

Alright, here they are the plans/instructions for building the BAD SPAD. For starters, I would like to give credit where credit is due: first and foremost to Chris Spad at *Chrisspad.net* where I found his "Designing Your Own Spad" page, and got all my numbers from. I also got many ideas from his 22cc echo trainer, for example, the bicycle wheel landing gear. Also, I want to thank Jon Holmgren who gave me my engine, and machined the necessary parts to convert it for aircraft use. Credit must also be given to Dean Tuinstra (aka Tattoo) and his Spad 3d where I learned several techniques for working with coroplast.

This plane was designed to be simple, cheap, and easy to build and fly, and to have STOL abilities. I believe that it has fulfilled these wishes well. I was also hoping for some mild aerobatics, but have not tried any yet. These plans/instructions are meant to be followed but not to the T. Make as many variations as you wish and I am sure that you will come up with many ideas better than mine. I might show some pictures that were taken during the construction of a previous version, so pay attention to what the photo is there to show, but don't be surprised if some of the things in the background are different. The previous version was uglier, not as well built, and is because of servo overload, no longer with us. Let that tragic end be a lesson to us; DO NOT skimp on the elevator servos.

I will start in the order I built mine (or wish I would have) and suggest you do the same. I hope this plane serves you well, and hope to see this plane built and flown by many. Now enough of the prelude, let's get right to it.

MATERIALS: as needed to build exactly what I did, the airframe should cost you under \$200.

- 2 4'X8' sheets 4mm coroplast
- 10'X2 ½"X2 ½" gutter pipe (genova rw200)
- ¾"X3 ½"X8' (aka 1"X4"X8') spruce board
- About 60+ 1/8"ID. Aluminum washers
- About 50+ 1/8"X5/8"shank aluminum pop rivets
- 6 5/64"X36" music wires.
- 8 standard high torque servos, I recommend hitec hs-430 or any servo with at least 70 inch oz. of torque the hs-430 are right at the bare minimum, (I would be far more comfortable if they had a little bit more) but they work and are cheap. If you go with a bigger engine, get bigger servos. Do not skimp on the elevator servos, trust me I know, it has caused me two crashes! If you can, try to get bigger servos than the hs-430 for the elevator and maybe rudder!
- Small assortment of small screws
- Everything forward of the firewall 30-50cc engine + prop to fit it (bare minimum 10 pounds of thrust, more like 12+)+ engine mount + anything I am forgetting]
- Fuel tank about 15oz. can easily go bigger for longer flights.
- Fuel line.
- 2"X1/8"X48" aluminum flat for gear legs.
- 1"X1/4"X48" aluminum flat for gear legs.

- Plastic cutting board for firewall, they are milky white and MUST say POLY! 3/8"++ thick.
- Thin/ medium CA glue.
- Two long 1/4" bolts for axles+ nuts or actual axles.
- 1 16"+ piece 5/32" music wire for tail skid/ski.
- 1 5/32" wheel collar to hold tail skid from sliding up.
- Some miscellaneous/make-it-work fasteners.
- Wood glue of choice to glue wing spar, or thin CA.
- Zip ties + wire.
- Wire for extending servo wires, I recommend soldering and twisting to minimize RFI.
- Hot glue.
- Some old preferably light cross country skis (for building the skis).
- Radio gear (RX, TX, and RX battery).

