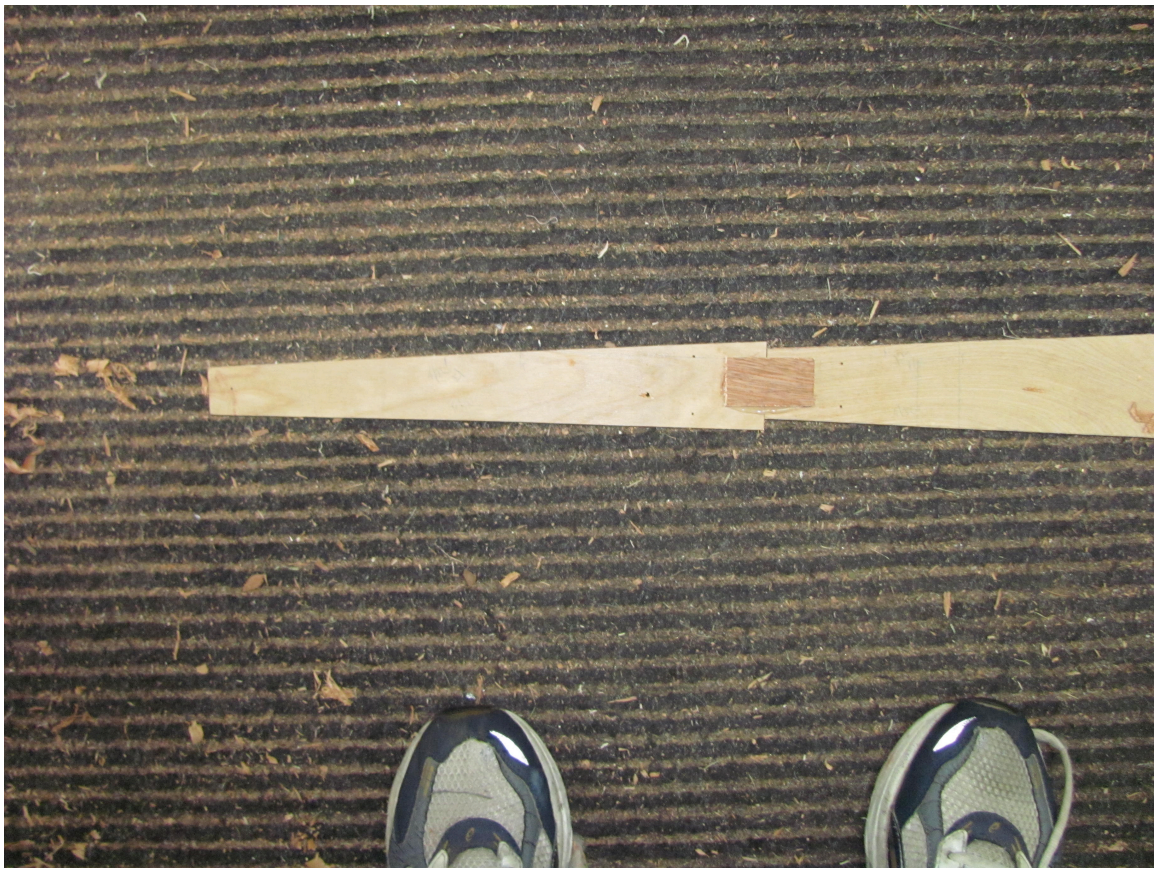
As you can see in the pic above, the forward end of P5 provides no room for clamps, so I have to resort to shores to hold it in place. This section of P5 is well forward of where P4 will reside, so I don't really need to hold this part in place, but it helps to insure that everything is where it should be when I mark the lower edge of P5.

The pic below shows (most of) the spiling batten for P4. (Top one in the picture; lower one was for S3). I decided to make the batten in four sections, which were then spliced together (hot-melt adhesive patches – redish brown squares).

The following pic shows the aft-most section of the spiling batten.



This aft section is actually a template the exact size of the hood end of P4. For sections of a plank that have a lot of detail, it's often easier just to make a template than to make a bunch of measurements. The following pic shows the forward most section that is also a template.



The splice for the middle two sections is shown here.

The two cutouts to the left of the splice are there to deal with the nib end of the plank below and the bronze strap both shown below.

The middle two sections are not templates. They were cut undersize to fit in the space to be occupied by the plank. To construct the full-length spiling batten, I tacked the forward and aft templates into their exact position on the boat. I then positioned the two middle sections (exact position arbitrary) and glued the splices in place. This effectively locked the two templates into proper registration (at least in theory).

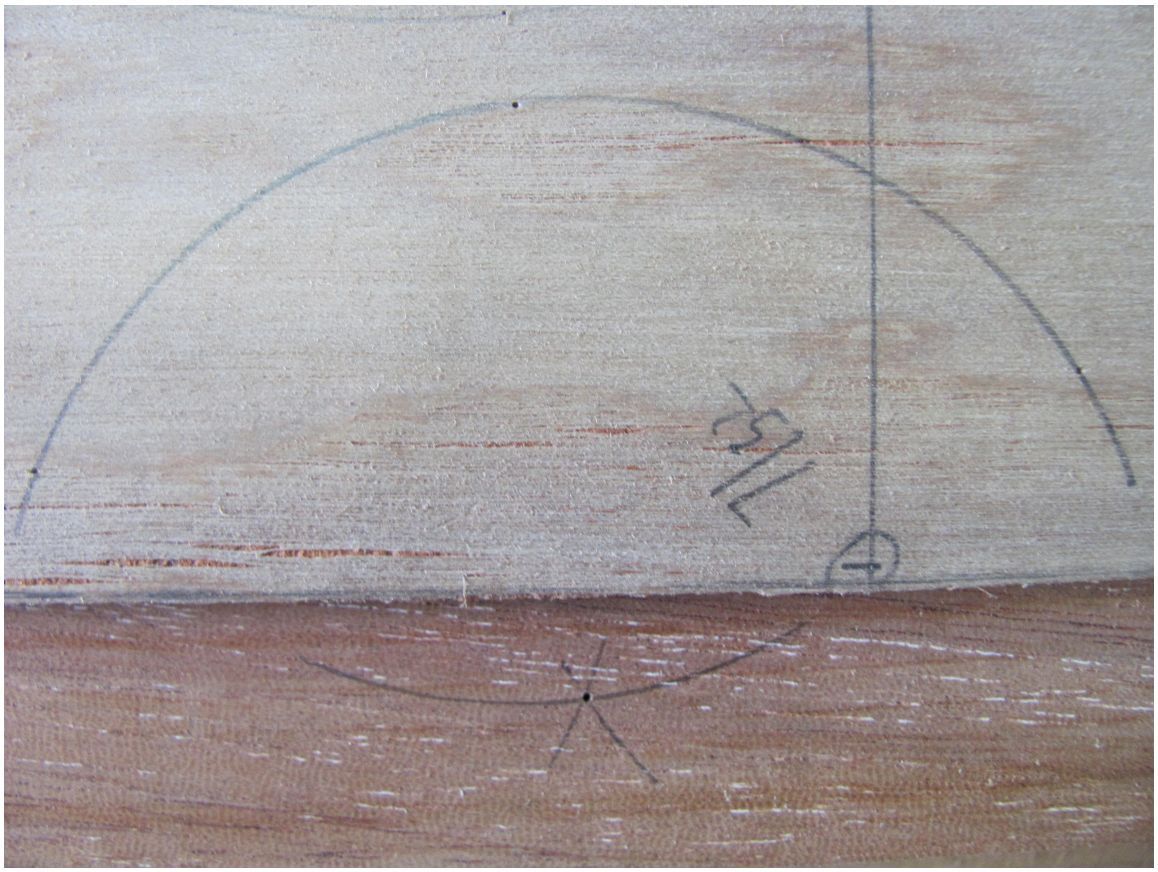
{An aside: Much later I discovered that the weight of the batten was sufficient to cause it to sag slightly in the middle (I suspect that the hot-melt splices allowed to much give as well). When the batten was removed from the boat, and laid flat on the planking stock, it relaxed to its original shape. The result was a plank that was a bit too straight forcing me to edge set it about ¼”}

