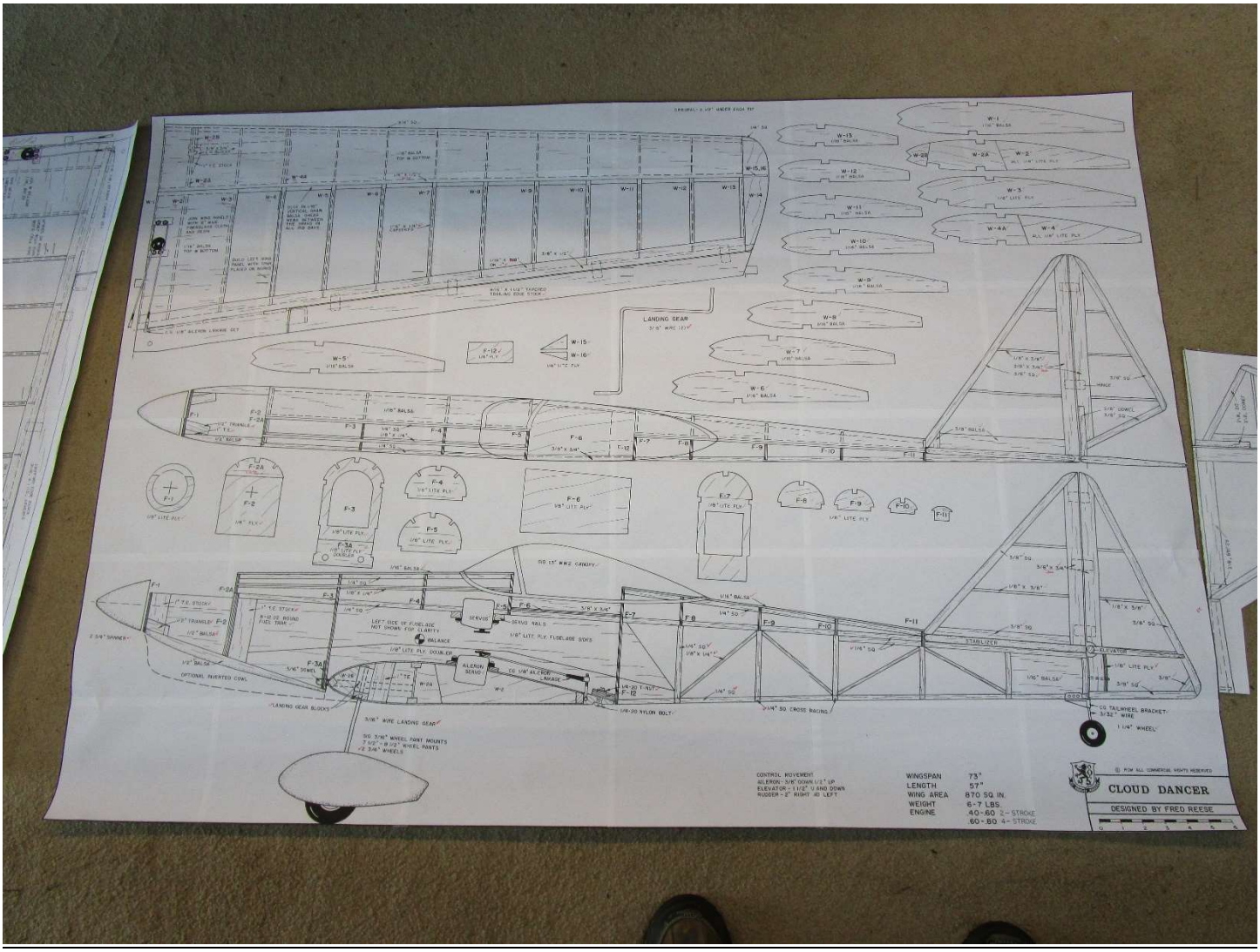
Cloud Dancer Build Description

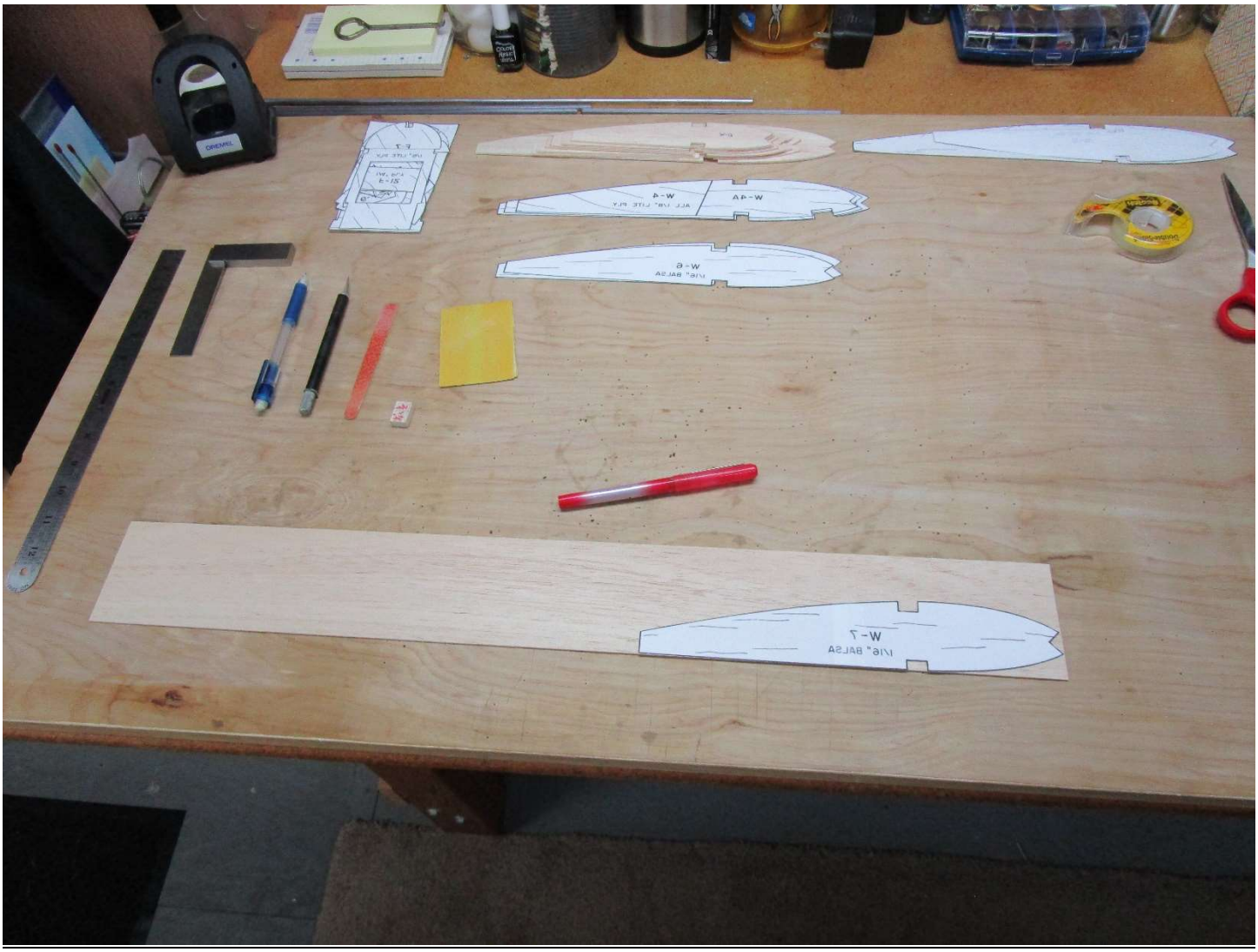


The free Cloud Dancer plan and article were downloaded off Outerzone.co.uk, but plans can also be found on AeroFred.com, which has several versions of the Cloud Dance ranging from 40" to 86" wingspans. There also is a laser short kit for the larger Cloud Dancer 120 available for purchase on Bulsaworkbench.com.

The Cloud Dancer I'm going to build was designed by Fred Reese, and the article is from a June 1993 edition of Radio Control Modeler (RCM). This 60-size version has a wingspan of 73" with a total wing area of 850 sq. inches, which will result in a light wing loading of approx. 17 oz. per sq. ft. The overall fuselage length is 57" and is designed for a .40 - .60 two stroke. I will be installing a Thunder Tiger .61 that my father used many years ago.

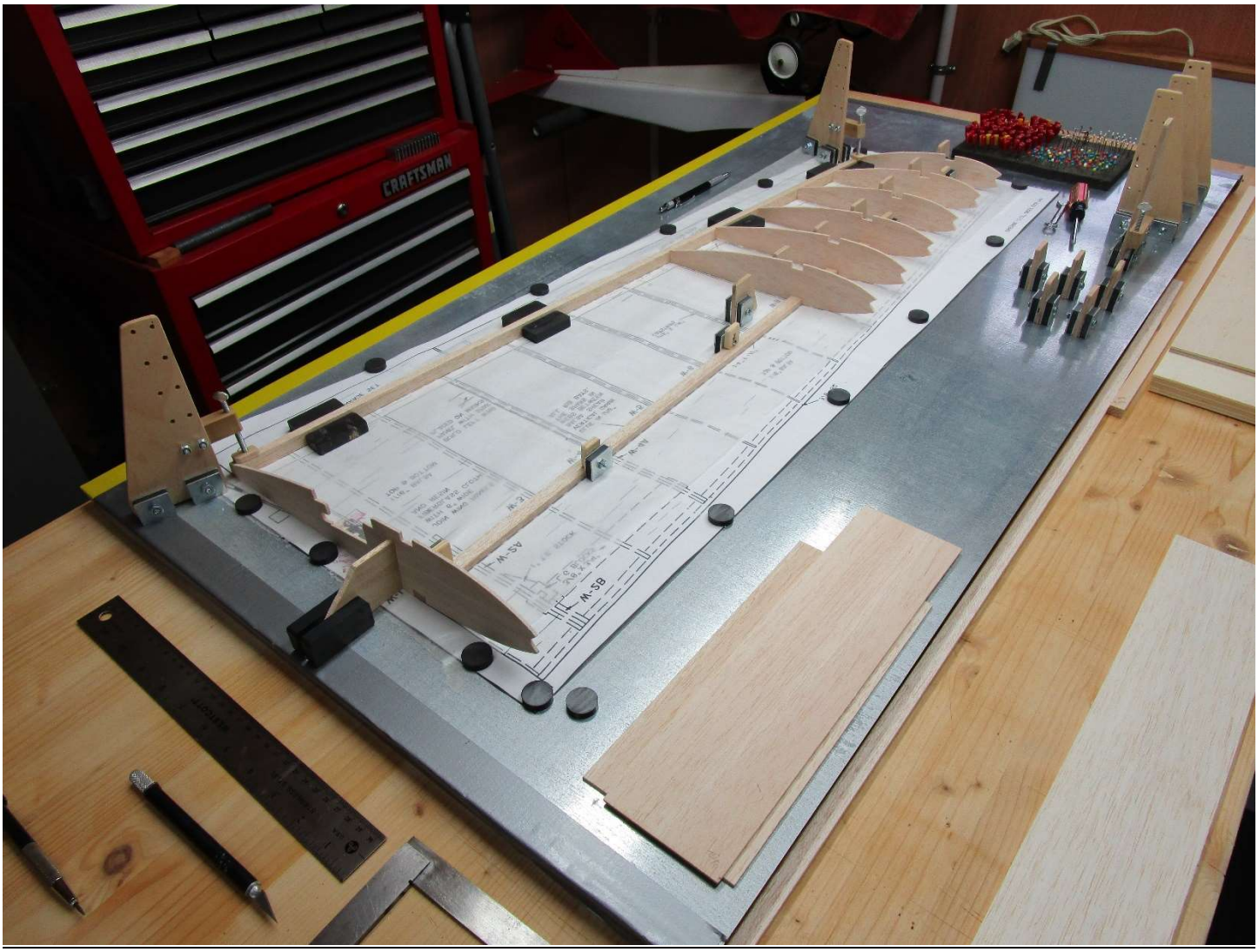
First step in this build was to print out a copy of the full-size plan on my Canon printer using the "poster" settings, and then putting all the pages together for an overall 77" x 51" plan. Given the plan only has the right wing and right horizontal stab drawn, I inverted the plan file vertically to get a left wing and stab, and that copy of the plan is cut up to get the patters for all the ribs, formers, fuselage sides, etc. You can also get the plan printed out at FedEx for around $25 a copy.