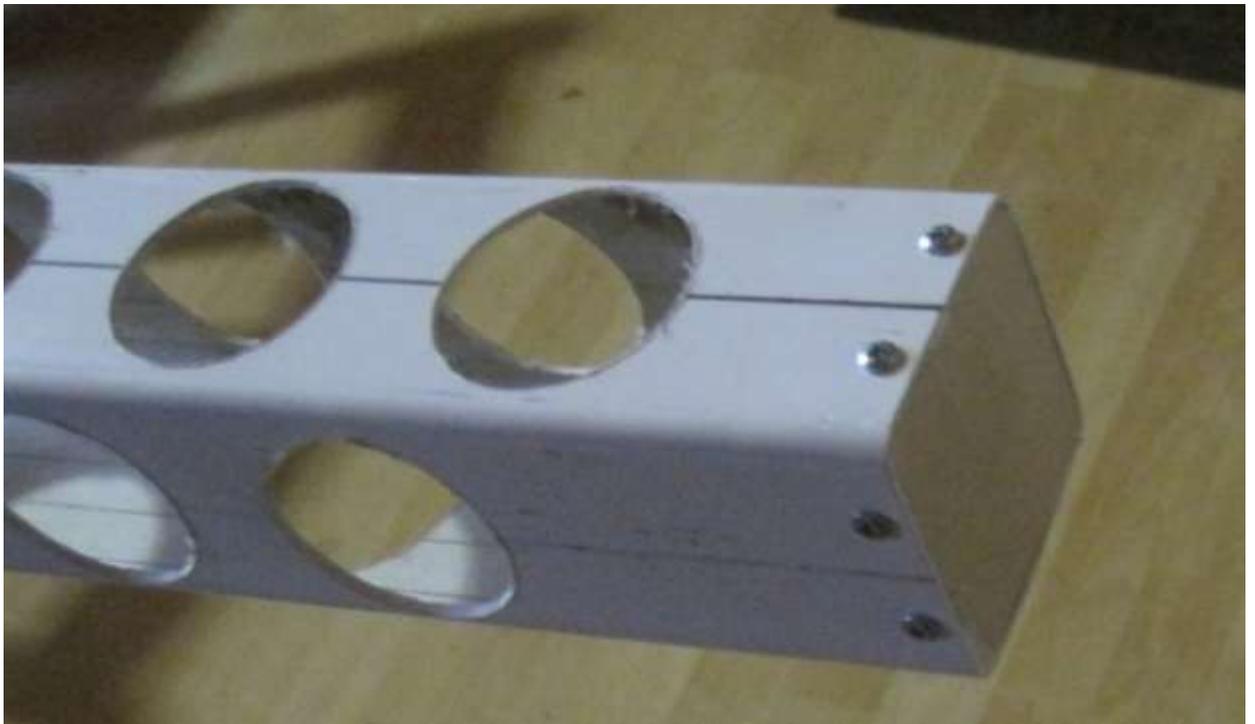
Fuselage:

Ok, time to start building! Start with the fuselage. Cut the gutter pipe to 72 inches. Cut a 45 degree angle off the end 72 inches being the longest point. NOTE!!! In the pictures, the fuse had a much longer taper, DO NOT do this! While it saves a few ounces, it adds LOTS of flex to the tail. Just cut a 45, it will keep the tail from flexing.

Next, drill the lightening holes. All measurements are to the center of the holes and from the front of the fuselage. I used a two inch hole saw to drill holes spaced 3 inches apart. The top and bottom start at 3" and continue 6", 9", 12", etc. the last hole on the top you will drill is centered at 57". The last hole you will drill on the bottom is centered at 66". DO NOT drill

the holes centered 6"-15" on the bottom as this is where the landing gear goes. The sides are staggered in relation to the top and bottom. Starting at 4 ½", and continuing, 7 ½", 10 ½", etc. The last hole you will drill on the sides is centered at 67 ½".

Next, attach the firewall. The firewall is attached to a wood block about an inch thick screwed into the front end of the gutter pipe. Cut the piece of wood to the inside dimensions of the gutter pipe making it as snug as possible, but being careful not to overstress the plastic. This is then screwed in from the sides with 8 short (3/4") screws, make sure to pre-drill the plastic. I added thin CA to the holes to ensure maximum strength.