With the spiling batten tacked in place on the boat, the process of spiling was used to capture the shape of the plank. I used a drawing compass to scribe arcs of circles at each frame location and other locations that required more detail. Below is the spiling batten in the vicinity of the notch for the nib of the previous plank. Note all the arcs used to describe the shape of the notch and the edges of the plank in that vicinity. I used two different compass settings (different radii) – a large radius for the low edge and a smaller one for the top edge.

It’s important to record your compass settings to recover from errors (dropped compass, broken pencil point, etc.). I do this by scribing arcs at the aft end of the spiling batten. See the arcs labeled F and N in the pic below. These arcs have a common center that is circled to the right. In this way, if I break my pencil point, I can resharpen it and then reset my compass to the appropriate arc below.

After taking all the necessary measurements, I removed the spiling batten from the boat. At this point, common practice is to transfer all these measurements to planking stock (reverse spiling) and cut out the plank. I've adopted an intermediate step that I feel is more accurate in estimating the bevel angles. Instead of transferring the plank dimensions to planking stock, I transfer them to another piece of spiling stock – in effect forming a template of the entire plank. In practice, I don't make one long template, but rather I produce three or more (substantially) overlapping sections. The overlap helps to keep the sections in registration – I don't use measurements that are near the end of any section.

The pic below illustrates the process of reverse spiling.



On the spiling batten you have the arc of a circle that was drawn with a compass. The center of that circle is where the compass point was when the circle was drawn – a point that represents a point on the edge of the new plank. To locate the center of this circle we simply place the point of our compass (same setting used to draw the original circle) on the arc and scribe a new arc off the edge of the batten. We repeat this operation at another location on the circle (preferably about 90 degrees from the first one). The intersection of the two arcs is the center of the circle. It's a good idea to scribe yet at third arc to check for accuracy. The third arc should have a point in common with the other two.

We perform this operation for every arc on the spiling batten. We then remove the spiling batten and connect the points with a line, using a fairing batten to interpolate between the points.

One must be careful in drawing these lines – don't be too zealous in making them fair. The edges of the new plank must match the existing planks, which might not be fair themselves. If your fairing batten won't lie nicely through all the points, find out why. It might be due to a mistake in spiling or the edge might not be fair.

Ok, we now have a template (in sections) of the new plank (I refer to this as the plank template). The pics below show the aft portion of this plank template.

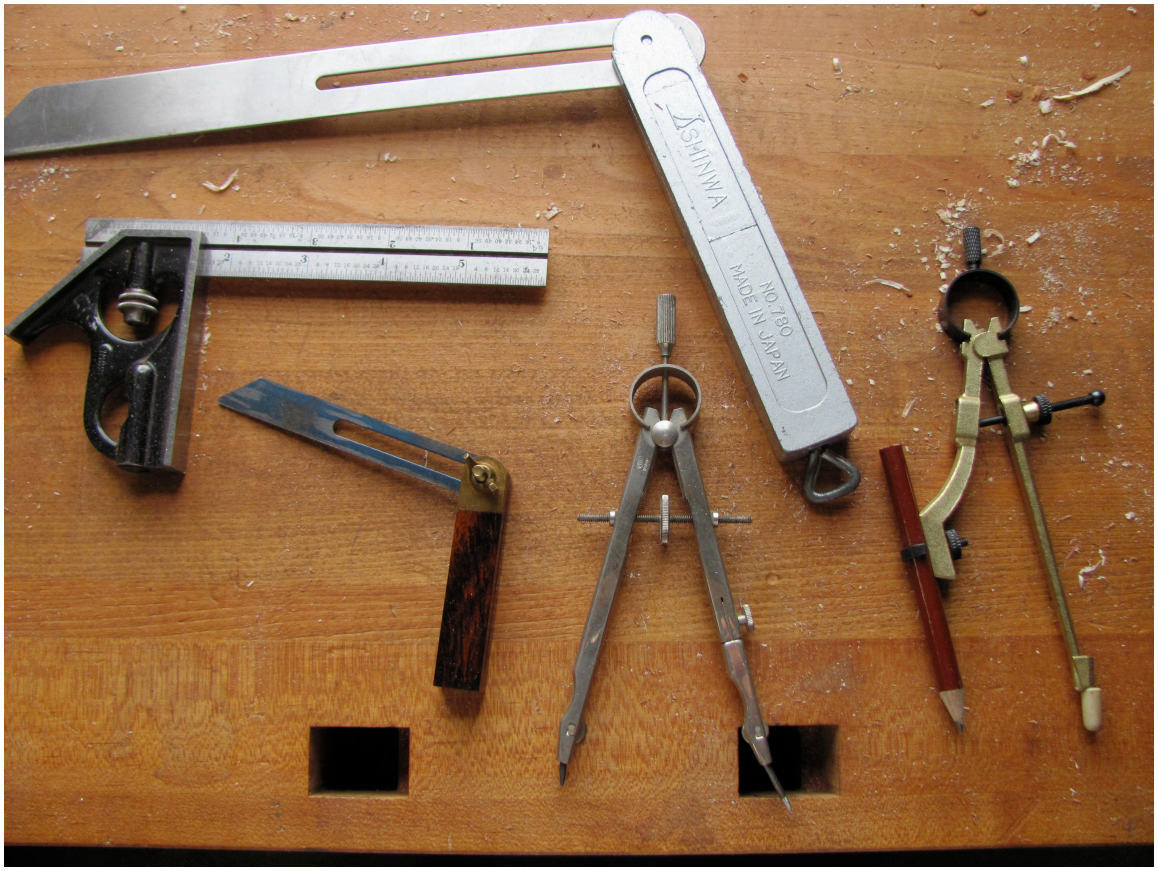
The purpose of the plank template is to determine the bevel angle at each station. The traditional way of doing this is to use a bevel gage to measure the angle between the top edge of the previous plank and the frame. But the frame is curved, which makes it difficult to get accurate results. Also there are situations where the angle between the previous plank and the new one is not the same as between previous plank and frame (see my article on “Planking a Carvel planked boat”). So I measure the angle between template and old plank and that solves both problems.