Having the full-size plan, I then go thru and determine all the materials I'll need to make the build. Any balsa sticks and sheets, basswood, or plywood I'll need is ordered from Balsa USA.

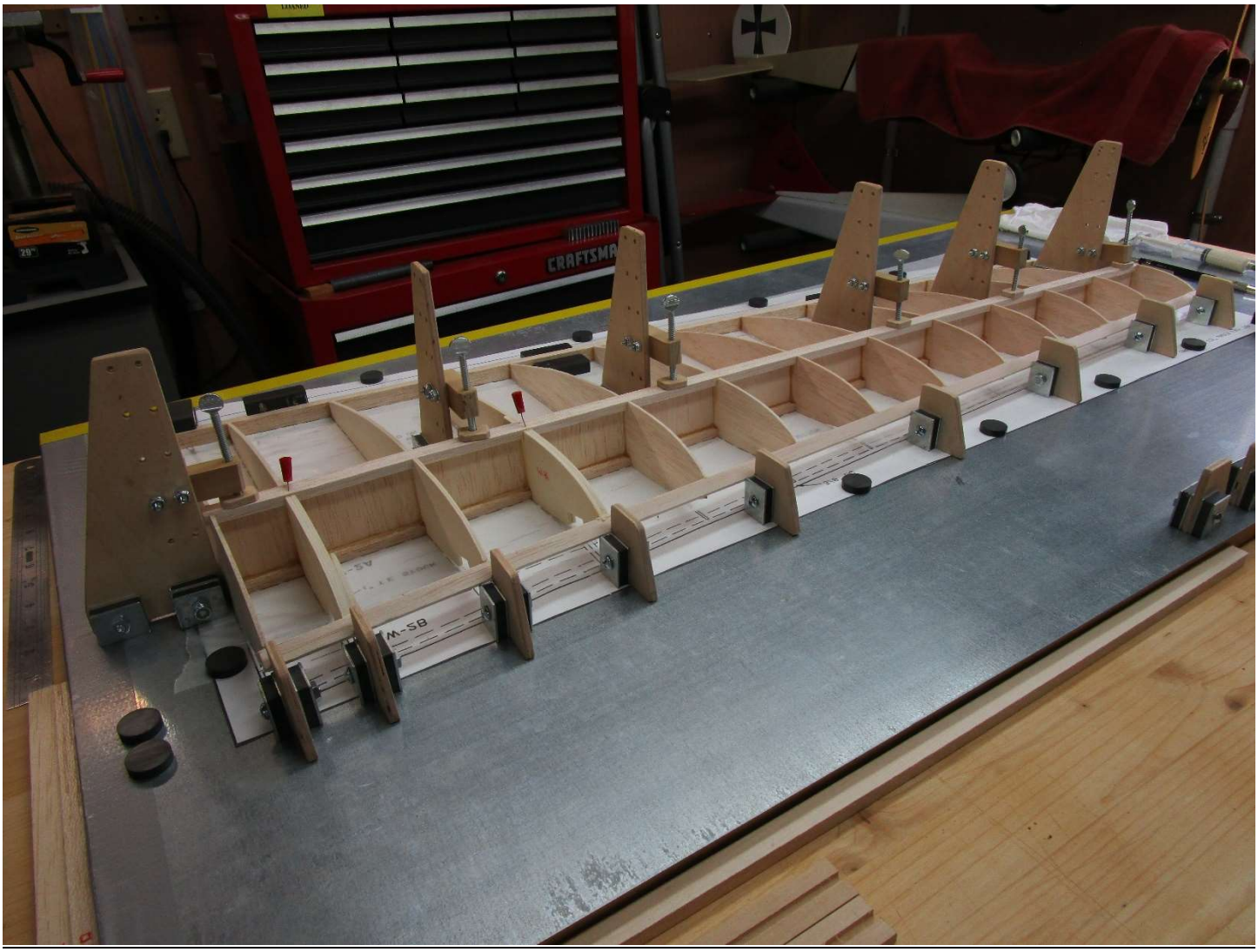


I plan to use my magnetic build board and fixtures for this build as I think all the major sections will fit on the 48" board. If not, I'll resort to the old wood build board with pins.

The Cloud Dancer is a fairly simple build for anyone with some basic woodworking skills and would make a good first scratch build project. The build is started by cutting out the templates in the plan for all the wing ribs W-1 thru W-13. With a double taper wing, you will only have two of each rib that are the same, so trace a given rib pattern on the 1/16" x 3" sheet balsa, and then put two pieces of balsa together using double sided scotch tape (small pieces at each end of the (rib) to cut both ribs out at the same time. I use a table band saw to cut out the rough rib shape, and then a table disk sander to sand down to the final shape, just removing the traced lines. Do the same for the several ribs that call for 1/8" lite plywood. All notches in the ribs are cut out with the table band saw, checking the width and depth using a scrap piece of spar, leading edge, and main landing gear (MLG) block.

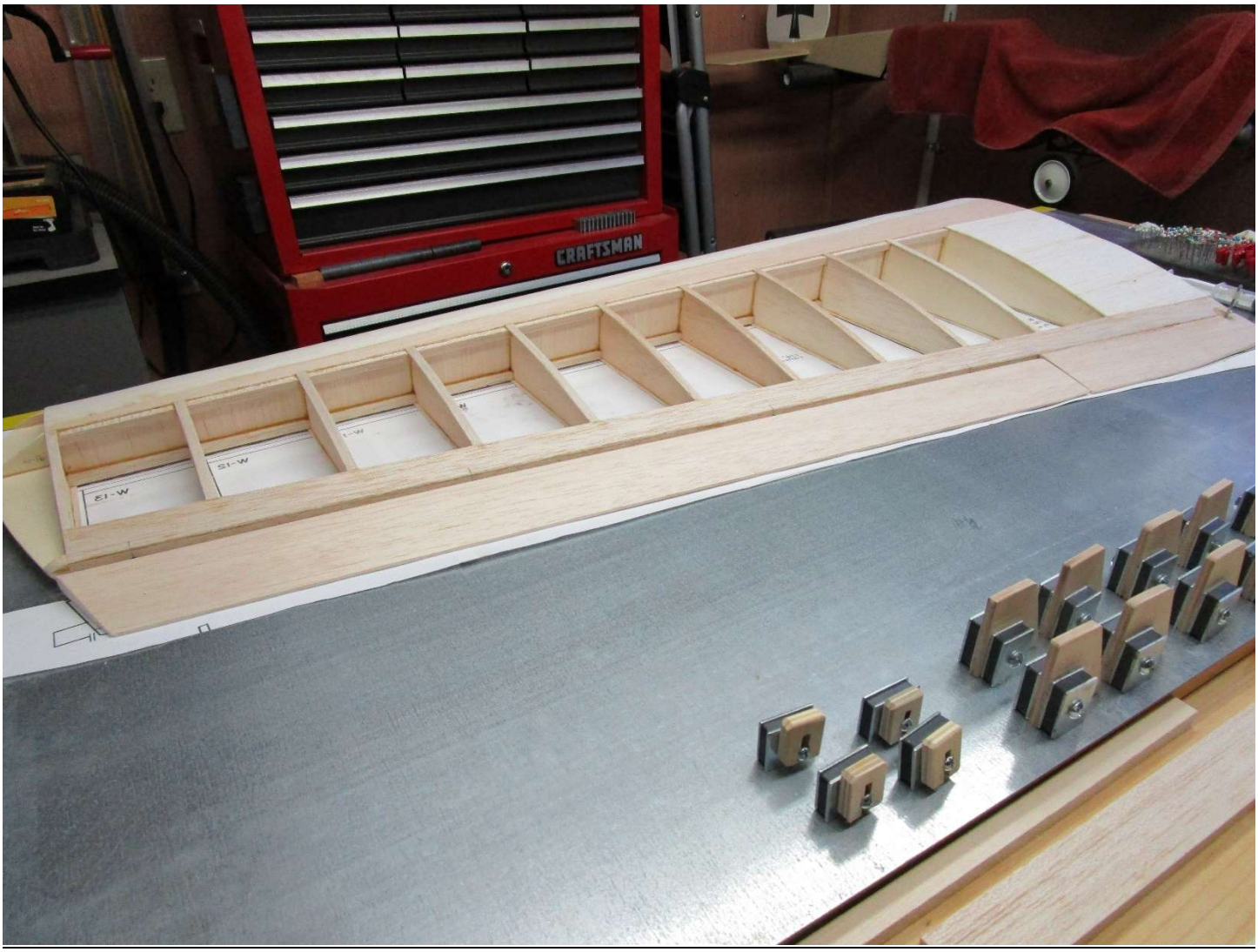


Since the airfoil is semi-symmetrical with a flat bottom, the wing sections can be built directly on the plans without having to use a wing jig. I'm using my magnetic build board for this project. The one big advantage of the magnetic board is it allows me to do a dry fit (no glue) buildup of the entire wing section. The build can also be accomplished using the standard wood table board with pins to hold everything together. As I'm cutting out each set of ribs, I test fit and adjust each to fit over the lower spar and trailing edge, holding each in place with the various magnetic board fixtures I've built. This wing design is called a boxed "D" because the wing surface is covered with 1/16" sheet balsa from the centerline of each spar forward to the leading-edge material, along with shear webs between the spars, making a "D". This results in a strong, but very light wing structure. The large rib on the left has a cutout for the aileron servo and rails, and is held at the correct angle using a dihedral gauge so that when the wing wings sections are glued together, the two large end ribs will fit flat together with each wing tip raised 2.5" at the wingtips. For increased strength I used 3/32" balsa sheet for ribs W-1, W-13, and for the vertical gain shear webs between all the ribs and the lower/upper spars. While many builders use CA for assembly, being an old man that moves pretty slow, I prefer to use a premium wood glue for most of the assembly, and two-part epoxy for the high stress areas (like landing gear blocks, firewall install, wing sections joint, horizontal tail to fuselage join, etc.).