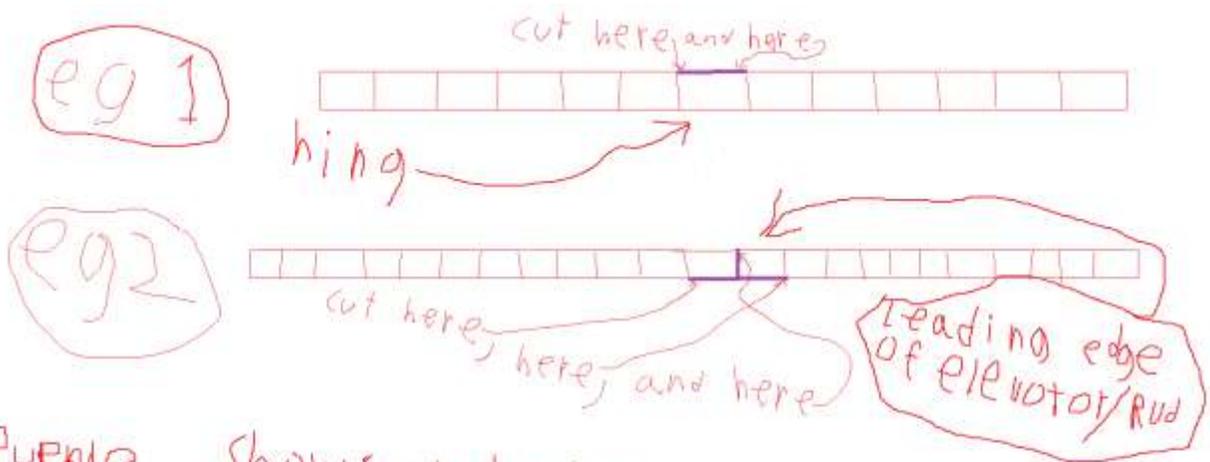
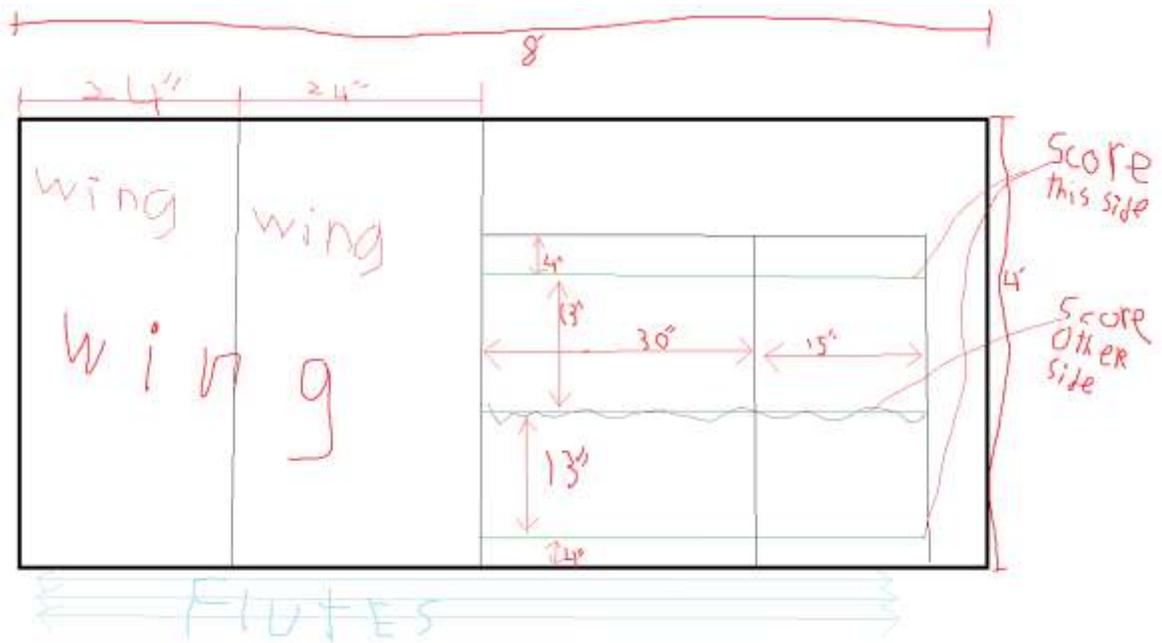
Next cut the poly firewall to the correct size for mounting your engine. Then with 4 wood screws I screwed it to the wood block.



Attach your engine, and rig your throttle servo (or rig all the servos after completing the airframe).

Tail:

Now, time to build the tail. Flutes run, as usual, length wise across the sheet (left to right on my drawing). Cut the black lines (Refer to sketch below). Green lines mean to cut through only one side of the Coro into a flute as to create a hinge (see sketch2 eg.1). The green line with purple squiggle means: on the opposite side as shown, Score two flutes, and cut out what is left in the middle (see sketch2 eg.2). Purple shows what should be missing after proper cuts are made. Cut out the wing panels, the horizontal stabilizer/elevator, and the vertical stabilizer/rudder.

