Hercules Pusher Building Instructions by CRASHTESTHOBBY.COM

The Hercules Pusher is one of the toughest FPV planes on the planet. The Hercules Pusher is designed to be a low drag larger flying wing that can fly slow and carry a lot of FPV equipment and resist tip stall. It is designed to have a great glide and has flown with over 21,000 mah of 3S batteries. We use the same techniques to build the Hercules as we use for our combat planes. It is one of the only big flying wings cut from solid EPP foam. EPP foam doesn't crush and doesn't dent. It has EPP elevons that don't split. It has bidirectional reinforced Extreme Tape hinges and laminate to make it strong while protecting the battery and radio. The plane is designed to use low cost off the shelf motors, ESCs, servos and batteries. You need one of these!!!! Your club needs a bunch of these. It's time to fly without worrying about breaking your plane.





Specifications

a) We recommend that you build and laminate the plane before you install the radio. It saves time when you need to trade out electronics giving the plane a longer life with less work.
b) All of the radio and linkages are on the top of the plane to prevent damage when landing.
c) Center of gravity with the 6" extension is 11.5" (29 cm) back from nose of plane. The CG is back 12" (30.5 cm) without.
d) Motor cut out is back 16" (40.5 cm) from the blunt nose of the plane.
e) Big flying wings tend to be tail heavy so you will need to keep the batteries and radio far forward.
f) Front spars are back 3" (7.5 cm) from the leading edge of wing on both right/left/center and on the top/bottom of the wing.
g) Center spars are back 10" (25.5 cm) from nose of plane on both the top and bottom of the wing.
h) Spars are tied together with wire joiners and reinforced Scotch Extreme Tape over the top to prevent separation.
i) Elevon throws 3/8" (1 cm) up/down. Use hole close to center of servo and hole at top of elevons horn for best leverage.
j) Target all up weight 50-80 oz (1500-2400 gm). Lighter always flies better.
k) 3536-1800 KV motor recommended with 9x6 propeller.
l) Use a 80-100+ amp ESC (Electronic Speed Control) Install it so there is airflow around it. We have burned out a 60A in testing.
m) 5000-20,000 mah 3S lipo batteries mounted as needed to get proper CG.
n) Standard sized servos recommended for any motor capable of over 20 amps.
o) Speed range 15-90 mph (25-145 km/hr) with suggested motor and standard build.

Equipment needed

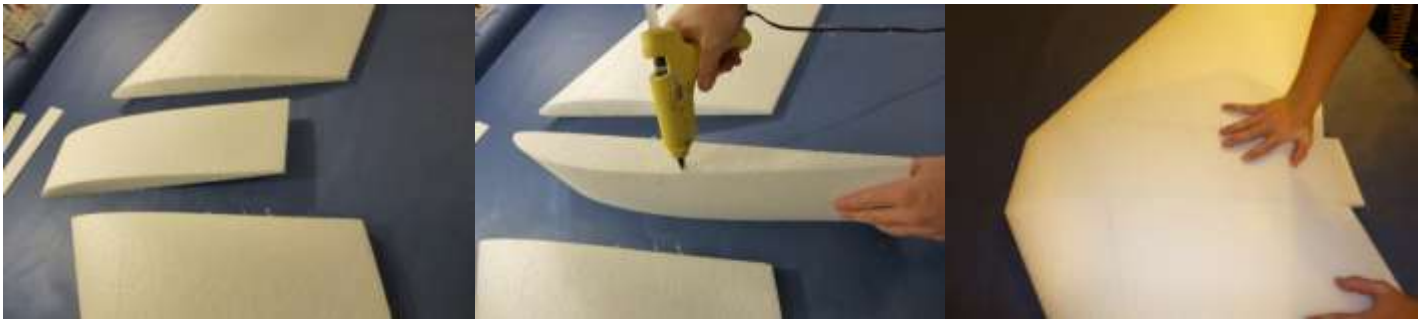
a) Low-temperature hot glue gun and low-temp rated glue or "Goop" brand glue
b) Screws (size #6 x 3/4") to attach motor mount to Formica (2-56 x 3" bolts and lock nuts may be used)
c) Scotch Extreme Tape (2" bidirectional (5 cm)) available at office supply shipping departments and on AMAZON
d) Metal straight edge that won't melt when used as a guide for the soldering iron or cut with a razor blade
e) Soldering iron with 5/16" wheel collar to set cutting depth
f) Pliers for cutting pushrod to length
g) New razor blade to cut slit for shock cord
h) Small Philips head screwdriver to push shock cord into slit
i) Electric drill and bits for attaching motor mount to Formica plate.
j) Iron for applying laminate (hobby iron is preferable, but clothing iron may be used)
k) Velcro strips

Hercules Building instructions

1. Image #1 below shows plane parts and shape.

a) Clean loose fibers off cores by rubbing the EPP parts together.

b) Glue the five main core sections together as shown with HOT GLUE or Goop.