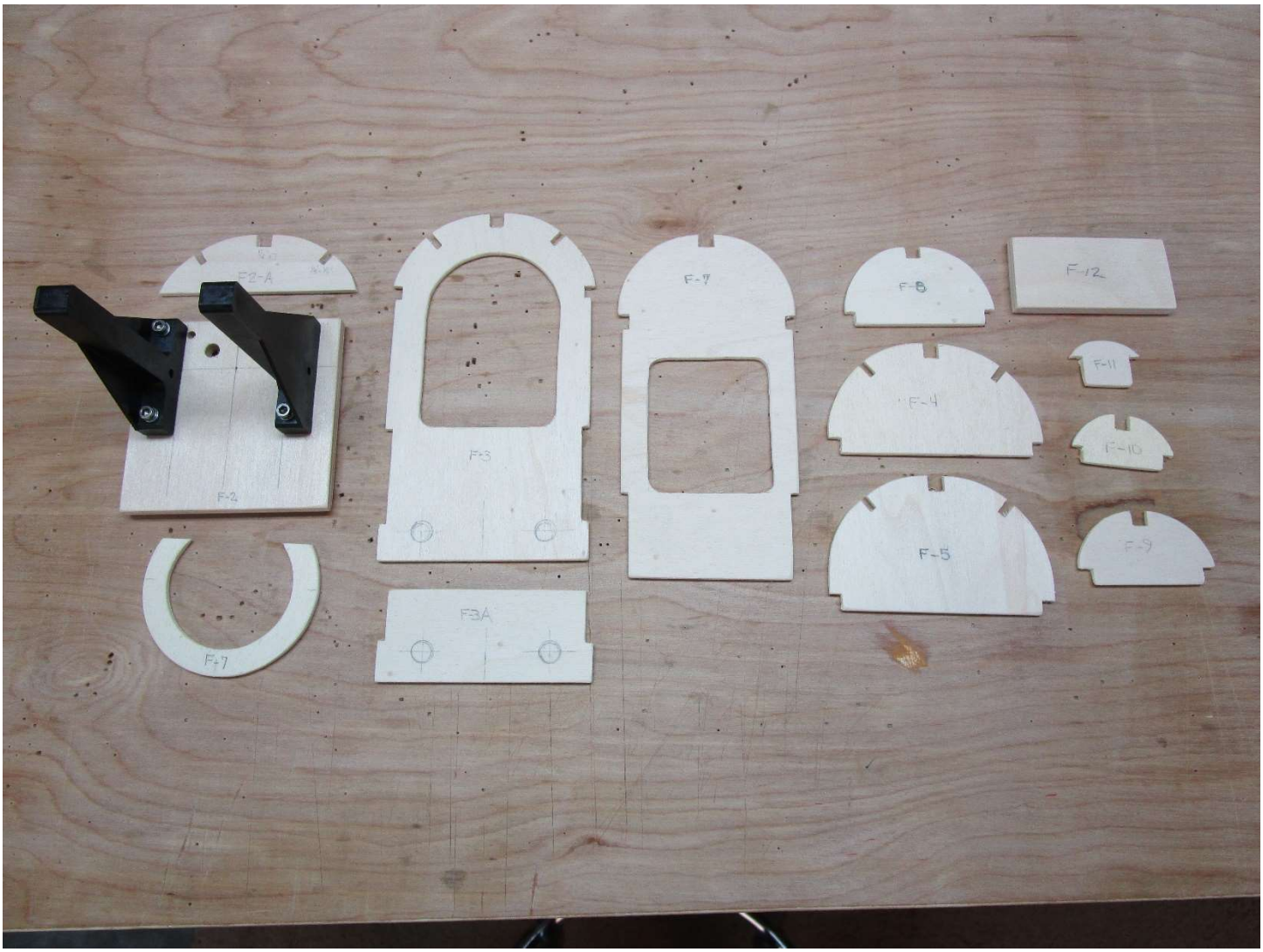


In this picture, all the left-wing ribs have been glued in place; the 3/32" vertical grain balsa sheer webs glued between each rib; the balsa top spar, 1/4" square leading edge, and trailing edge are all then glued to the ribs. Ribs W-2, W-2A, W-2B, W-3, W-4 and W-4A are all 1/8" light ply and have notches cut in the bottom to install the MLG block. Once this all dries, the wing can be removed from the board to sand anywhere needed to make a smooth transition between ribs, spar, leading and trailing edges. Then a 1/16" x 1" balsa strip is glued along the top edge of the entire trailing edge, and 1/16" x 1/4" balsa cap strips are glued along the top of ribs W-4 thru W-13 from the center of the top spar back to the piece just installed. Next, 1/16" x 3" balsa sheeting is used to cover the area over ribs W-1 thru W-3 from the center of the top spar aft. Unlike in the build article, **DO NOT** install the 1/16" balsa sheeting from the top spar forward to the leading edge yet.

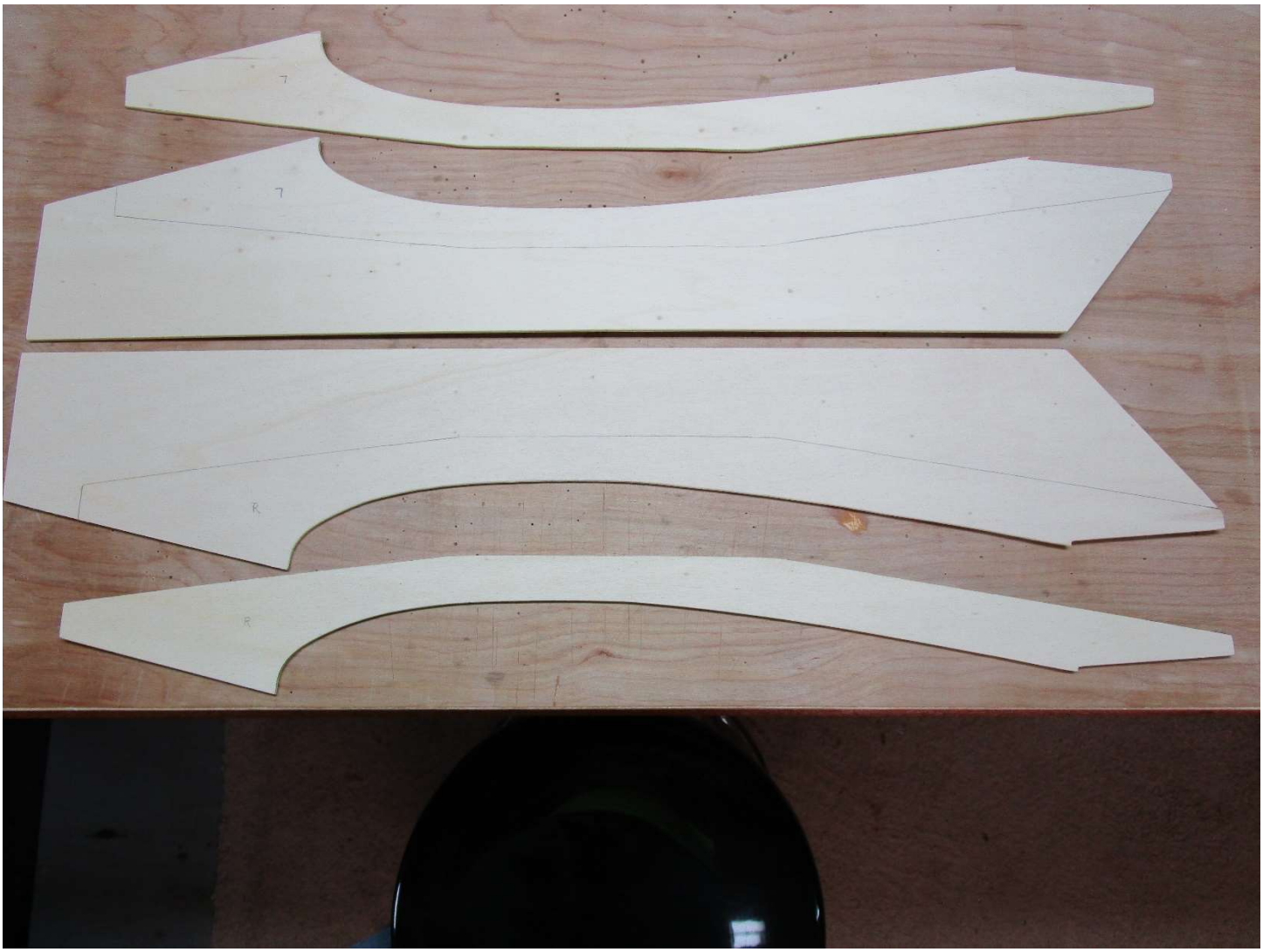
After all that dries the wing can be turned over (bottom side up) to install the left MLG block and supporting structure from ribs W-2 thru W-4. After any required sanding, repeat the install of the 1/16" x 1" strip along the trailing edge, the 1/16" x 1/4" rib cap strips, and the 1/16" sheeting to cover the area over ribs W-1 thru W-3 from the center of the top spar aft. Now use 1/16" balsa sheeting to cover the area over all the ribs from the center of the top spar forward over the leading edge. When that all dries you can turn the wing back over (top side up) to see the MLG block assembly. I've not completed a scratch build yet without making changes, and this one is no exception. While the plan and build article does not call for it, I used fiberglass cloth and glass resin to strengthen all the joints between the MLG block and ribs W-2 thru W-4. I'm known for carrier deck landings, so this will help to ensure my MLG gear structure stays in place. **Builder's tip** - now is the time to use a pin to push thru the 1/16" balsa sheeting at each end of the MLG block center channel so you can easily find where to remove the 1/16" sheeting over that channel. Also, use a 3/16" drill bit and run it down thru the vertical MLG end block and the 1/16" sheeting on the bottom side. With all this done, again use 1/16" balsa sheeting to cover the area over all the ribs from the center of the top spar forward over the leading edge. This makes the wing "D" structure I mentioned earlier.



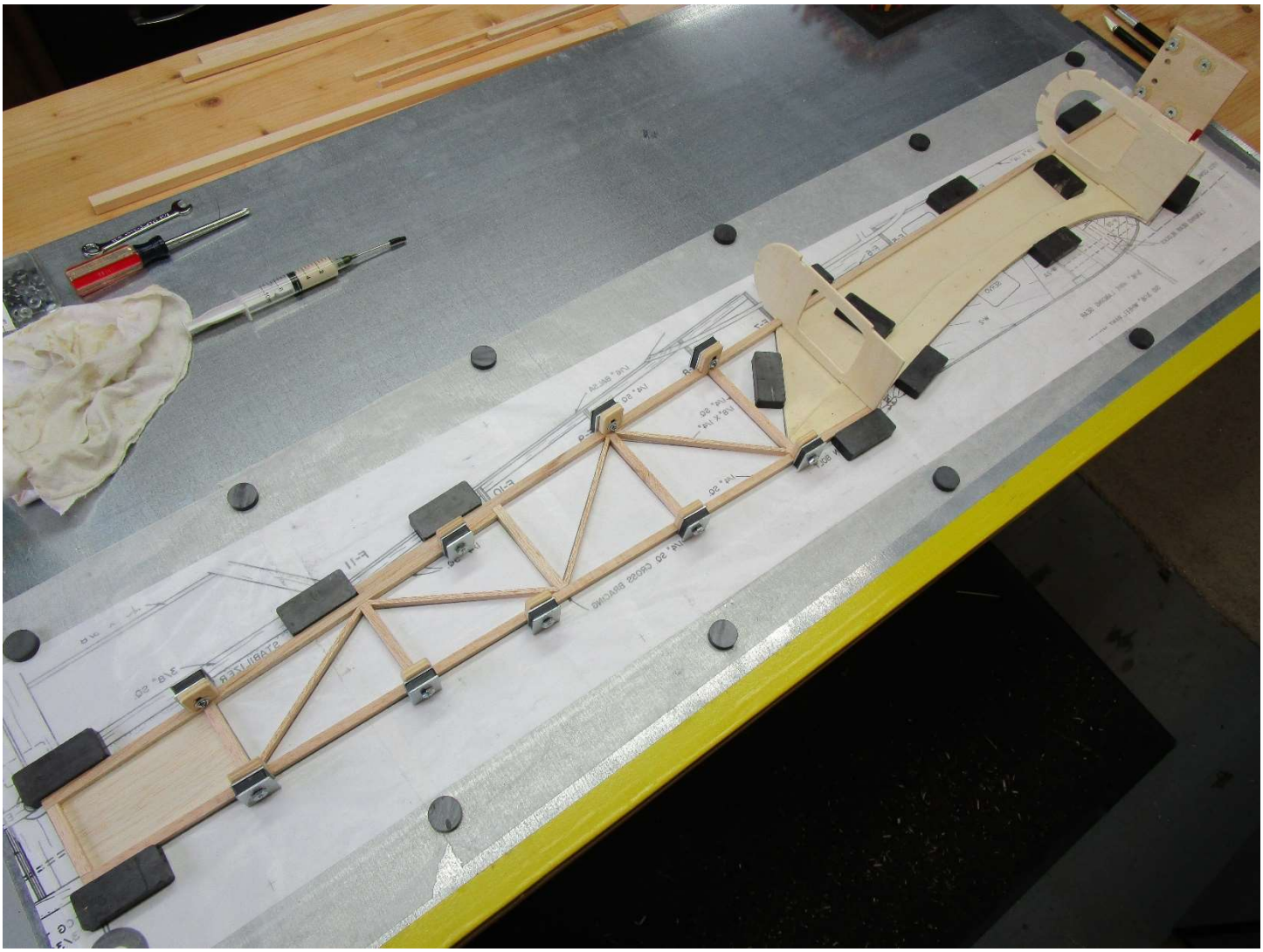
With all the wing balsa sheeting installed, do a complete sanding of the wing half to shape the leading edge, smother the transitions between the rib caps and wing sheeting, and to trim any sheeting that extends out over the end ribs. As seen on the left side of this picture, the 1/8" lite ply wingtip (W-14) and supporting structures (W-15 & W-16) can now be glued to W-13. Now for the wing root trailing edge and aileron. The plans call for 9/16" x 1.5" balsa tapered trailing edge stock, which I could not find, so I used 1/2" x 2" TE stock. Larger ailerons won't hurt. I used a 4-40 rod (threaded at one end) to make the aileron torque rod, with 1/8" brass tubing for the sleeve bearing. **Note** - put the sleeve over the rod before you make the final bend. Yes, I've made that mistake before. This assembly is then epoxied in a channel cut into the TE stock at the root of the wing. Take care not to get epoxy in the brass tubing when joining this assembly with the wing trailing edge. For the aileron I used 4 each Robart pin hinges. I find it easier to drill the required holes in the aileron and trailing edge using the little Robart fixture they sell to ensure the holes are centered and drilled perpendicular. I think drilling is also easier than cutting slots for flat hinges, which I only use if the wing trailing edge is very narrow. Now bevel and sand the upper and lower forward edges of the aileron so it can freely pivot approx. 45 degrees up and down when moving the torque rod. Set this left half wing off to the side and then re-accomplish all the same steps for the right-wing half using the other plan sheet you printed out earlier.