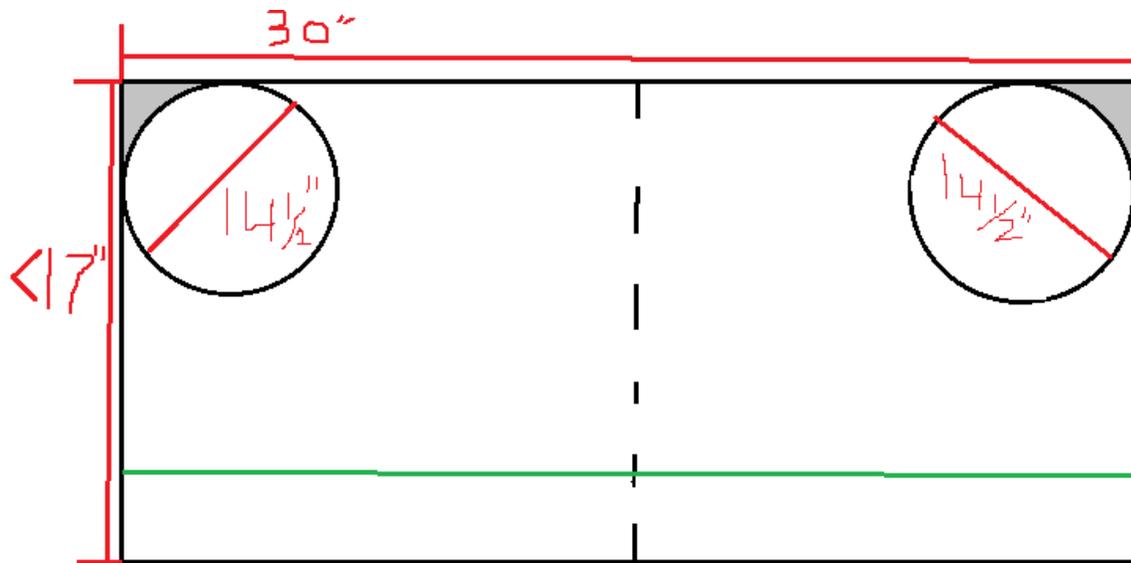


PURPLE shows what will be missing after cutting

The bubble "leading edge of elevator/rudd" should read "leading edge of horizontal/vertical stab. I use a ballpoint pen to draw on the Coro, and a carpet cutter/razor blade to cut it.

Now that you have the pieces cut out, it is time to assemble the tail. Set aside the wing panels, and get the tail pieces. Let's start with the horizontal stabilizer. Fold the coroplast back along the green/purple squiggle line. This should make a nice round leading edge. Make sure all the edges line up well, and especially the hinge line. For the hinges, the side of the flutes that you did not cut must be touching! Now fold it back open, and add a LIGHT zigzag pattern of thin CA. Make sure to outline all the edges and hinge line. Now carefully fold it back over, making sure everything is lined up before letting them touch. Once they touch, apply pressure to set the glue. Now carefully set it on the floor and, using something like a piece of plywood to spread out your weight (so the flutes don't crush), stand on it to fully set the glue. Remember, once the glue surfaces touch they will set, but not completely. If you pull them apart again before applying adequate pressure, the glue joint will be ruined and you will have to start over. Now follow the same process on the vertical stabilizer/rudder.

Next cut the rounded corners on the leading edges. The horizontal stab has two (left and right) and the rudder has one (top). To draw these, first cut a 14 1/2" diameter (7 1/4" radius) circle out of paper or card stock. Now push this circle as far into the corner as possible without anything sticking over and trace the edge. The vertical stab/rudder is exactly half of the horizontal stab/elevator. Grey shows what will be missing in the sketch below.

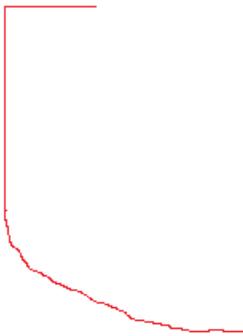


Cover all open flute ends with clear packing tape to keep out dirt and reduce drag. The finished horizontal stab/elevator should be 30" wide, and just under 17" deep, the vertical stab/rudder should be 15"X17".

Next, attach the horizontal stab to the vertical stab. Cut two pieces of gutter pipe corner angle 1"X1"X13"; these will be used as mounts. Draw a line running down the center of the horizontal stab, where the dashed line is in the sketch above. Now attach one of the angles. Put the angle off center one Coro thickness (4mm). Attach it by holding it where it needs to go, then drill the three rivet holes, but do not rivet it! Add a small amount of CA to the angle and using rivets as guides, line it up where it goes, and set the glue. Follow the same process on the other angle but this time use two pieces of scrap Coro, or the vertical stab, to get the spacing right. Make sure it is snug, but not too tight. Make sure the vertical stab fits this groove, and then position it to sit 2" further forward than the horizontal stab. Cut off two Coro thicknesses