Note in the first of the three pictures above, the use of two shims at the top edge of the template. Over time, some of the backbone members, frames, and floors have moved a bit, resulting in some unfairness from station to station. I suppose I could have glued shims to the frames, etc. and re-faired (I did this in some places). It seemed easier at this location to just make up the gap by appropriately shaping the back of the plank. In either case, it’s important not to force the template, which is quite flexible, to contact all the frames if it results in unnatural twist or bow. Remember that the much stiffer plank might not be able to comply.

So the key to using the plank template is to attach it to the hull making sure it defines a fair surface from one end to the other. Note that the template does not have to be a perfect copy of the plank. In particular, the bottom edge should be trimmed to provide some

clearance so that the edge of the plank below does not interfere with it – so it's free to form a fair shape; however, you want the template to be close as possible to the proper width for accuracy in measuring the bevels.

The pic below shows some of the tools I used in spiling and taking bevels.



Note the difference between the points of the two compasses. It's important that the point can reach the apex between frame and plank edge and this varies with location.

The bevel angles are recorded on a bevel board. The one for the bottom bevels is shown below.

A close-up is shown below.

Typical of all bevel boards, we see the long downward sloping lines recording the bevel angle at each station (e.g., from 33 to 28) relative to the left edge of the board. The vertical line is 1” from the left edge and represents the finished thickness of the planking. At the intersection of the bevel line and the vertical line, we draw a horizontal line to the left edge of the board. The distance from the end of the bevel line to the end of the horizontal line is the amount of wood to be removed from the front face of the plank to achieve the correct bevel angle. This is a feature of some convenience. One could just as well check the bevel angles at each station directly, but this is a slow process. By scribing a line indicating how much wood is to be removed, one can more quickly establish the correct angles. It’s a good idea to actually check the bevel angle directly when you start to get close to the line just to be sure.

This bevel board also illustrates a number of features important to my method of taking bevels.

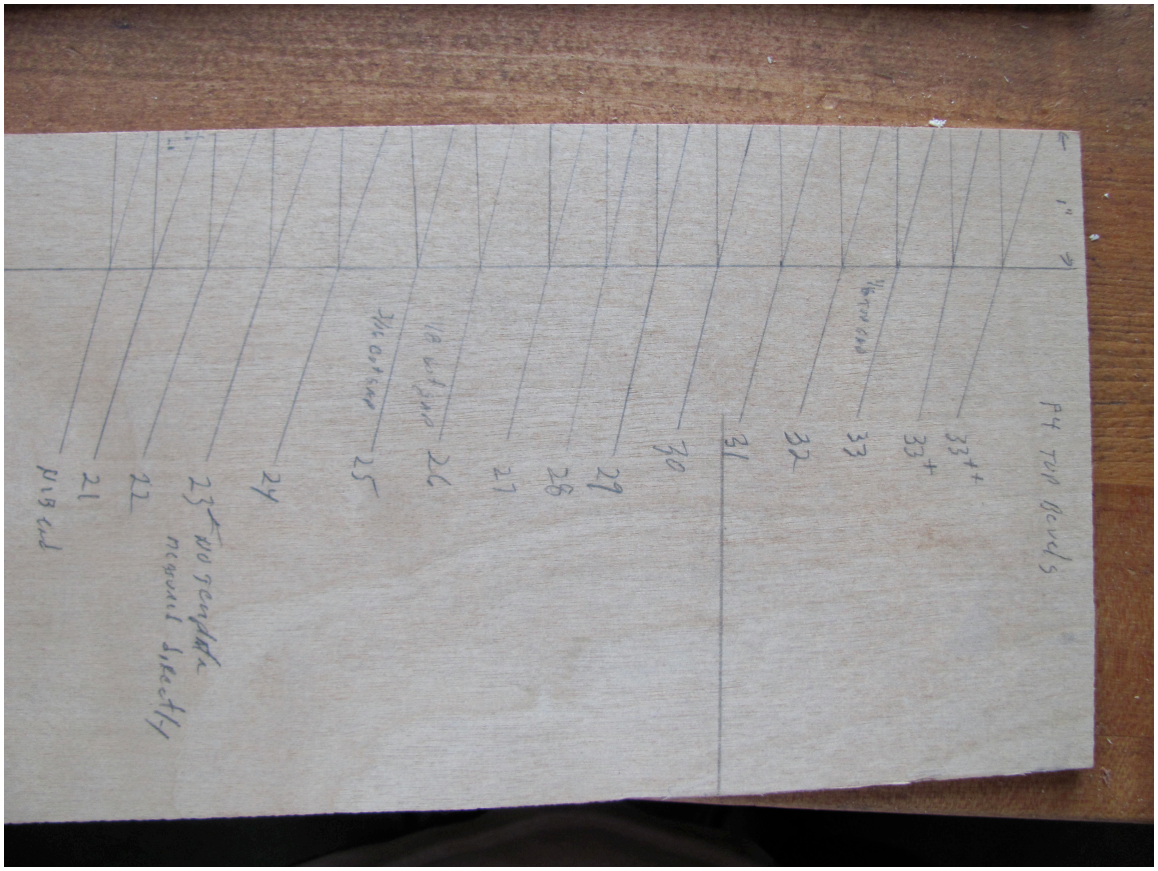
Consider station 25 for example. The notation says (although it's a bit hard to read) that at this station be have a gap of 3/16" at the bottom edge of the plank template. Station 25 is very close to the notch for the nib of P3, so as I describe in my article on Planking a Carvel planked boat, one expects a gap at this point since the plank cannot twist enough at this point to make contact with the frame (unless we adjust the thickness of the plank by 3/16"). Since the plank will be thicker here by 3/16", we must take this into account on the bevel board. So instead of a vertical line 1" from the left edge, we use a line 1-3/16" from the edge to determine the amount of wood to be removed. Note that these issues have nothing to do with the bevel angle itself. The angle is the same regardless of plank thickness. It's only because were cutting bevels based on the amount of wood to be removed that we have to make this adjustment.

Observe that between stations 24 and 25 we have two bevels associated with the notch for the nib. The bevel aft of the notch is measured to the top of the plank below, whereas the bevel forward of the notch is measured to the keel rabbet.

Finally, note that most of the bevel lines are sloped downward, making an acute angle with the left edge of the board. An acute bevel angle means that one must remove wood from the outside face of the plank to achieve the bevel. Note, however, that the nib end of the new plank has an obtuse bevel angle (visible in the first bevel board pic). This means that wood will have to be removed from the inside face of the plank. This is somewhat

problematic since the width of the plank is determined from the inside face (where it contacts the frame). To avoid changing the width of the plank, we must increase the width of the plank at this point to account for this. Consequently, it's important to record and review all your bevel angles BEFORE you cut out the plank! Also don't forget the bevels at either end of the plank. For P4, the hood end aft must be beveled to fit the rabbet in the stern post. These bevels can be found in the pic above. Note that the bevel angle varies along the end and the bevels are obtuse (the length of the plank must be increased)!

