

***Chapt. 14 – Match Drilling
Spar and Wings
(an alternative approach)***

There are many ways to match drill the spar to wings. The plans call for you to put your spar and one wing on the bench and align them and then do the same again for the other wing. They also call for you to use a spot facing tool with a 5/8" bit to cut through the hardpoints. This is a long laborious task that generates a lot of heat and usually ends-up dulling the bit to the point where it is no longer serviceable. Some builders have resorted to using a 5/8" hole saw, filing-off the outside of the teeth to make sure that it cuts only 5/8 of an inch with no slop. The problem with the hole saws is that they tend to wobble a little, making for inaccuracies. I used this method to install my landing gear, but I started the holes with the spot facing tool to take the wobble out. But this was only 2 holes. The wings have 6 holes. Tim Andres used a different approach, using a long 1/4" bit to start, then a long 3/8" bit, and then a long 1/2" bit. The problem is that it is very difficult to find a long 5/8" bit, or anything larger than 1/2", and the drills often make holes that are not entirely round. He used a 6" bit that was 37/64", and then reamed out the holes with a 5/8" reamer. I decided I would do it his way. Tim had passed his equipment along to Ted Davis, who did his match drilling the same way Tim did, so Tim had Ted send me his equipment in a small box. I wasn't entirely sure how to use them. The long drills were fine—I got that immediately. But the 6" drill and reamer wouldn't reach through the entire spar box. It finally occurred to me that I could enlarge the holes in the forward part of the spar and fit the drill chuck into the spar box. By the way, you need a drill with a 1/2" chuck.

First, you need to properly locate the holes on the spar. I think it's pretty straight-forward, and the plans are a good source of information on how to do that. The aft part of the spar (where the hardpoints are) is comparatively easy. The forward part is less so, since both upper and lower corners are beveled, so you have to take that into account when you are measuring and locating those holes. Then drill through, forward to aft, with the 12" x 1/4" drill.



Then, the alignment. I wanted to do the whole expanse in one shot—not just one wing and then the other. I used 6 jigs to do this—2 each copies of the lower half of wing jigs #2 and #4, and 2 to hold the spar. (see below).



As you can probably see, each of these jigs has large carriage bolts through the feet. These can be adjusted to raise or lower the forward and aft parts of the jig to adjust angle and height. Caution—this approach will add time to your operation—lots of time, but it was fun to work with, and actually did a good job for me. The jigs were stable, and I also bondeoed the “feet” to the cement to keep anything from moving. I think the jury is still out on whether or not I have OCD :).

I used bubble levels on the level boards I had installed on the wings, and a 4-place water level (3/8” vinyl tube with water and a touch of food coloring). A few hours of fiddling with the screws and I finally had things level—both wings level along the 17.4” WL ***and*** with each other.



I had glassed my wing level boards on all 6 sides to discourage warpage, then used dabs of dry micro on the wing as bases to glass these level boards to the wings for a stronger and more stable hold. I knew it would be a long time between finishing the wings and doing the match drill, so I wanted to prevent issues.



The spar box also had to be mated to the wings so that the centers of the hardpoints would match, as well as the angle of the wings. The spar jigs helped with that adjustment, along with some shims to tighten the spar in the jig. A little moving around and re-adjusting, and in about a half a day I had things ready to go. I bondoed the feet to the sidewalk and some patio blocks I had dug in, and put some dabs of bondo between wing and spar to help hold them in place. I knew that drilling could lead to some jostling around, so I had applied some dry micro with peel ply in 8 places—2 on each wing/spar, across from each other. When everything was in-place and bondoed, I applied about 4 layers of glass (both BID and UND) across the gap between wing and spar so