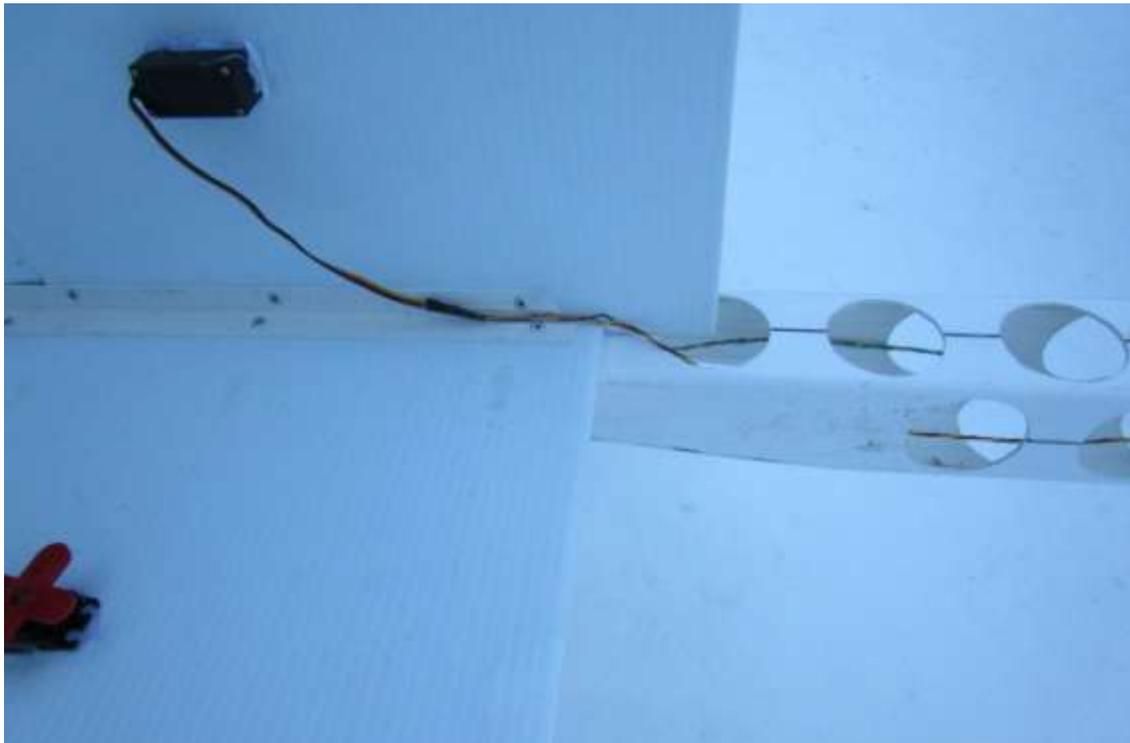
(8mm) off the bottom of the vertical stab/rudder except the front 2" to create a notch for the horizontal stab to sit in.

To construct the steerable tail skid, take a piece of 5/32" music wire and about 2 1/2" from the end, bend it 90 degrees with as sharp of a bend as possible. About 6" further down, make a bend parallel to the previous one. This should be a rounded bend to act as a spring. Bend the wire to about the shape in the sketch.



Now on the bottom of the rudder hinge line on one side (left), take out an extra flute behind the hinge line to about 5" up. NOTE, I did this in front of the hinge line but I think behind will prove to be better. Take the horizontal stab and mark the bottom of that cut out flute, and drill a 5/32" hole there so the skid can pass through. At the upper end of the cut out flute, drill (or melt) a 5/32" X 2 1/2" hole into the rudder 90 degrees to the hinge line. Make sure the upper part of the skid fits all the way into the hole. Now stick the bottom of the skid through the hole in the horizontal stab, slide the vertical stab into its groove, and make sure everything fits well. Take the vertical stab/rudder/skid assembly back off and rivet the horizontal stab onto the top of the fuselage through the holes in the glued on gutter pipe angles and horizontal stab. Make sure the horizontal stab is perfectly centered and square to the fuselage. The back of the

fuselage should sit ever so slightly in front of the elevator hinge line. The gutter pipe material is too elastic to rivet into. So, add a washer to the rivets keep them from pulling out. Start with just one of the rivet holes and place a rivet into the hole, then make sure it is square and drill and rivet the rest of the holes. Now slide the vertical stab/rudder/skid back into its place and rivet it on with three rivets and washers. Zip tie the skid into its groove to ensure it stays there. Add the wheel collar to the skid under the gutter pipe. The gutter pipe angles will extend past the rudder hinge line so you will have to cut an inch off the bottom of the rudder, and cut a bevel on the back of the rudder to allow the elevator to move up. If you feel that the rudder/elevator moves too stiff, you can cut out parts of the hinge line. However, I would wait until you have installed the servos to ensure that there is hinge material by the control horns.