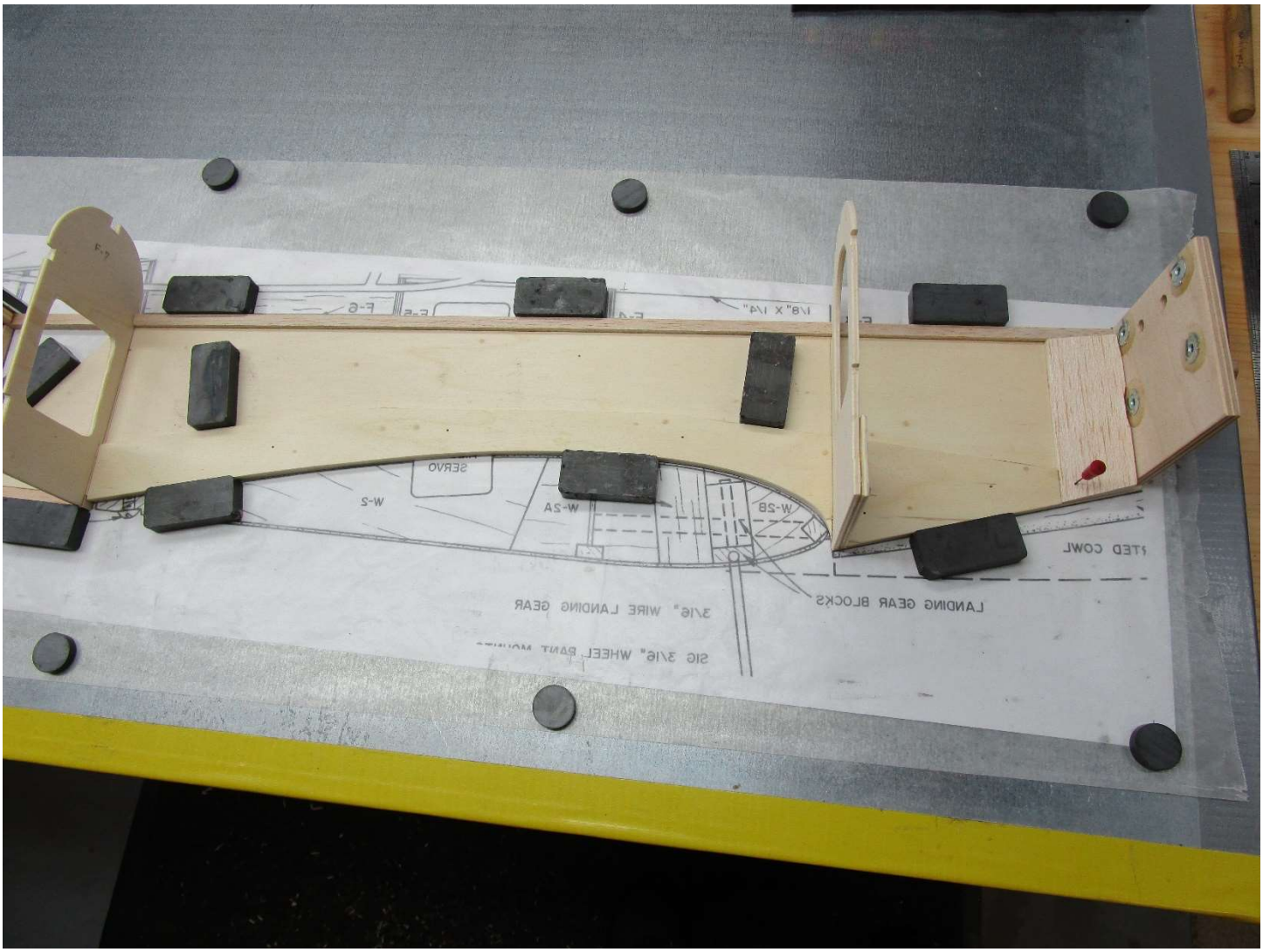
While waiting for the glue to setup on the right-wing half, I decided to start on the fuselage build. My first step is to cut out all the fuselage former templates from the plan sheet. Lay out each former on their respective size of ply (1/4" 5-ply for F-2 and F-12, and 1/8" lite ply for all the others), and cut out using a small table band saw, and a table jig saw for the openings in F-3 and F-7. **Builder's tip** – Now is the time to check that your fuel tank will fit thru the opening in F-3. I'm using a Sullivan No. 729, 12-ounce RST style flex-tank, which fits thru the opening per the temple just great. Glue F-3A to F-3, and when dry, drill the two 5/16" wing dowel holes. Now for the firewall F-2, the most important former. Mark the centerline and thrust line. Use these to properly place the engine mount that will fit the engine you plan to use. I'm using SIG SIGEM001 large glass filled engine mounts. Make sure your engine mount does not extend above F-2 and is long enough to allow your engine to fit far enough forward so the spinner backplate will just clear the nose ring F-7. Mark the positions for the engine mount holes, fuel tank lines, throttle cable pass-thru, and then drill all of those in F-2. Install the four 6-32 blind nuts for the engine mount on the back side of F-2 and epoxy in place.



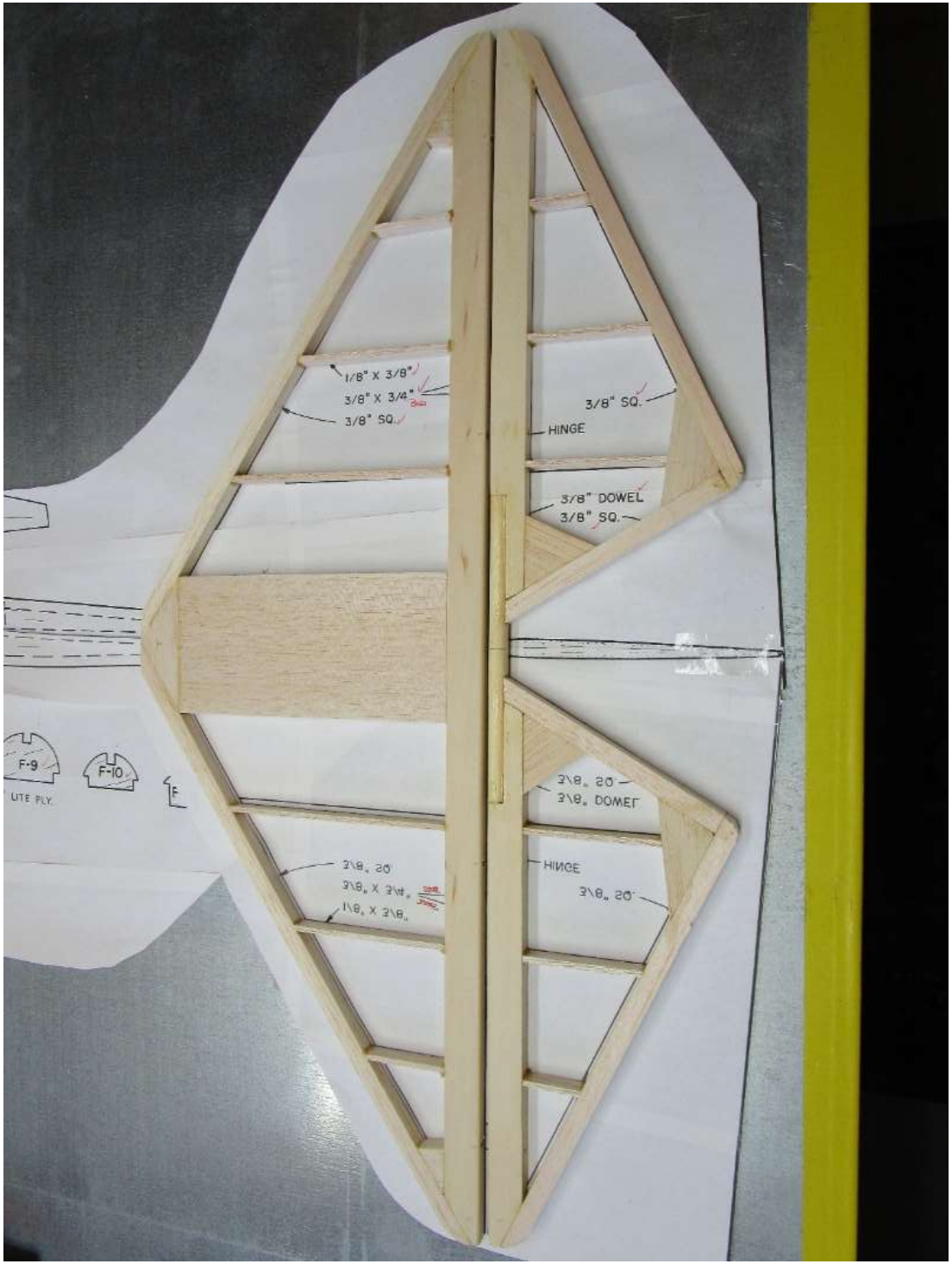
Now cut out the patterns from the plan for the forward fuselage side panel and wing saddle doubler. Trace the patterns onto 1/8" lite ply, and cut out using a band saw, and then final sand the edges just removing the traced lines. For the curved areas over the wing, I used a small drum sanding wheel on my table drill press. **NOTE** - Before gluing the doublers to the side panels, each doubler needs a small notch cut out at the bottom to fit the keys on bulkheads F-3 and F-3A. Doublers are glued to the insides of each side panel.

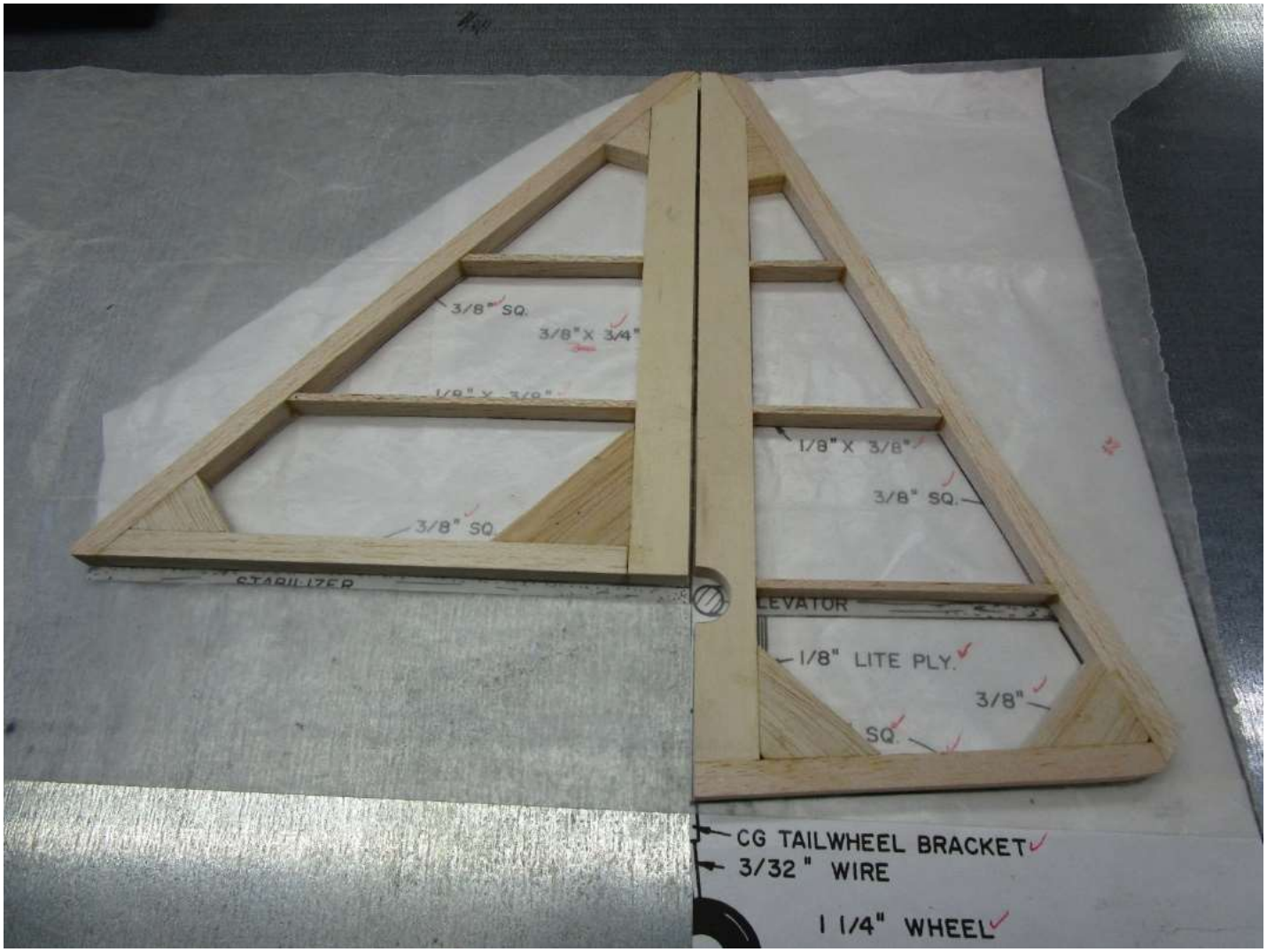


Take the side view of the fuselage on the plan and cover with wax paper. In this picture you see the complete left side in "dry layup" to check the fit of all parts before any glue is used. For the aft fuselage side, 1/4" square hard balsa is used for the top and bottom side longerons and uprights, while 1/8" x 1/4" balsa is used for the diagonals. A 1/16" balsa sheet filler is used in the aft bay to support the control pushrod exits. I cut balsa sticks using a fine-tooth hand razor saw, and then use a 150-grit sanding block to get the required angles and good tight fits.