The next pic shows the bevel board for the top bevel of P4. Note that the typical plank will be beveled on only one edge, but since this plank must mate with two existing planks, we need to bevel both edges.



As this bevel board shows, gaps can also occur at the top edge of the plank template, although not as often or severe. We treat stations with gaps somewhat differently for the top bevels. This has to do with how I decided to measure these bevels. I suppose I could have measured them the same way as for bottom bevels, using the plank template, but I wasn't sure that I could use the plank template with P5 in place. So instead, I made a bevel pattern at each station. The pattern for station 31 is shown below. Note that it is labeled P5- Bottom Bevel, which is the same as the top bevel of P4 – the plank we're making.

Here is how it's made. I start with a piece of spiling stock with one edge planed straight. I then trim the bottom of the pattern to match the bevel of the plank below (Easy to do from the info on the bevel board, but not really necessary. All you need is for the apex to touch the intersection of plank P3 and frame.). I then cut the pattern to length equal to the width of the new plank at this station (data from the plank template). Now I made a rough estimate of the yet to be determined bevel angle using a bevel gage against the frame, and cut the top of my pattern to this angle – just steep enough angle for some clearance between pattern and P5. Next I put the pattern into position between planks P3 and P5 at station 31. If cut correctly, the pattern jams into place, with the bottom edge flush with the top of P3 (again not strictly necessary). I then lay a straight edge against the bottom edge of P5 and scribe the bevel line onto the pattern (pencil line seen at the top of the pattern). The angle between the straight side of the pattern and this bevel line is the desired bevel angle.

Of course you need to make adjustments for any gaps. What you have just done is (accurately) measure the angle between the cord (of the curvature of the frame) and the bottom bevel of P5. You could have done this (maybe less accurately) with a bevel gage. The advantage of the proposed method is that it can account for gaps. A bottom gap effectively rotates the plank away from the frame at the bottom causing an increase in the

bevel angle. A top gap rotates the plank in the opposite direction. To adjust for a bottom gap “d”, you scribe a line on the bottom of your pattern a distance “d” from the straight edge and draw a line from the top apex to this point. Now measure your bevel angle from this line to the bevel line scribed at the top of the pattern. For a top gap, “d” is measured in from the top apex.

I actually didn’t use this method when I made P4. Instead I rotated the horizontal lines on the bevel board to account for the gaps. For the life of me I can’t remember how I determined the amount of rotation.

In addition to the bevel angles, the inside face of the plank has to be shaped to fit the curvature of the frames. This is again done with patterns. At each station, we create a pattern (convex in this case) that matches the curvature of the frame and a mating pattern (concave). An example (station 31) is shown in the pic below.

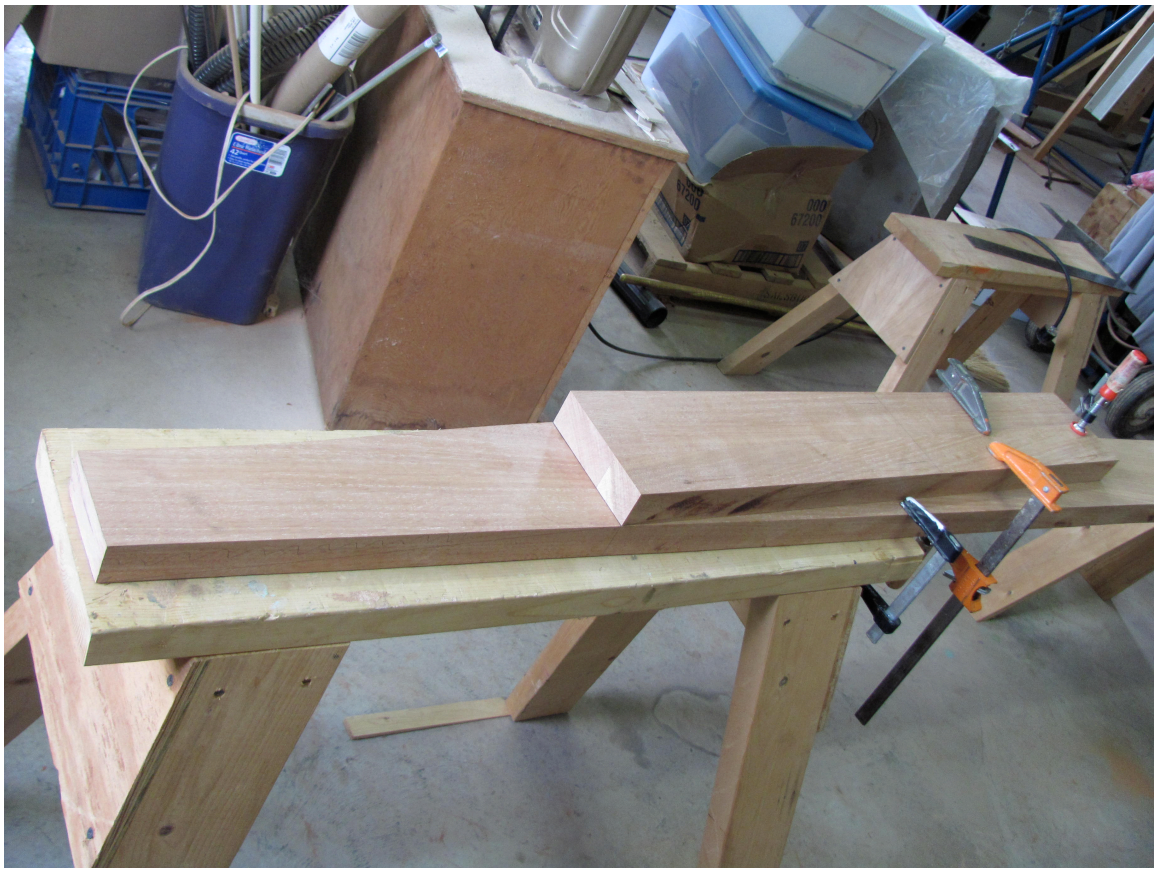
See my article on Planking a Carvel planked boat to learn how to construct these patterns. The bottom pattern is used to shape the inside face of P4, while the top pattern is for shaping the outside face. Originally, I measured the bevel angle from the top pattern (the angle between the base of the pattern to the point of intersection with the top edge of P4. This is just the cord angle that must be adjusted for gaps. At this time I was not using a

plank template – just the spiling batten. So numerous calculations were required to account for the gap. Hence the large number of notations on the pattern. Because I was using the spiling batten which was substantially narrow than the plank, gaps would occur just due to the narrow batten not reaching the frames. So I had to record where the spiling batten intersected the pattern and the gap at that point (top and bottom). From that information I could project what the gap would be if the batten were as wide as the plank. In this case the projected gaps were 0 top and bottom – so a lot of work for nothing.

Under the revised method (using the plank template) the gaps that you measure are real and so there is a lot less work to get the same result (PT gap = 0; top and bottom).