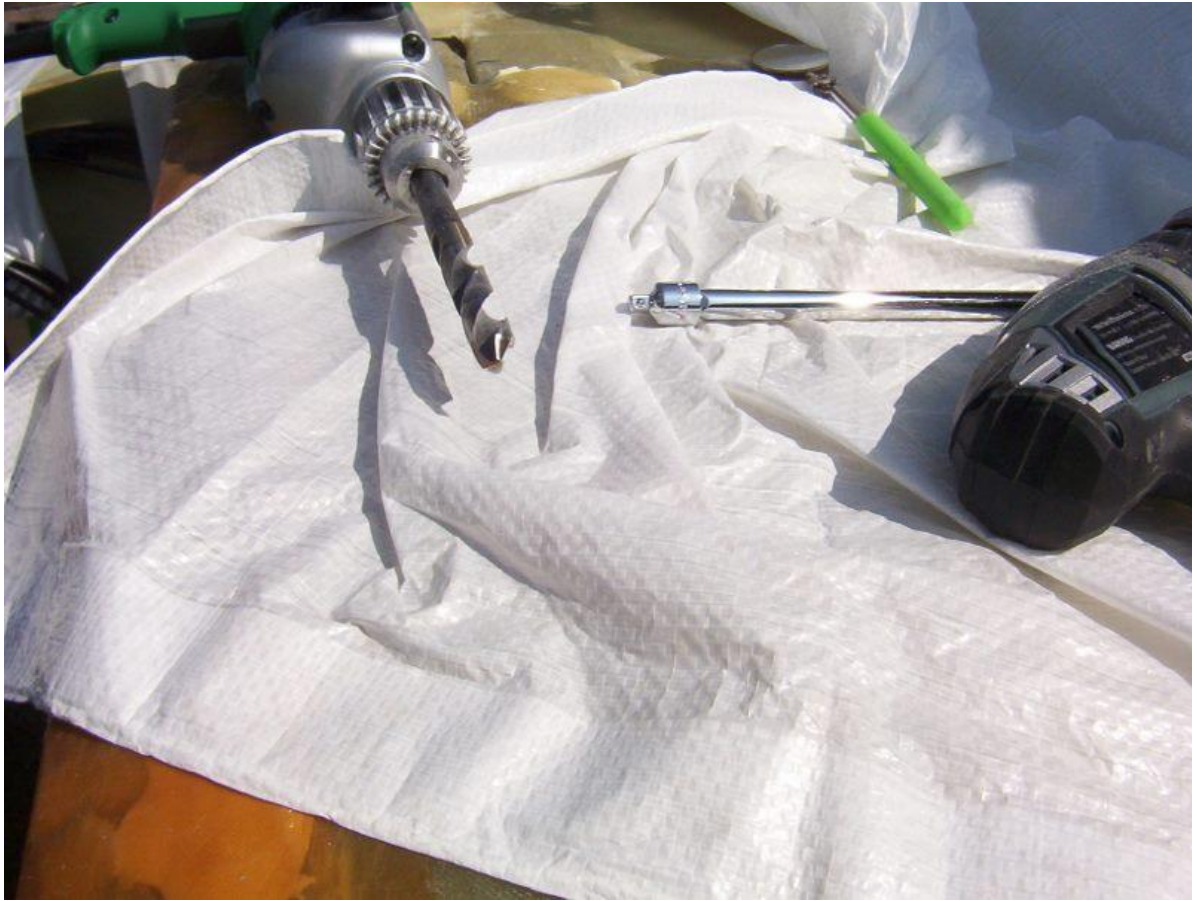
that each wing was held to the spar in 2 places, and let it cure. This would hopefully hold everything in place during the drilling process. I'm glad I did that.



Sometime before separating spar and wings, it would be helpful to install level boards on the spar, with everything level fore to aft, side to side. I did this, although I am not totally confident that these level boards will get the job done the way I want it. Tolerance buildup *is* a thing. If anything is a little off on one step and a little off on a succeeding step, you can be further off than you want in the end. I am pretty confident that my wing level boards are good. Translating that to the spar and then to the fuselage is quite another thing. Sure, we can cure stuff with washers on the wing bolts, but really... Again, OCD rears its ugly head with me. I'm leaving the level boards on my wings, and I'm also installing my spar *with* my wings attached and canard in-place. I also want those wings to disappear behind my canard to assure alignment. How will I do that? I'll use my four handy wing jig bottoms on longer standards, and install the spar that way. Having said that, I did install the level boards—same way I installed them on the wings.