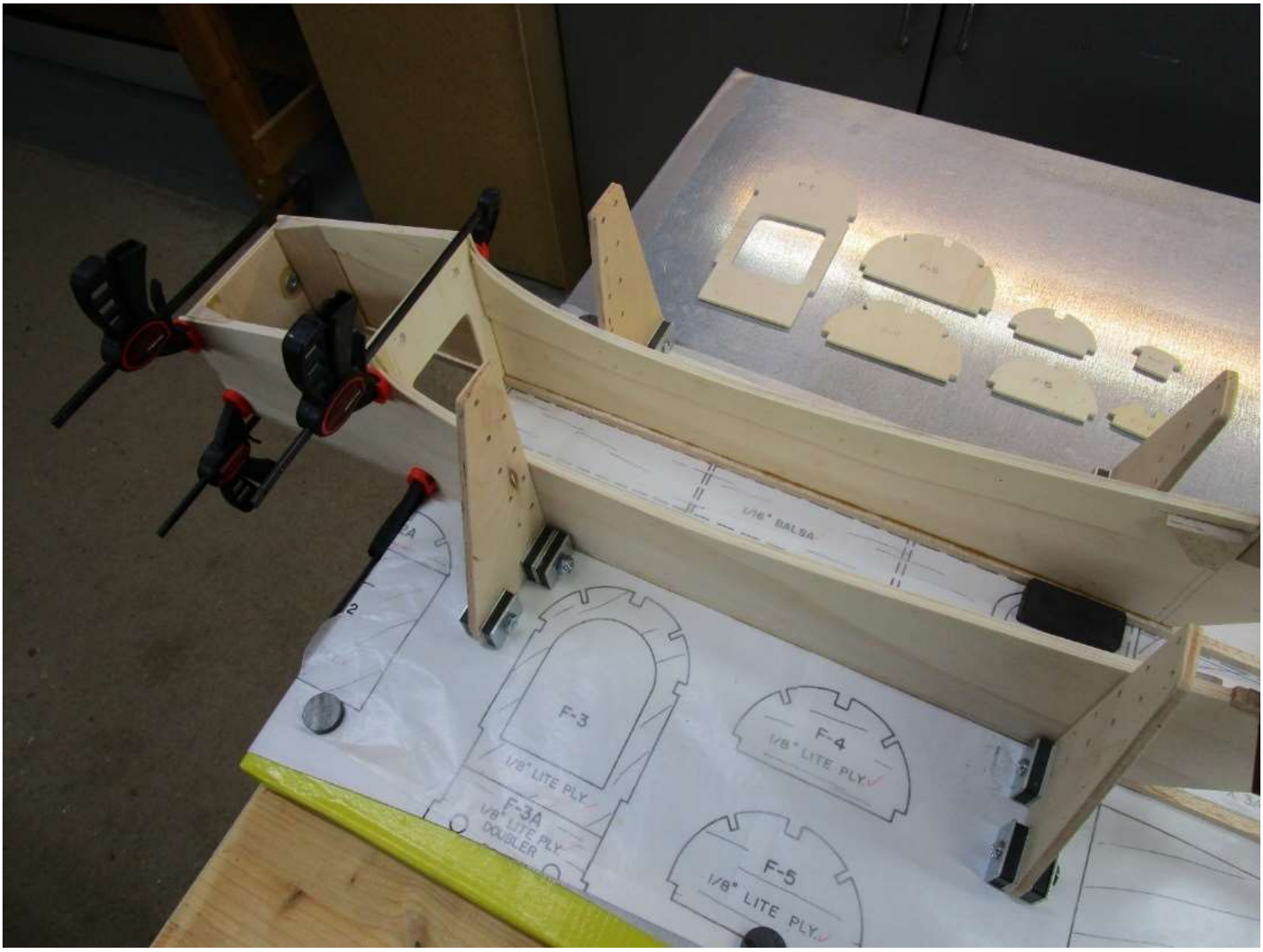


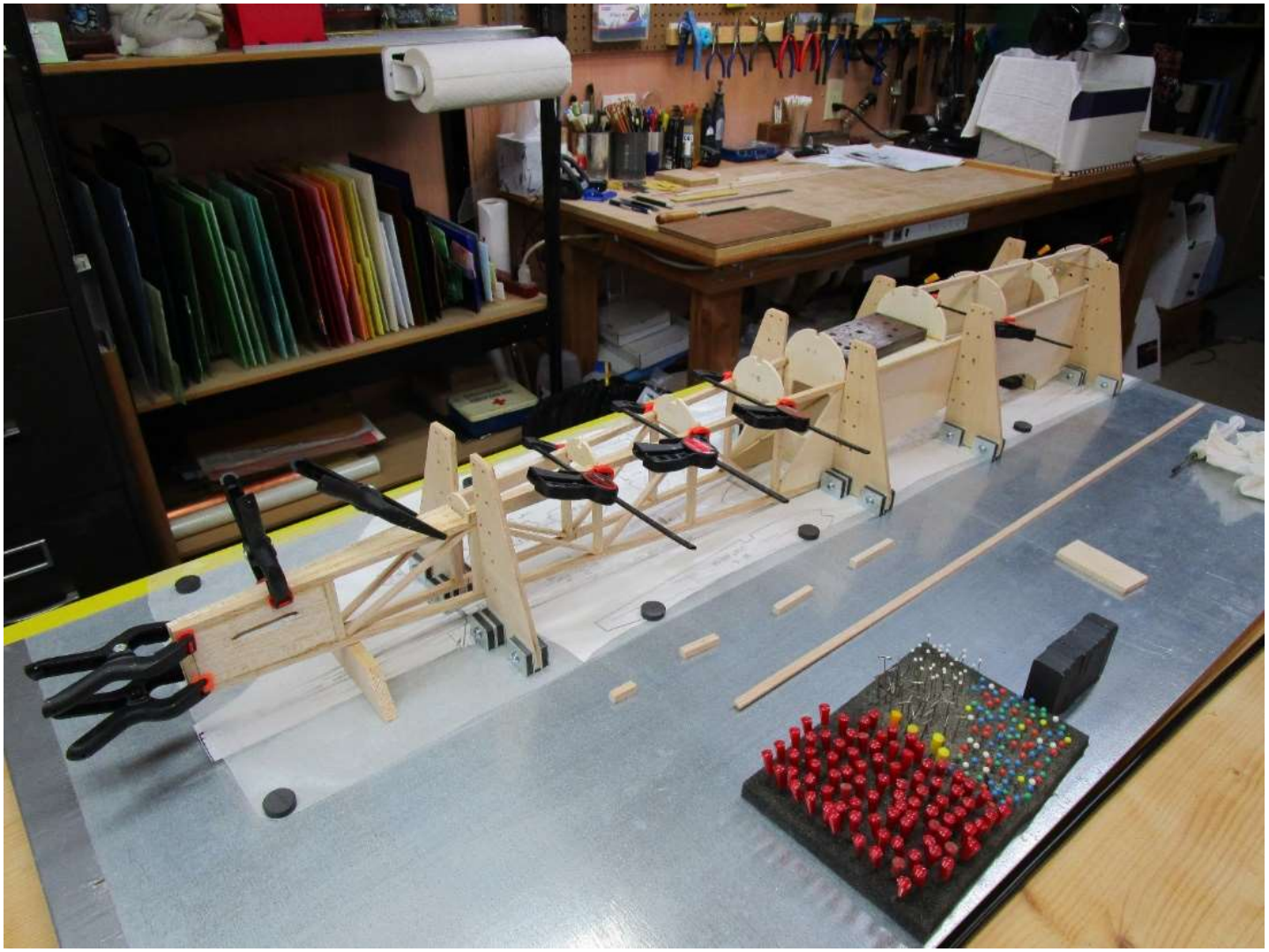
I also temporally place formers F-2 (firewall), F-3/3A, and F-7 on the side to check their fit. In doing this I found I'm going to need to cut the opening in F-3 another 1/2" lower to allow room for the receiver battery pack to be installed below the fuel tank. Also, the 1/4" square longeron on the top needs to be notched at the front end for F-2. Now is the time to determine if any support structure needs mounted on the side panels for items like fuel tank supports, servo rails, etc. Double check everything, and once you're good with how it all fits, go back and glue everything together (except the 3 formers) to make a complete fuselage side. Accomplish the same procedure for the right fuselage side.