Note, the rudder control horn is covering the upper part of the skid.



To make the control horns, cut 3" pieces of the 1" gutter pipe angle. Shape them like the sketch below. The hole is $\frac{3}{4}$ " above the bottom of the control horn.



Attach the elevator control horns 7 ½" from each side. All the control horns get 1"X3" strips of gutter pipe material as back plates on the opposite side of the Coro. Add CA glue under the control horns and back plates to keep the rivet holes from enlarging. As always use washers on the rivets. Place the servos about 5-6 inches in front of the control horns, glue them in with hot glue. Remember that both servos must be offset to the same side as to work correctly.

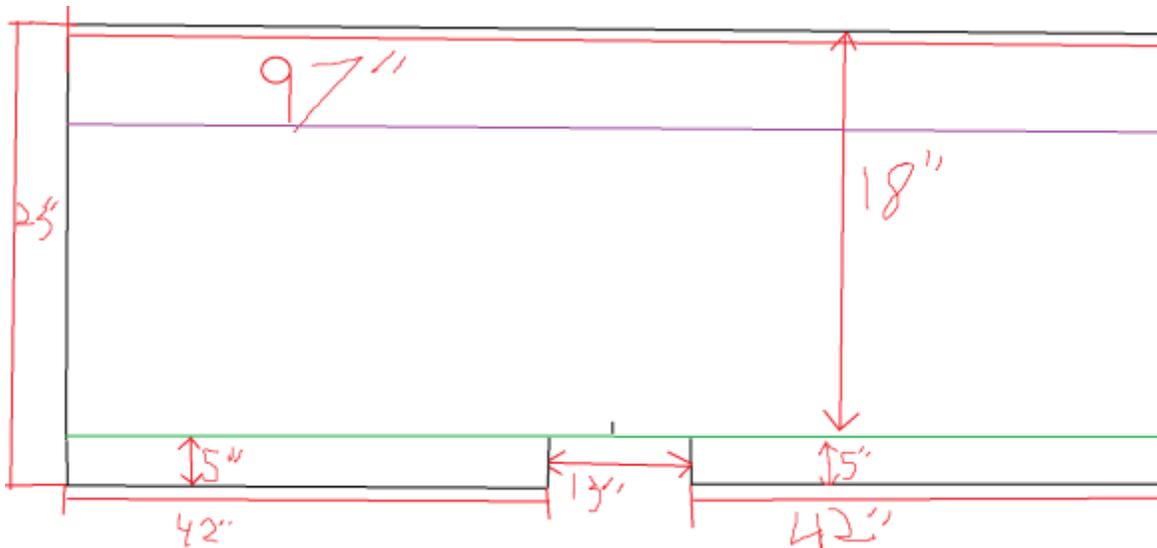
All the push rods will be made out of 5/64" music wire. Bend the first Z-bend into the wire, then about half way along it, add another Z-bend, but not as sharp and make it larger, then bend the other Z-bend for the servo. The bend in the middle allows for adjustment.



The process is the same for the rudder, however, the control horn covers the top of the tail skid for maximum leverage (see photo). One servo on the rudder works well for flying, but is a little underpowered for aggressive ground handling (not worth the \$7.99 to me). I used the second hole from the end on the servos, and 125% throws. Depending on your set up, try to get about 25-30 degrees deflection. be sure to set your throws to 125%, that way you maximize your servo's power.

Wing:

Now for building the most important part, the wing. First you must cut out the bottom panel of the wing.



This is assuming that your Coro is 97" wide like mine was, if this is not the case, just adjust the measurements. The factory edge goes to the front. The purple line is where the spar will go, it is 5 7/8" back from the leading edge. Draw a line one inch on either side of the 5 7/8" marks showing where the spar T-beam will go. The green line is, as usual, the hinge line. This shows how to build the Flaperons wing. If separate flaps and ailerons are desired, then re-draw it so that the ailerons have the same amount of square inches (210 each). Use the remaining space for flaps. Lay the bottom of the wing on the floor, with the spar placement lines down.