Next was the drilling itself. With everything in place (although I checked and re-checked, and even made slight adjustments), I began the process of drilling between spar and wings. I first drilled through with the long 12" x 1/4" drill, as the wings had not yet been tapped. Then I went with the long 3/8" drill, and the long 1/2" drill. I began to notice a problem with the drill grabbing. It became more evident as the size of the drill bit increased. I remembered I had seen somewhere how a drill bit could be dressed to mitigate this problem, and asked the group where I could find it. It is found in **Chapter 3, Page 12** of the plans. It is a matter of honing the flutes each side of the tip of the drill, flattening the angle. I did this and it helped a lot. It still occasionally grabbed slightly, but it wasn't to where it was almost breaking my wrists as before. The last drill bit I used was a 6" x 37/64" drill that was in Tim's box of drills. Then, of course, I used the 5/8" reamer to bring the holes to nominal, perfectly round. The bushings fit very snugly, and could not easily be removed.



I then used the 5/8" reamer to complete the process, while the spar box was still in contact with the wings. Having done that, I both cut and pried the glass away from the micro dabs on the wings and spar, separated them, and whisked the micro from all parts.

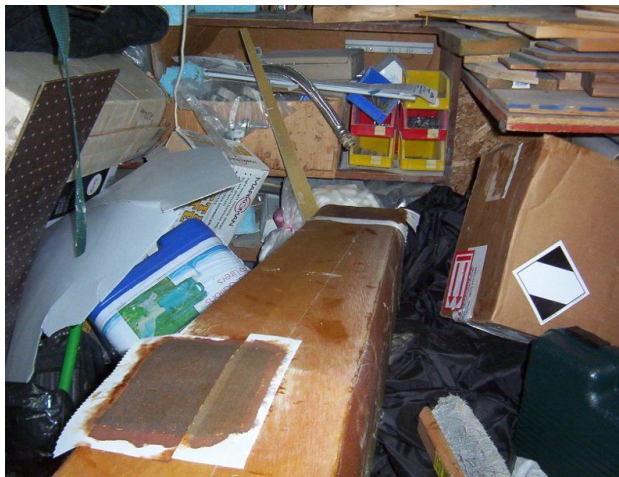
What I haven't yet mentioned is that in order to use the 3/4" drill, I had to enlarge the hole in the forward part of the spar so that the chuck would protrude into the spar box in order for the 6" drill (and reamer) to reach through the wing hard points. I first enlarged the existing 1/2" hole in the forward part of the spar box to 5/8", and then used a 5/8" hole saw inside a 1 3/4" hole saw to maintain the same center, and enlarged the hole to the size of the 1/2" chuck on my drill. It worked gr8.



Next it was to install the bushings. This is pretty much as per plans, except I wanted to take pains to prevent floc or epoxy from intruding into the bores of the bushings. I used the same technique I used for my landing gear bushings in Chapter 9. I poured wax through the flanged end of the bushing into the bore. I used a slick plastic box to keep the wax from sticking, but box tape would work, too. This way, when you insert the bushings into the floxed holes, you keep the floc out of the bushing bores. This worked great. Maybe a quarter inch of wax would do. It requires some force to remove these wax "plugs" from the bushing afterwards, but not a big deal. You need to let the wax cool completely before attempting to remove them from whatever surface you use to pour the wax on, otherwise the wax can be sticky and shift as you attempt to remove the bushings from that surface. I used cold water to speed that process.



I wiped away the excess flox without worry. The final step is to close-up those holes in the forward part of the spar box. I don't believe these are structural, but they can be subject to intrusion of gasoline. EZ 10 resin with #87 hardener should be used, if possible. I closed up the holes by using foam cutouts from a 2" hole saw and microing them into place, and then glassing them over, from the outside only, with 2 BID. Trying to glass the inside of these circles seemed to be a futile task to me, and I felt that the extra glass on the inside was not all that structurally significant in my mind.



I hope this has been helpful to anyone wanting to choose an alternative method in match drilling spar to wings. There are several different methods that will work, and we all have different skillsets. Do what works for you. As always, I believe it is good to constantly check things for level, measure twice/cut once, etc. Whatever approach you use, in all this, I wish you the best of luck, and remind you—check and double check as you go.

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