Also recorded on this pattern is the depth of the cord (6/32" in this case). The maximum cord depth over all the patterns was just shy of 3/8", so I planed my planking stock to 1-3/8". As shown on the lower pattern in the pic above, both the top and bottom corners of the plank will be planed down to 1" leaving the center 6/32" higher. If this station had any gaps, then one or more of the corners would be planed down to less than 1", allowing the extra plank thickness to fill the gap(s).

Having recorded all the necessary measurements, it's time to cut the plank. Unfortunately, my planking stock is only 10' long and I need 12'+ stock for my plank. So I needed to scarf an extension onto my plank stock. The pics below show how I made a 12/1 scarf bonded with Aerodux 185 resorcinol.

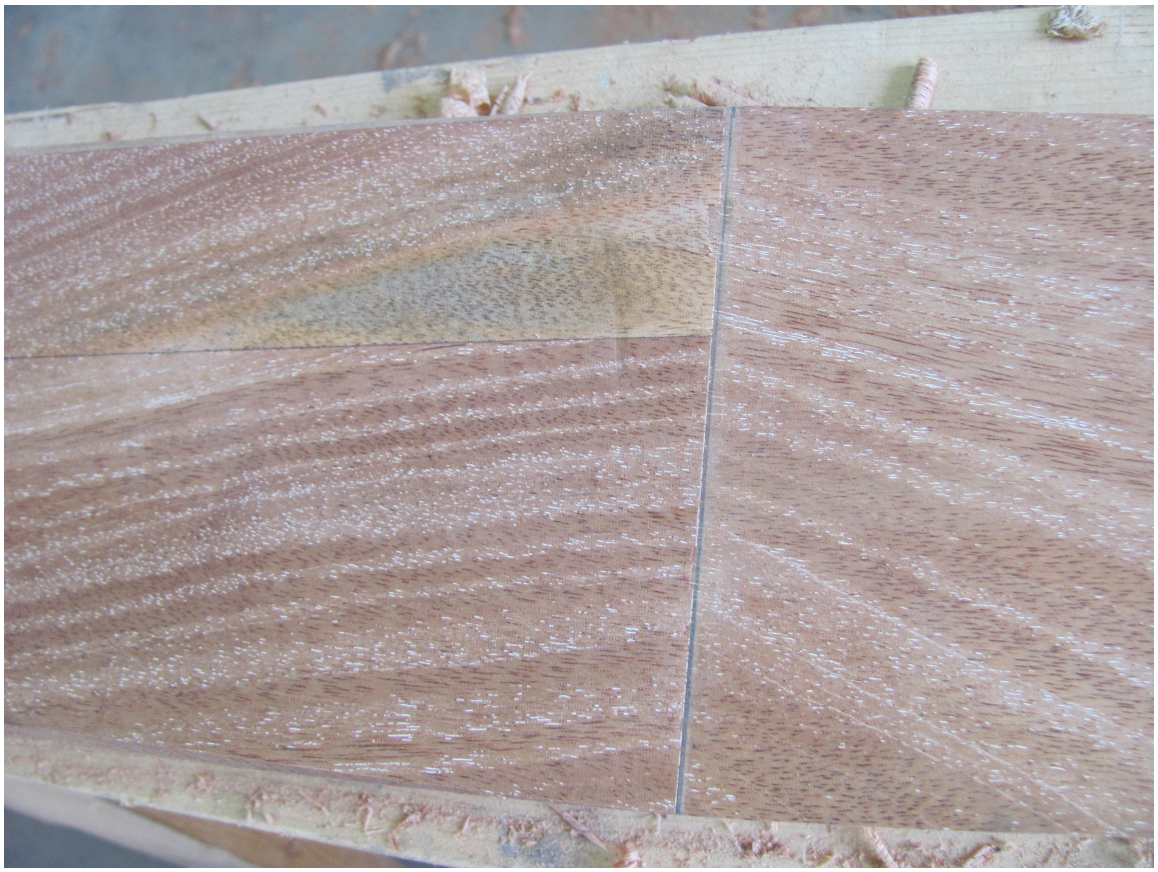


Here is how it starts with the extension lying on top of the plank stock.

Here’s a view from the other side. Although the top and bottom pieces have different shapes the ends are perfectly parallel to each other. This is important in judging the progress as we cut the scarf. The end of the top piece is about 16” back from the end of the bottom piece for a 12/1 scarf on a plank that is 1-3/8” thick. If you look closely, you can see a diagonal pencil line the runs from the bottom of the forward end to a point 16” back from the end of the top piece. This is our depth limit for cutting the scarf.

A power plane gets us close followed by careful hand planing – first with a smooth plane, followed by a jack plane, and finishing up with a joiner plane.

Here is the finished scarf.