Get the wing panels you cut out while cutting out the tail, and lay them along the leading edge of the wing. Due to the Coro sheet being 97"X48, there will be an inch gap between the top panels. Now, with the spar line down and the top panels lying against the leading edge, tape the top and bottom panels together with packing tape running span-wise.

Make sure to run a couple strips of tape the across the seam as well, especially at the tips and on either side of the 1" gap. Flip the whole thing over and, using a rounded instrument like the back of a butter knife, crush in the flute that keeps the top panels from folding up smoothly. Do this until you can easily bend the top panels back far enough that they create a 45 degree angle to the bottom panel.

Lay them back out so that the spar/ inside side is down. Measure and mark the center, making sure that it is square. Now center a scrap piece of gutter pipe on this line. Cut two pieces of gutter pipe angle 1"X1"X18". Lay these along the scrap piece of gutter pipe. The scrap piece of gutter pipe acts as the fuselage. Drill a hole in the front of one of these angles (the right one). Add a rivet through this hole and be sure to use a washer. Line up the back and repeat this process, riveting only the ends of the angle. Repeat this process on the other side, but this time make sure the angle is pressed firmly against the gutter-pipe-fuselage-stand-in. the middle of the angles will be riveted into the spar.

Now, it is time to mill the wing spar. The wing spar consists of two pieces of wood glued together to form a T. the bottom piece is 2"X1/4"X8' the upright piece is 2 1/2"X1/4"X8'. The bottom piece has a 1/4" wide by 1/8" deep groove cut into it where the upright piece is glued into. After this is glued, clamped, and the glue has dried, put it in place on the wing. Work from one wing tip to the other bending the spar to fit the lines you drew earlier. Rivet every 2ft. on

the front side of the upright, and from the inside. Add washers to the rivets.



Rivet on the front side of the upright (right in picture above), except for the wing attach angles where you should add a rivet front and back. Rivet the angles from outside in, adding a washer to prevent splitting/pulling through the wood. After the spar is securely fastened, it is time to form the top of the wing. I will warn you, this is the hardest/most pain in the neck part of the plane. The more helpers the better, but it can be done by yourself. Try to get it as good as possible, but it will look bad long before it'll fly badly. The most important part is that both halves are the same, again, it does not have to be perfect, but take your time and get it right. With the bottom of the wing laying on the floor and the spar facing up, bend one of the top panels over the spar. Make sure the leading edge crushes nicely and looks good. Repeat the process on the other panel. Now, the goal is to get the top bent over, and keep the bottom as flat as possible. This is achieved by holding the leading edge down to the floor and pushing the top panels forward as much as possible. Do one panel at a time, starting at the wing tip. It helps to have something like a wall you can push against. Make sure the panel is square by pushing the entire length forward against the wall, and making sure the panels line up before riveting them. I suggest having at least one helper. Get the following things ready to use: rivets, riveter,

washers, and a 1/8" drill. Now with your helper at the inboard end of the panel and you at the wing tip, push the top panel forward against the wall while bending it down. Add a washer to both ends of the rivet as the factory rivet head is too small and with pull through Coro. Double check that the top and bottom line up, and add a rivet about two inches in from the wingtip and about an inch and a half in front of the aileron hinge line. Next add a rivet two feet in from the wing tip, making sure that the panel is square and pushed forward. Next drill out the back rivet in the fuselage attach angle. Again, making sure everything is square, add a rivet through that hole from the bottom up, using a washer on the Coro side. Add two more rivets in-between the existing ones, ending up with a rivet every foot. Again, rivet 1 1/2" forward of the hinge line. Follow the same process on the other side. Cut the excess off the top wing panels flush with the aileron hinge line. Add a piece of packing tape to cover the 1" gap between the panels. I added a ring through the top of my wing spar to hang the plane off of for storage and CG check.

Next I rigged the Flaperons servos. The control horns are the same size Mount them like all the others. Again the servos are about 5-6 inches ahead of the hinge line, glued in with hot glue. The wing servos are offset to the center of the wing. Use the same technique for the pushrods as for the tail. I used different servos, for the wing based on what I had, but the same set up as the tail should work. The aileron deflection should be about the same as the elevator/rudder. The neutral flap/ailerons should line up with the bottom of the wing. Make sure to extend your servo wires, I twist, solder, and heat shrink. Both wires from the each wing should be soldered into one wire(both reds together+extention, both blacks together+extention, and both yellows together+extention). Google/ contacting me should be

able to help you with any questions. The wires should extend about 12"-16" past the center of the wing.