1/8" X 3/8"
3/8" X 3/4"
3/8" SQ.
3/8" SQ.
HINGE
3/8" DOWEL
3/8" SQ.
F-9
F-10
LITE PLY
HINGE

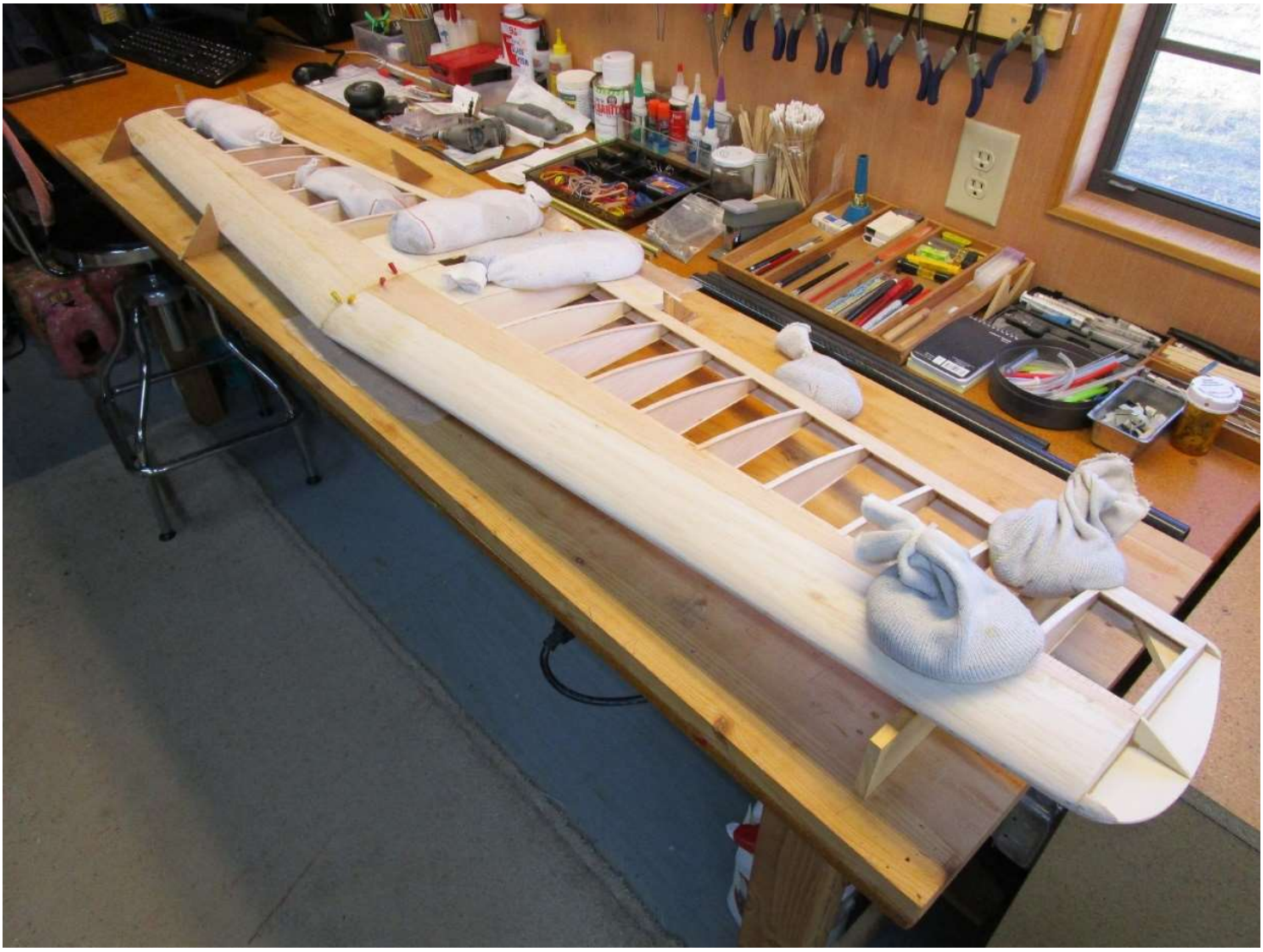


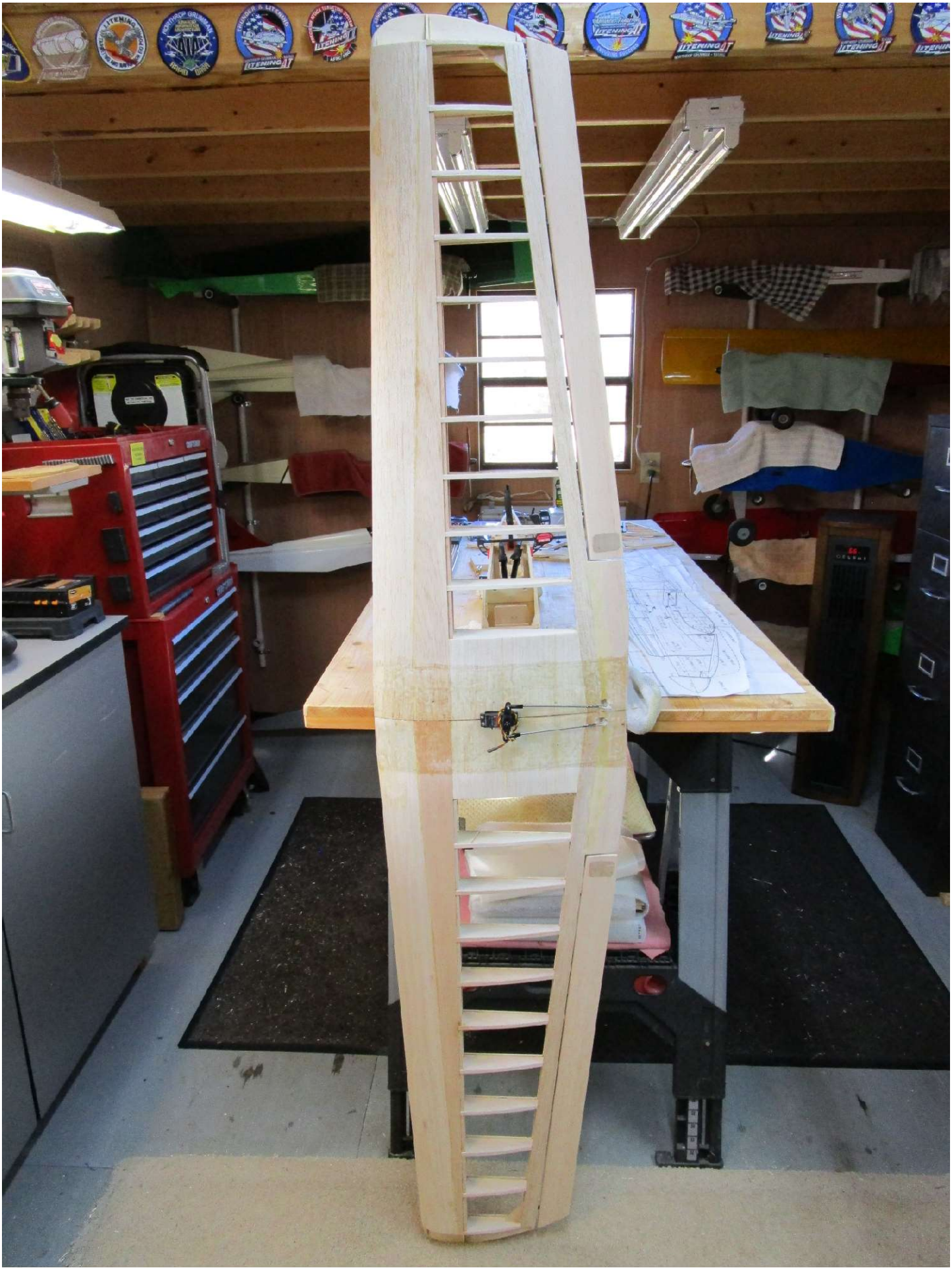
These two pictures show the build-up of the various tail feathers. Each are built directly over the plans covered with some wax paper. Modifications I made were to use basswood for the vertical stab trailing edge, rudder leading edge, horizontal stab trailing edge, and the elevator leading edge. As you can see in the pictures, I also added some corner bracing using 3/8" balsa sheeting (note the grain alignment for these). Another mod I make to all my scratch builds is to place some 1/64" ply on the bottom of the elevator to cover the joints between the center hardwood dowel rod, the leading-edge pieces, and the balsa corner bracing on each side of the center gap. I also add a piece of 1/64" ply to the area at the lower portion of the rudder where the control horn will mount (not shown in these pictures). All these modifications will add a very small amount of weight but will greatly increase the overall strength of the tail feathers and provide solid surfaces for the control horns. The leading edges of the elevator and rudder must be rounded to allow each to pivot at least 45 degrees in both directions. Again, I will use Robart pin hinges, drilling the required holes in basswood pieces using the little Robart fixture. These get epoxied into the tail feathers after all covering is finished, and the tail surfaces are epoxied to the fuselage (horizontal stab first, followed by the vertical stab, then the elevator, and finally the rudder which fits over the elevator center dowel).


1/16" BALSA
F-3
1/8" LITE PLY
F-3A
1/8" LITE PLY
DOUBLER
F-4
1/8" LITE PLY
F-5
1/8" LITE PLY



Now back to the fuselage build. First, epoxy the firewall (F-2) and former F-3/3A to one of the fuselage sides. Ensure both are at right angle to the side by using a 90-degree triangle to hold each in place while the epoxy sets. This is where my magnetic fixtures work really nice. The first picture shows joining the two sides. Do this right over the plan top view, both sides turned upside down, with the top of former F-3/3A just off the building board edge. This will ensure the two sides are parallel and square to the formers. I use small bar clamps and my magnetic fixtures to hold everything in place while the epoxy sets. When that has all cured, turn the fuselage right-side up and align over the plans with F-2 and F-3/3A in their correct positions on the plan. The tail end of each fuselage side needs to be sanded a small amount to provide for a flat surface between them. Now wood glue former F-7 to both sides and pull the two sides together making sure they align with the plan overhead view. Note, I also added a filler (1/4" balsa sheet) between the sides aft of former F-11 to strengthen the joining and to provide more surface to epoxy the horizontal stabilizer to the fuselage. The second picture shows the two sides being clamped in place with formers F-2A thru F-5 glued in front of the cockpit, and formers F-8 thru F-11 glued aft of the cockpit. Also glue the 1/8" lite ply cockpit floor (F-6) in place between F-5 and F-7. When dry, glue the 1/4" square and 1/8" x 1/4" stringers in the slots cut into the formers, and then the 1/4" square bottom rear crosspieces as shown on the plan.