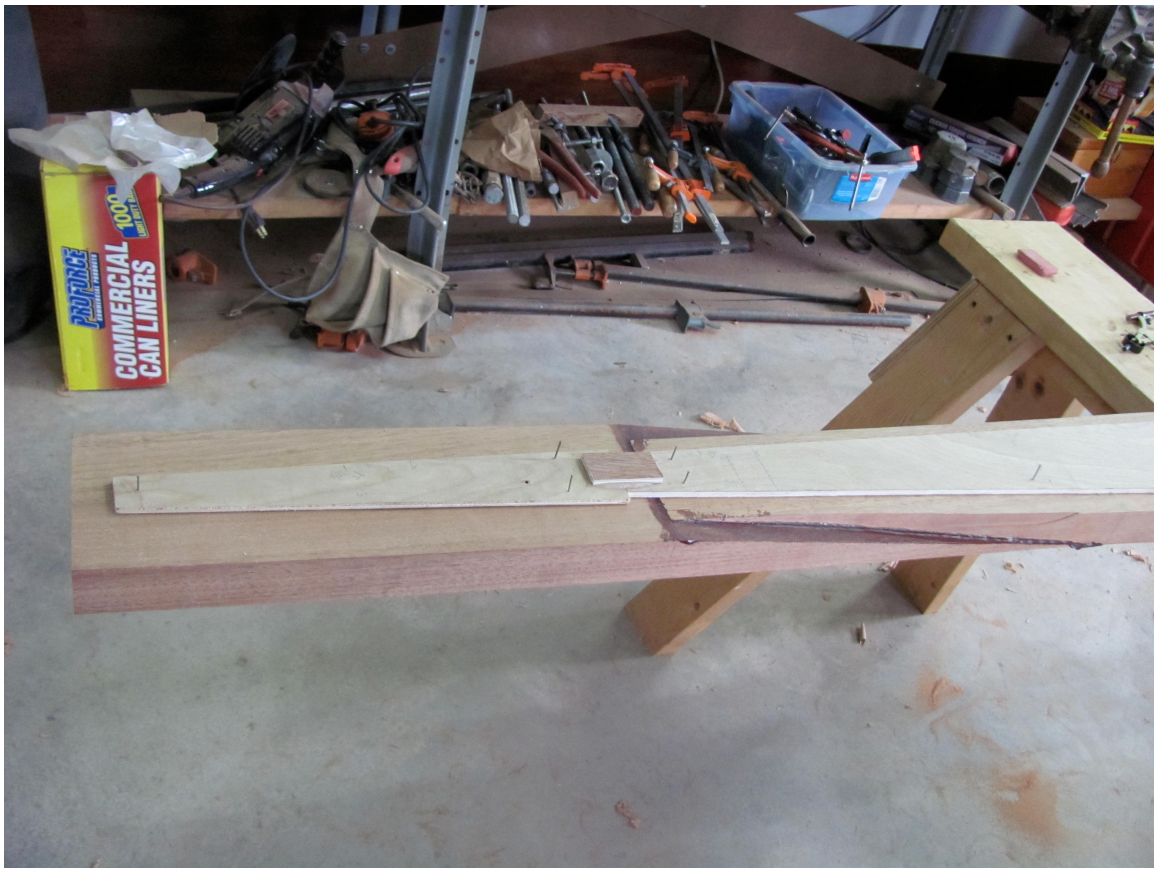


Here’s a close up. The horizontal line shows that the extension piece was first widened before the scarf was made.

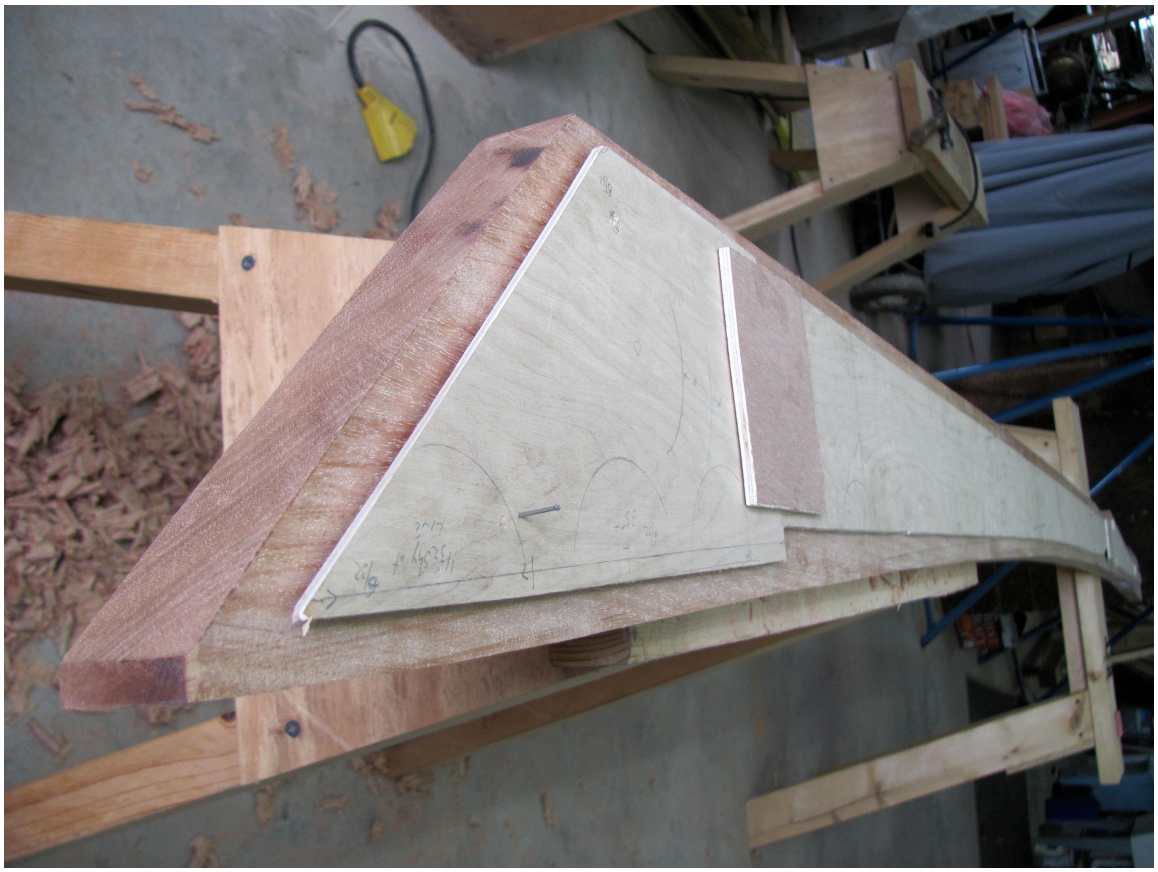
It's finally time to transfer the plank dimensions to the stock. I'm using the spiling batten not the plank template, because the plank template is in sections and the bottom edge has been trimmed for clearance.

Note that the stock has already been cut to approximate shape before spiling to finished dimensions. This allows the stock to relieve any internal stress that might affect the final shape (a lesson that I learned the hard way).

As I mentioned earlier, I think the spiling batten may have sagged some in the middle when it was on the boat and then straighten out on the stock, which caused some fitting problems. I think for S4, I'll use a thicker spiling batten and maybe mechanically fasten the splices.



In this close up, you can readily see the scarf.



Here we see the hood end aft. Remember that this part of the spiling batten is a template that is an exact match for the inside face of the plank; however, we will have to leave the plank longer to account for the obtuse bevels of the hood end.

Here is the plank cut to size and the convex inside face beginning to take shape.

The pictures fail to capture the amount of curvature involved, but you can get a feel for it by looking at the curvature of the dark line of resorcinol (from the scarf). If the plank were flat, the line would be straight across the plank.

The following pics show the plank on the boat for one of its many trial fittings. As you can see, many sturdy clamps are required to coax this plank into place.

The forward nib end (above). Wedges are used on the top edge to hold the plank firmly against the rabbet. Note the two home-made clamps (one wood, one metal) to provide lateral force where there isn't access for a conventional clamp.

Here we see the notch that receives the nib end of the plank below.

Here we're a bit further aft. Again heavy clamps and wedges.

Just about all the way aft. The rope is used to hold the aft end of the plank while, working alone, I can clamp the forward end into position.

The hood end is particularly nasty. It takes a considerable force to close it up and no convenient way to clamp it. Ultimately, I have to settle for a plank position about 90% of where it should be. I should be able to get complete compliance after I steam it.

I don't remember how many trial fits that I've made – maybe five or six, but it still takes me about ½ hour to complete the clamping. I'm not sure that extra hands would help all that much. The clamps have to be installed in a particular sequence to avoid trouble.

First, you have to get the notch in position over the nib of the plank below. (This is one place where a helper would come in handy – to support the hood end.)
Then clamp the front end (tightened about 90%). Then work you way aft for a couple of stations. At this point the hood end is just hanging in space. You can now lift it and bend it into place in the stern-post rabbet, but it won't be flat. It will be in at the bottom but rotated away at the top 60 degrees or more.

At this point the middle of the plank is well above the plank below, but you can how finish tightening from the notch forward, making sure the plank is down against the keel rabbet and that the notch is tight against the nib (some judicious hammer at the front end of the plank might be needed).