Landing gear:

Start with your two pieces of aluminum, and bend them to the shape in my photos. Next rivet them together, and then bend and drill the bottom for the 1/4" bolts/axles. Remember, sharp corners will bend, round corners will flex. The bottom of the landing gear is about 28-30 inches apart. I did end up cutting about an inch of each side when I placed the axle. This version of the gear is a little overbuilt, but works good. You can also use half of a bicycle tire rim, or whatever works.





Next, attach your wheels/skis to the axles. To build the skis I used a old set of cross country skis, cut of the front 20 incher or so, glued a 5 or so inch wide strip of Coro to the bottom, added a wood block in the center, cut notch in the block, and glued a arrow shaft into the groove. To spring the skis, I used some 5/64" music wire and ran it from the back of the ski to the landing gear leg.



Attaching the wing and landing gear:

Attaching the wing and landing gear is a bit of a balancing act. You want the landing gear about three inches in-front of the leading edge of the wing, and the gas tank as close to your CG as possible (depends on your fuel pump). With the landing gear and wheels hanging over the top

of the fuselage, the wing on the fuselage, and the gas tank as close to the CG as you fuel pump will allow start sliding them around till the plane with empty tank balances directly under the center of the spar(or slightly in front of it). Mark where the landing gear and fuel tank go, remove the wing. cut a piece of cutting board to fit the inside of the gutter pipe, that is about 8 inches long, this goes on the inside of the fuse and is what the landing gear bolts/ rivets onto, and acts at a stiffener/hard point.. Attach the landing gear to the bottom of the fuselage and cutting board with rivets and washers. Run a wire from the gear legs to the fire wall to help support the gear from folding back. Next, put you tank into place. Now, get your RX battery, and find a good way to attach it where you want it. I put mine in hole I cut in the top panel of the trailing edge of the wing, and rubber banded it in (I have since switched to Velcro).



Now with the battery, landing gear and fuel tank in place, slide the wing back on, and balance the plane, it should balance perfectly under the center of the spar. Now without sliding the

wing around, lift the trailing edge and push down the leading edge onto the fuselage and drill an 1/8" hole through the wing attach angles and fuse, ad a bolt through the hole. Next, push down the trailing edge with the leading edge bolted down, this will keep the botome of the wing from bubbleing out. Drill and bolt the trailing edge. Next drill a final hole under the spar, this bolt will hold most of the weight, so be sure to get a good amount of meat.



Add the washers, lock washers, and Teflon nuts.

Finishing the aircraft:

You are almost done, just the finishing touches left! Run all wires to just behind the wing, and attach your RX. Make sure all your servos are rigged and working properly, and all wires plugged in. attach your fuel line and kill switch. I recommend running a wire from the top of the vertical stabilizer to the fuselage just behind the firewall/directly to the firewall, as a little stiffening is nice. be sure not to over tighten this wire! pull it just tight enough so the fuse is straight, but don't bend it up! Do anything still required to make your very own BAD SPAD airworthy. and finally, let me know how it went!

Fly:

Here are a few pointers to help get you in the air safely. First, I cannot suggest doing crow hops to get used to her, as two feet above the ground is a bad place to find out how a plane flies. Slowly add full power, and get up high in a gentle, but deliberate, climb. I do not suggest flaps for the first few flights as the plane behaves kind of odd when they are deployed, this plane is so slow that flaps are not really needed, and I have not experimented with flaps. In fact, I believe I will remove the Flaperons setting in my radio, as I only fly it without them. Coordinate your turns using the rudder. Since this is a tail dragger of considerable size, I can highly recommend reading the book *the compleat tail dragger*, a very informative book that will make your take-offs and landing straighter, safer, shorter, easier, and much smoother. Thank you for building this plane (or reading the plans), I hope you will get many hours of enjoyment from my design, and have many safe flights. Hopefully the plans are clear and the plane will serve you well, please contact me with any questions, ideas, complements, criticisms, problems or flight reports you might have.

Keep the wings level,

Leo Hicker.

leoleohicker@gmail.com