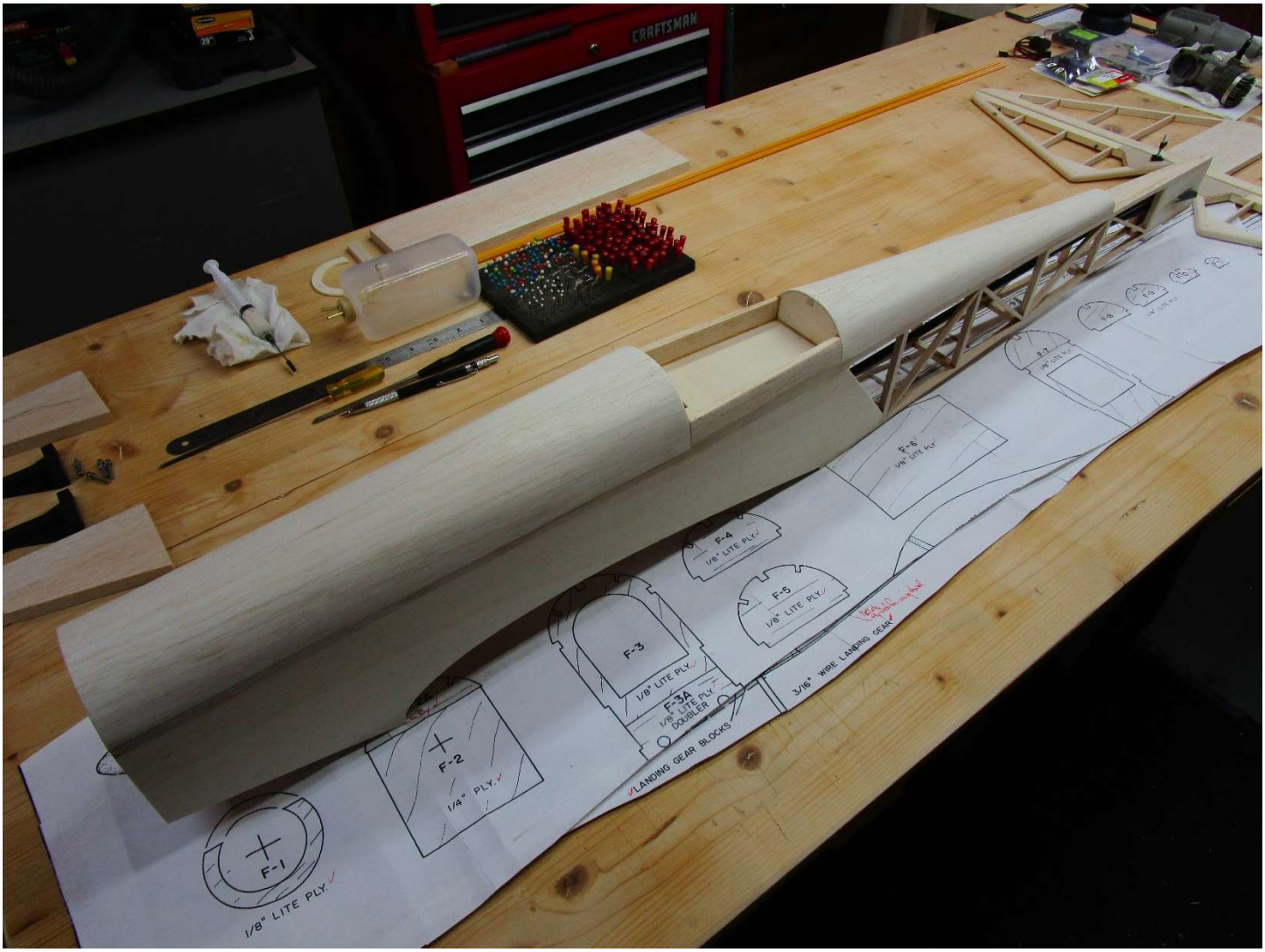




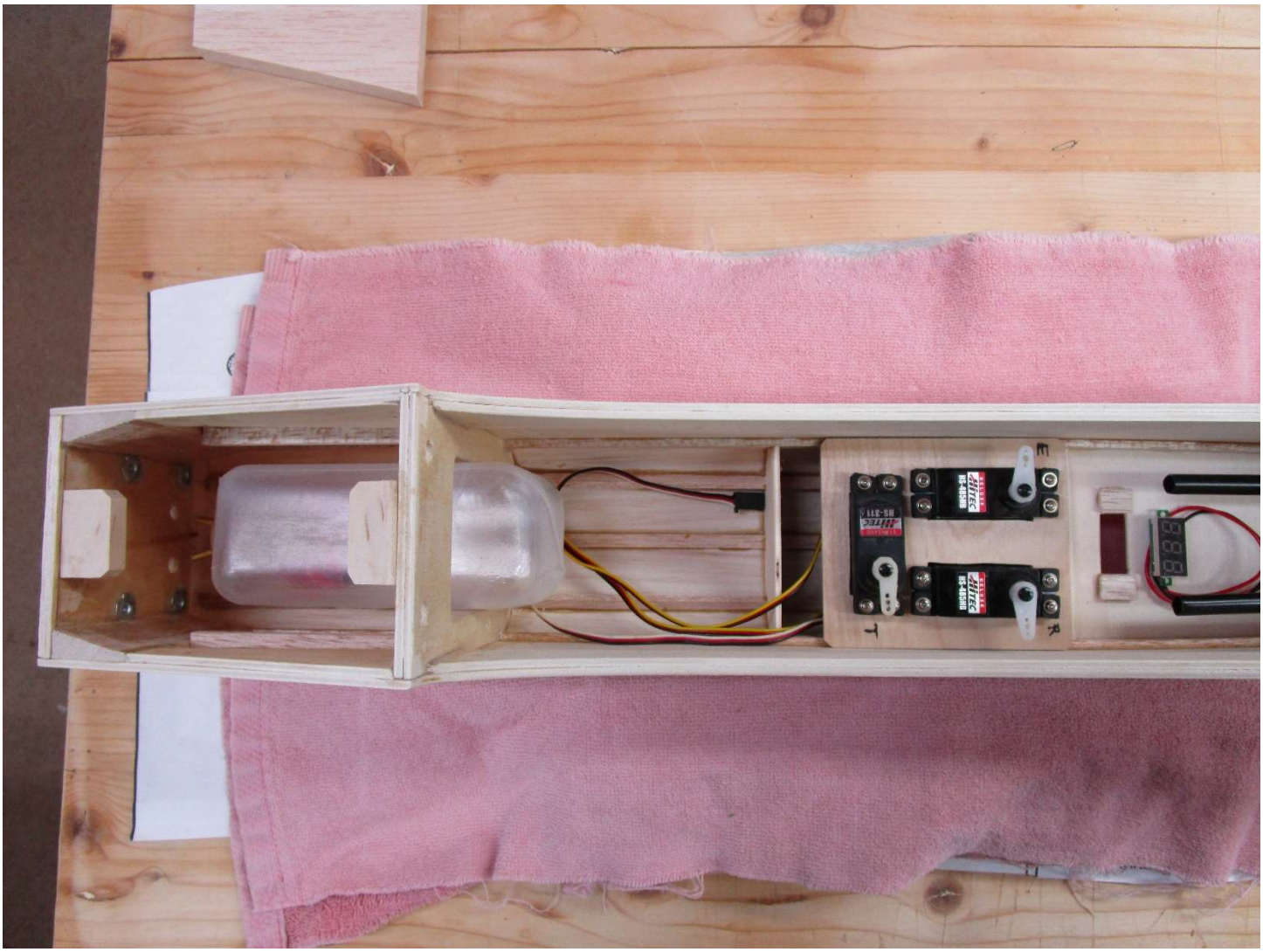
Let's finish the wing build. First, make sure both root wing ribs (W-1) are as flat and straight as possible to ensure they touch the entire cord span when matted together. In the first picture the right-wing half is laid flat on the bench and secured in place. Then position the left-wing half to check its fit against the right half by raising the left-wing tip up off the bench. The build article calls for a height of 5" at the wingtip. Given I used 3 degrees for the wing root rib angle template, this resulted in a 3.5" rise at the wingtip when both wing half root ribs are matted flat together, which is just fine for me. You can increase or decrease the template angle as you wish. I used 30-minute epoxy to coat each wing half root rib, and then placed them together ensuring the halves align properly at the front and trailing edges. Once you feel everything is right where it needs to be, pin it all in place and let it set overnight.

Remove the joined wing from the bench and lightly sand both sides at the center joint to prep the surfaces for the fiberglass cloth installation. In the second picture you can see the bottom of the wing with a 6" wide piece of fiberglass cloth installed over the center joint. I used 20ml of polyester glass resin to seal the cloth to the balsa sheeting. SIG sells a real nice kit that contains everything (pint of resin, hardener, large fiberglass cloth sheet, mixing cups, mold release gel, and instructions) you need to do the fiberglass work. Also note, I glued a 2" X 6" piece of 1/32" ply at the rear of the wing to cover the joint between the center trailing edge and the main wing. This increases the strength of that joint and spreads out the stress across the wing surface where the two wing bolts pass thru at the rear of the wing panel. Now install a 6" wide fiberglass cloth over the center wing joint on the upper surface of the wing. Cut away any fiberglass cloth that lays across the landing gear mounting slots, the aileron servo mounting hole, and aileron torque rod passthroughs. Lightly sand the fiberglass cloth areas and feather the edges.

The last picture shows the entire wing, with both ailerons, a Hitec HS-645MG aileron servo, and 4-40 linkages temporarily installed. This ended up being a larger wing than I first visioned.

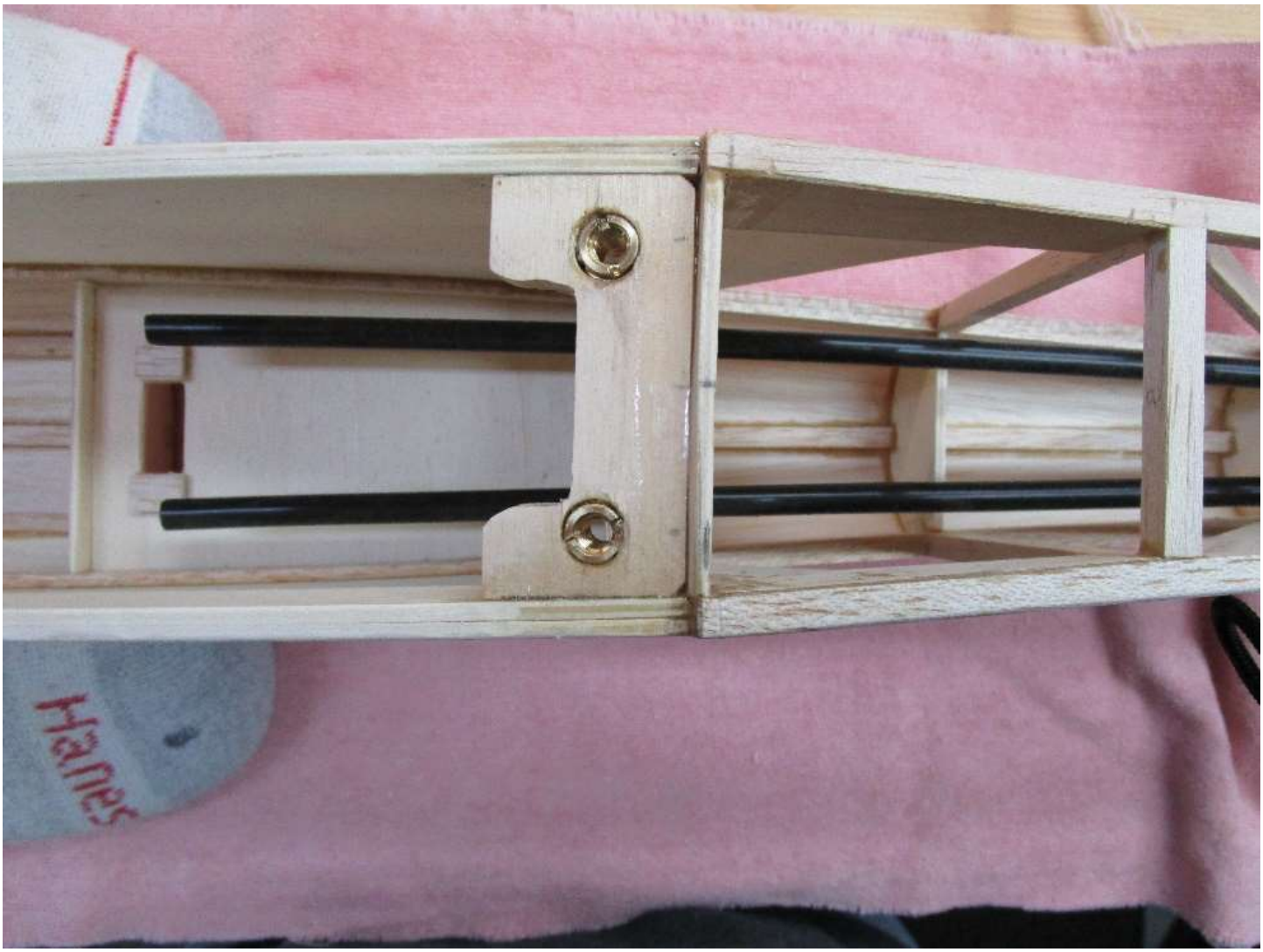


Ok, back to the fuselage build again. Sand lightly all the stringers running along the top and sides of the formers for a smooth transition between each joint. Carefully measure the length from fuselage side top ¼" square upward along the curve of each fuselage former to the center of the top ¼" square stringer. Transfer these measurements to a piece of 1/16" balsa sheeting that has been cut the length of the front and rear turtledecks. Do not assume these measured lengths are identical for each side, because they are most likely not. Once you have the deck covers cut out, glue a forward and rear sheet for a single side to the ¼" square along the top of the fuselage side. Let dry overnight. Now you can glue each of these to the formers. Use warm water sprayed to the outside surface of the sheets to soften the balsa sheet so it will not crack when bending. Once one side has dried you can accomplish the same for the other side of each deck. Sand the decks smooth with the cockpit formers (F-5 and F-7), and then add the 3/8" x 3/4" balsa cockpit side fillers. The picture shows all this once everything has been sanded to shape. I turn the fuselage over and run a bead of glue along the sides of each stringer and former to ensure there is a strong bond between the deck covers, stringers, and formers. This can be easily accomplished using a 10ml plastic syringe with 14-gauge x 1.5" blunt tip (seen in picture), which I also use throughout the entire build for gluing. These can be purchased on Amazon. After cutting away the area required to clear the aileron linkage movement, glue the ¼" ply rear wing mount F-12. I doubled the F-12 mount because I'll be using SIGSH735 ¼-20 brass threaded inserts versus the T-nuts called out on the plan.