After securing the front end, you can start driving the middle downward with wedges, but you can only go so far before the severe rotation of the hood end limits the travel downward. At this point, you can start cranking in the hood end. Unfortunately, this is too much for one clamp to handle. You need about five clamps over the last three feet, tightening them in turn, to rotate the hood end.

Once you get so far, you have to rearrange the aft most clamps because they run out of travel. You can then go back to the wedges and apply some more edge set.

The goal of course is to achieve a light-tight seam for the full length of the plank. For me, at this point, this is more like the holy grail than a realistic goal. Allow me to relate some of my experiences …

Ok, I've got the plank cut to shape, beveled, and scrubbed inside and out to match the curvature of the frames, but no caulking bevel yet. So after a couple of hours, I finally have the plank on the boat. Oh did I say it takes ½ hour to clamp the plank? Well that's how long it takes after I've done it six times. The first time takes a lot longer. First you have no idea what to do first, and some sequences just won't work. For example, you can't clamp the hood end first and have any hope of pulling the plank in forward. When you do stumble upon a workable sequence, you realize that you don't have enough clamps, or the wrong kind, or a custom clamp is required.

Eventually you get the clamping sorted out and the plank is on the boat – sort of. Now you get the first view of edge set – the center of the plank is more than ¼" above the plank below. So after a day of agonizing over the thought of throwing the plank away, you decide to give wedges a try. It takes a few tries to make a wedge system that can actually apply some force without damaging the plank. Finally, you get the seams down to something manageable.

Of course if you look into the seams, they look as wide as a picket fence, but this is (mostly) an optical illusion. Using a set of feeler gages, I determine that the gaps are at most 1/16", and then just in spots. Most of the gaps won't allow a 0.020" feeler gage to pass through. Now I'm feeling a whole lot better about my approach to spiling.

The tricky part is closing up these remaining gaps. In principle, you can go along the plank recording the size of the gaps and then plane down the tight spots. But if you find a tight spot on the outside edge (0 gap) how do you know what's happening on the inside edge of the plank? Is the gap bigger there? You could possibly measure the gaps on the inside as well but not where the plank lays against the backbone (which it does a lot with these lower planks).

Ok, let's say you've recorded the gaps. So you remove the plank to the bench and plane down the high spots. But how do you know how much you've taken? Ten thousandths?

20? And have you maintained the correct bevels? So now you've done your best, so it's back on the boat with the plank (another ½ hour at best), and you re-measure the gaps. Hopefully, it's better. At least not worse!

Eventually you get tired of this viscous cycle and you begin to question the sanity of it all. After all, won't the plank eventually swell to close up these gaps. And how likely is it to drive cotton caulking through a 10 thousandths gap?

So you give up and cut the caulking bevel (1/16" gap per 1 inch of plank thickness, covering about 2/3 to ¾ of the plank thickness). Now it's no longer possible to have 0 gap on the outside. So all your work to close up these gaps was for naught if the gap opened up on the inside.

You can try to fix this of course by again measuring the gaps and trimming the high spots. But now the only planing surface that you have is about ¼" wide, which makes it nearly impossible to maintain the correct bevels. Of course you can always check the bevel after you trim, but what if it isn't right? Now you have to remove too much wood to get the bevel right, and the gaps become worse.

Well after considerable though, I think I might have a reasonable approach. I won't know for sure until I try it on plank S4.

First, make or buy shim stock in each of the following thicknesses: 0.010", 0.020", 0.030", 0.040", 0.050", and 0.060". If you have gaps larger than 1/16" there is something wrong with your initial work. These individual shims are a lot quicker than fumbling with a set of commercial feeler gages, where you have to combine several shims to get the thickness you want.

The first goal is to trim the edge so that you have 0 gap at the front edge of the plank. Start with the 0.010" shim and slide it along the seam until it sticks. Write 0.010 on the plank at that point. Also indicate whether it's sticking at the back or front edge. In principle, since the bevels are flat, the smallest gap at any point must occur at either the front or back. Repeat this for all the shims. You now have a picture of the high spots.

Remove the plank and plane away 0.010" at the high spots. A plane doesn't work very well for rolling bevels – even a small plane has a sole that's too long to follow the bevel. Maybe a spoke shave would be better? An angled blade should be used so that wood is removed from high side – changing the bevel angle but leaving the low side untouched.

Clamp the plank back on the boat and repeat the cycle. After about 4 or 5 cycles the front edge should have gaps smaller than 0.010".

Now cut you caulking bevel. If you didn't have any large gaps at the back edge, the seam should still be tight. If not, you can measure again. This time you can't have any gaps at the front. Remove the plank and trim the high spots. It will be harder now to maintain the bevel angle because the width of the bevel is only about ¼".

With this method, you normally don't have to worry about gaps at the back edge that are larger than those at the front. These get closed up as you trim down the front edges. In rare cases where the back gap is quite large, a gap at the back edge might persist undetected until you cut the caulking bevel. At which point you fix it then.

The disadvantage of this approach is that it requires several cycles, which is a pain for recalcitrant planks. But it's a methodical approach that I believe is less prone for error. If instead you measure gaps from both the outside and the inside of the boat, you can see a more complete picture of the situation and possible plane away more than 0.010" per cycle and thus require fewer cycles – in principle just one. But it's very difficult to judge how much wood you're removing, so I view this approach as more risky.

Ok, back to the plank. I now have gaps that are less than 0.010" in all but a couple of places (at most 0.030" over a couple of inches). I'd prefer if all the gaps were <0.010", but I've already cut the caulking bevels and I'm afraid of ruining the plank with more trimming. So it's time for steaming.

First I paint the inside surface of the plank with 2 coats of Primocon.

You can see in the pic above an area that has not been painted. A close up is shown below.