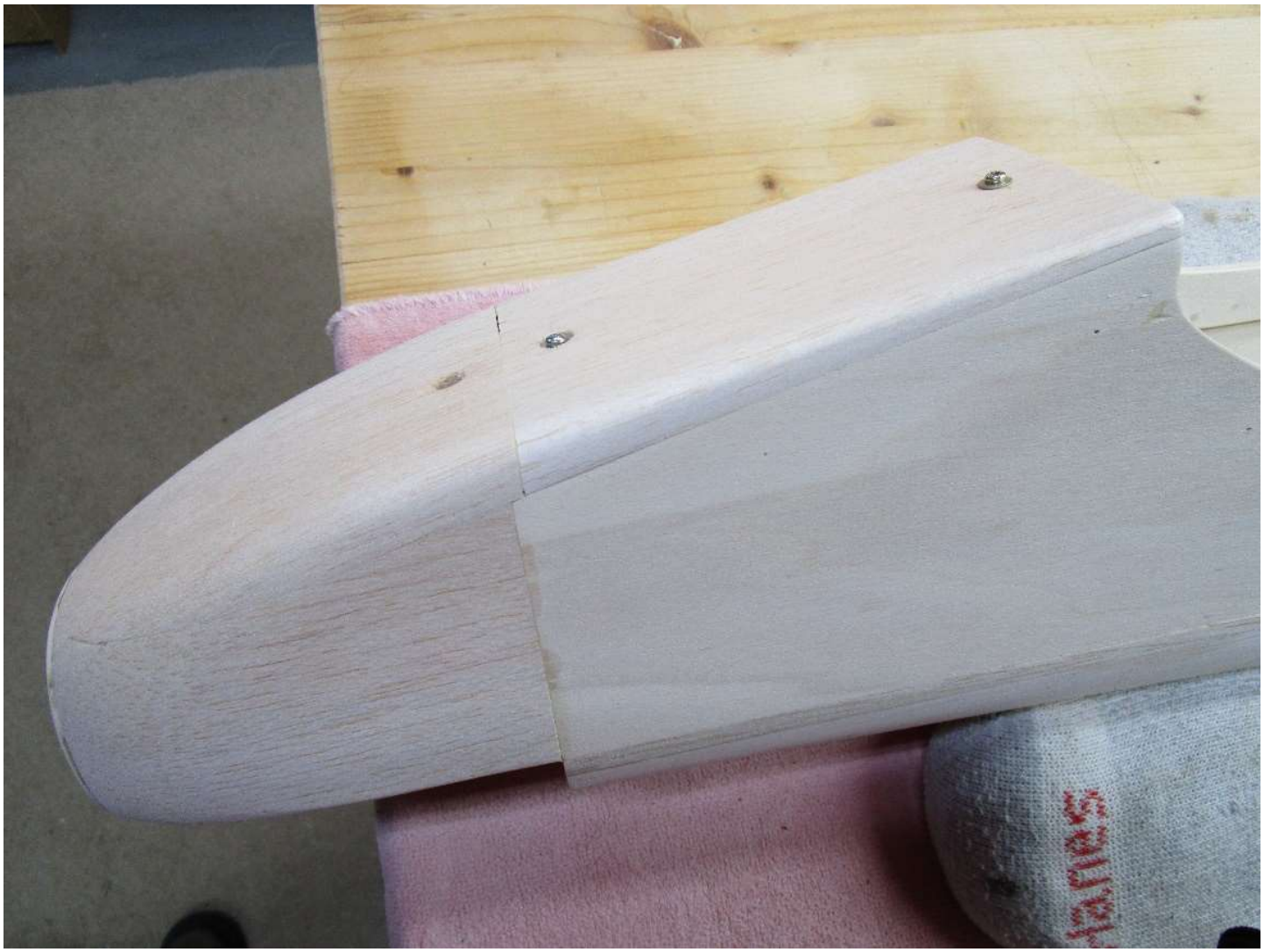
This picture shows the preliminary layout inside the forward fuselage. On the right you can see a square hole cut in the cockpit floor (F-6) which is where I'll install a voltage meter (to the right of hole) for the receiver battery pack. To the left of that is the servo tray. This was made using 1/8" 5-ply and will slide along the ¼" squares at the top of the fuselage sides to aid in balancing at the proper CG. To the left of the servo tray is where I'll place the receiver and mount the ON/OFF switch on the left fuselage side. At the far left is the 12 oz. fuel tank, and the area ahead of F-3 will be for the 6-volt receiver battery. To aid in getting to the fuel tank and receiver battery, I've modifying the plan to allow for an access hatch to be installed on the bottom of the fuselage from the rear of the firewall (F-2) to the rear of F-3. This will be secured using small screws into the blocks I've placed on F-2 and F-3. The throttle cable tube will be routed thru the firewall, passing next to the fuel tank, thru F-3, and then thru a small mount that will be glued just forward of the throttle servo. As can be seen on the far right, I've installed Sullivan Gold-N-Rod rudder and elevator control rod tubes which exit the fuselage thru the 1/16" fillers placed at the aft on each of the fuselage sides (see earlier picture).


4 x 4 Grid Layout



There are two steps in any build that are critical, the wing-to-fuselage join, and the tail feathers-to-fuselage join. We are going to take on the first one now. Place the wing into the saddle on the fuselage. Check the alignment between each on both sides. For this build I found that my wing was sitting ¼" high at the front, because the dowel holes in F-3 where not aligned with the wing leading edge, which would not put the wing dowels directly thru the 3/8" square leading-edge material, and also ends up changing the overall angle-of-attack for the entire wing, which needs to be parallel to the line-of-thrust per the plans. I had to correct this with adjustments to the wing saddle in both fuselage sides using my handy little Dremel tool. I also removed approx. 3/8" of material at the center of the wing leading edge to provide for a nice flat area to match up against the back of F-3, and approx. 1/8" of material at the rear of the wing to fit flat against F-7. Once you have everything fitting as needed, secure the wing to the fuselage for drilling. I use a 12" bit to drill the dowel holes in the wing. This length of bit helps me to keep the bit parallel to the wing centerline, and the hardwood block seen in the picture keeps both dowels at the same angle vertically. Now drill the 5/16" holes thru the leading edge, and the shear web between the main spars. Temporarily put the two 5/16" hardwood dowels (5.5" long) thru F-3 and into the holes in the wing. Now for the rear mounting bolts. After carefully measuring the placement of the holes per the plan, first drill the two wing bolt holes thru the wing and F-12 using a 1/8" bit. Ensure the bit is kept perpendicular to the surface of F-12, not the bottom of the wing. Remove the wing and enlarge the two wing bolt holes in the wing using a ¼" bit. Epoxy the 5/16" dowels

into the front of the wing. Enlarge the two holes in F-12 using a 5/16" bit for the brass threaded inserts. The close-up picture of F-12 shows these inserts epoxied into F-12, and the area removed to provide room for the movement of the aileron torque rods.



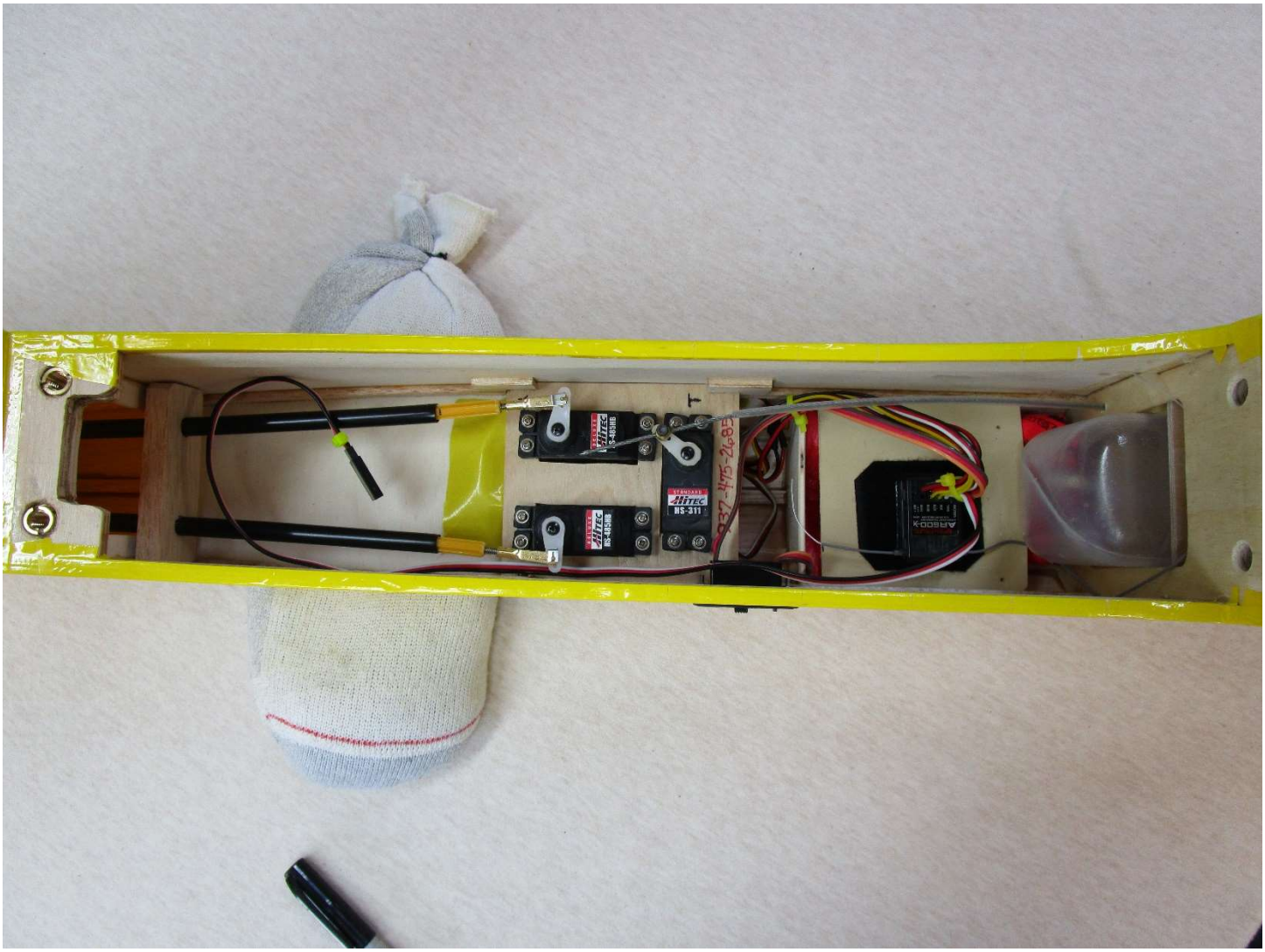
Let's finish the fuselage build. Build-up the nose forward of the firewall using ½" balsa sheet for the sides and bottom, along with some trailing edge and triangle stock to fill in behind the nose circle F-1. Ensure the lengths of this build-up are such that the backplate of the spinner clears the front of F-1 by at least 1/16". I used the plan measurements, and then positioned my .61 engine on the motor mounts to mark the position of the mounting holes with 1/8" clearance at the front of F-1. When gluing F-1 in place, you need to double check the alignment of F-1 to the spinner backplate so they are centered on each other. Once all this dries, shape the sides and bottom to taper them down to F-1 as shown on the plan and in the first picture. The second picture shows the installation of the bottom hatch from F-2 back to F-3. This provides easy access to the fuel tank and receiver battery compartment.

Time to see how everything fits together. Install the engine along with the muffler, prop, and spinner. Install the fuel tank and receiver battery along with any required padding, and the throttle guide tubing. Slide the elevator and rudder control rods into guide tubes. Install the landing gear rods and tires on the wing. Attach the wing to the fuselage, and then temporarily pin the tail feathers to the fuselage. Now to see where the servo tray assembly needs to be placed in the fuselage to obtain the correct longitudinal CG. As I expected using the larger .61 engine, the plane was nose heavy even with the servo tray positioned as far aft as possible. Rather than add weight to the tail, I moved the receiver battery to just aft of F-3 against the underside of the forward turtledeck. This resulted in being able to position the servo tray just forward of the cockpit to obtain the correct CG. You also need to check the lateral balance and place any required weight in the wingtip that is light. Disassemble everything, finish sand all surfaces with 220 grit, wipe surfaces down with a tack cloth, and lightly coat all areas that will contact your covering with Coverite Balsarite from SIG. I paint the inside of the engine compartment with flat black oil-based enamel paint to protect the balsa from any glow fuel. Apply whatever covering you like to use. I'm planning to finish mine with yellow-red checker patterned Ultracoat on the bottom of the wing and horizontal stab, and both sides of the rudder. The rest of the plane will be covered in matching yellow Ultracoat, with red on the wingtips, the ailerons, the top of the horizontal stab, both sides of the vertical stab, and along the leading edge of the wing.

Shown here is the fuselage with yellow Ultracoat iron-on covering installed. Engine compartment and cockpit are painted with flat black enamel. I installed the fuel tank, servo tray (with servos for the throttle, elevator, and rudder), receiver battery, motor mount, throttle control cable guide tube, ON/OFF switch with charging port, and the battery voltage meter. Added a 1/4-inch red tape along the sides.

The tail feathers are covered with red Ultracoat, and Robart pin hinges are temporarily installed. Hardwood dowels will be used to strengthen the matting between the vertical stab, horizontal stab, and the fuselage.

As indicated earlier, to help with identifying the plane orientation during flight I covered the bottom of the wing with Ultracoat red and yellow 2-inch checkers. Since the wing is more than 72 inches long and the Ultracoat only 23 inches wide, I had to match up three full width sections of covering along with two smaller sections at each wingtip to get the entire bottom covered. The top of the wing is covered using yellow Ultracoat. The tips of the wing and the aft center section between the ailerons are then finished in red along with a 1-inch red strip on the top and bottom of the leading edge. Each aileron is covered in red, and then mounted to the wing using epoxy and 4 pin hinges in each.



Epoxy the horizontal stabilizer to the fuselage making sure it is level, then install the vertical stab to the top of the horizontal stab using the hardwood dowels and epoxy. I use a plastic triangle taped to the two stabs to ensure they remain perpendicular to each other while the epoxy cures. With that finished the elevator is matted to the horizontal stab using epoxy and 4 pin hinges, followed with mounting the rudder to the horizontal stab. With all the tail feathers in place the control horns are mounted to the elevator and rudder and the control rods measured and installed. The picture above shows the interior of the fuselage with control rods, receiver, receiver battery pack, and the ON/OFF switch all installed. Install the engine and throttle cable and then secure the canopy to the fuselage using two small screws and black trim tape.

The last two pictures below show the finished Cloud Dancer. Double check all the control throws, and throttle throw for correct directions, and verify the CG is per the plans.