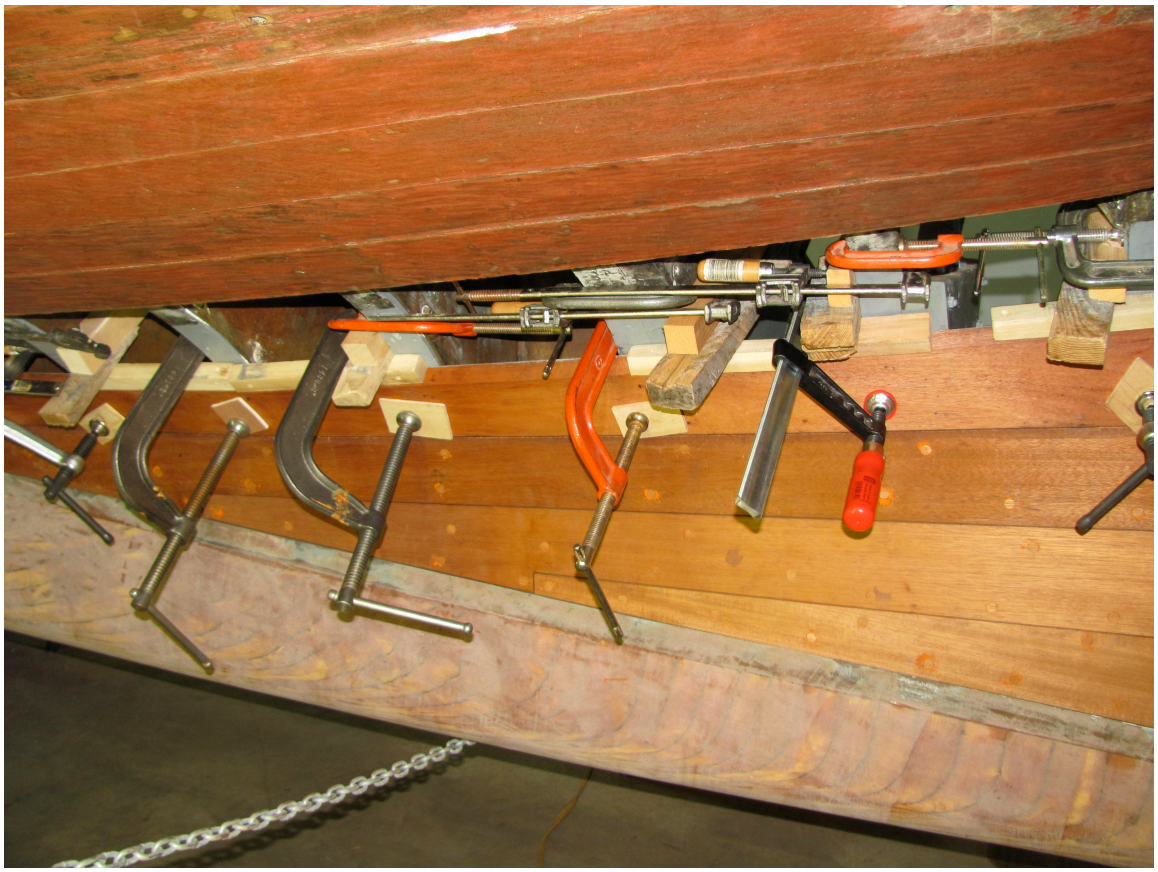
This area of the plank was relieved to provide clearance for the bronze hull strap. I decided to coat this area with epoxy instead of just paint, because I plan to fill the gap between strap and plank with an epoxy filler after the plank is hung. The strap is screwed to the planks, so it's important that the strap fits tight to the planks. In retrospect, I should have been more careful cutting the relief.

Now it's on to steaming. My 8' steam box isn't long enough for this 12' plank, so I had to improvise with some plastic.

This worked quite well. On the advice from the WoodenBoat Forum, I drilled a hole in the box and inserted a cooking thermometer. When the temperature in the box reached 200 degree F, I started the timer. After 75 minutes (recommended by Wood Handbook), the plank was ready.

It's important to work quickly, since the plank starts loosing flexibility quickly as it cools. I had everything organized and recruited help to hold the plank. It still took about 15 minutes to complete the preliminary clamping (most of the extreme bending/twisting). Fortunately, the plank continued to be quite compliant during this time frame. In the end, I was able to achieve a reasonably tight fit to the frames and backbone. The inside edge of the bevel was also tight except for the couple of 0.030" gaps that I already knew about.

The following pics show that final clamping arrangement.



The hung plank appears below - forty-five #12 bronze screws and 5 hours later. The screws into the backbone are 2-1/2” those into frames are 2”.


21
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23
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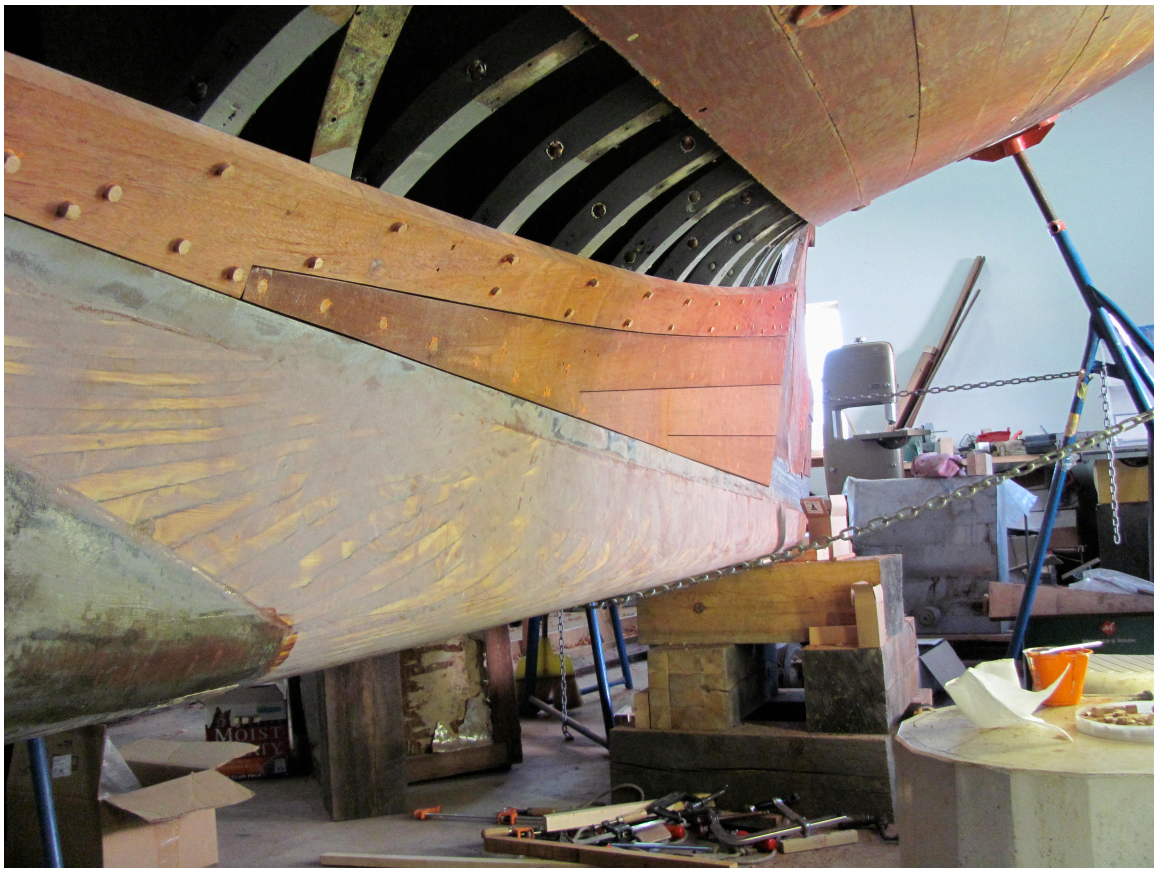

After all the screws were in, I checked the caulking bevel with a 00 caulking iron. Most seemed fine, but a few sections were a bit tight (another negative side effect of trimming the edge after cutting the caulking bevel). Whether or not this will pose a problem with remain to be seen. At this point it's hard for me to judge, having never done this before.

Well, the next step is to see if I can get the next plank up (P5) to fit. After that, I'll move to the starboard side.