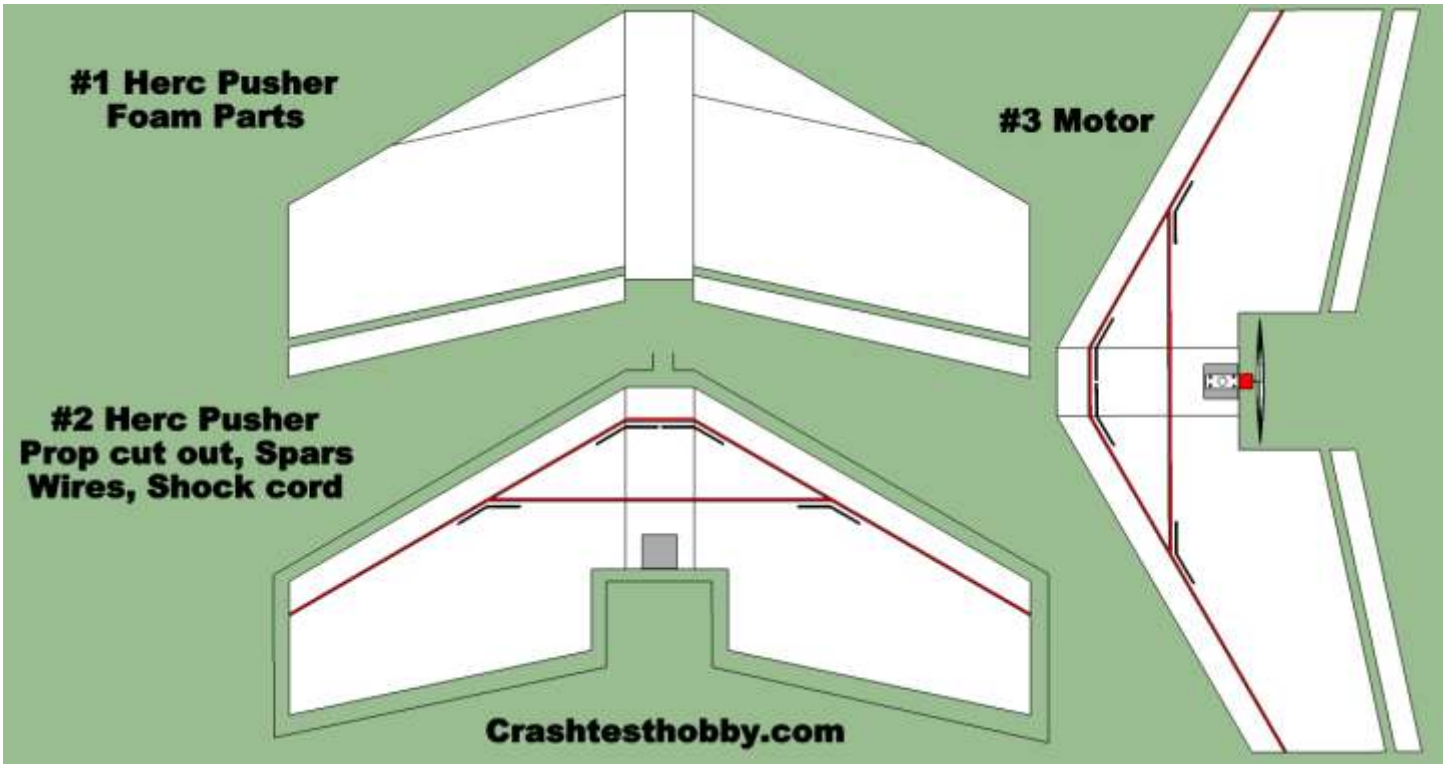


Image #2 (TOP of wing) and #3 (BOTTOM of wing) show spar, wires, shock cord, Formica plates and motor placement.

2. The spars are installed on both top and bottom of the wing, directly over each other to create an "I-beam" type structure.

a) The spars (red) and Formica plates (grey) and wires (black) are installed the same on both the top and bottom of the wing.

b) The front spars are back 3" (7.5 cm) from the leading edge of the wing and across the extension in the middle. (shown in red below)

c) The center spars are installed across the center of the wing back 10" (25.5 cm) from the nose of the plane.

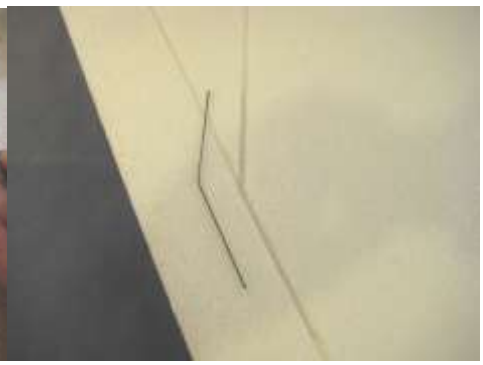
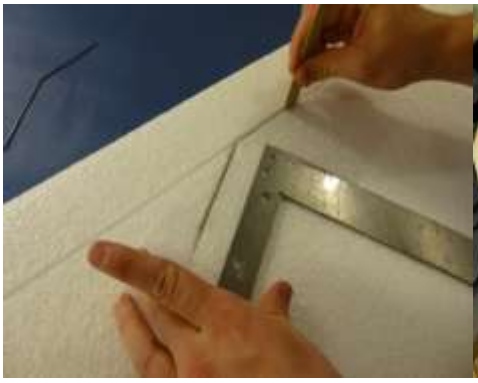
d) The wires (black) overlap the joints where the spars come together to prevent tearing or separation of the foam between spars.

e) You will see us use black spars in many of the pictures but white spars are included in most kits.

3. Spar Slots

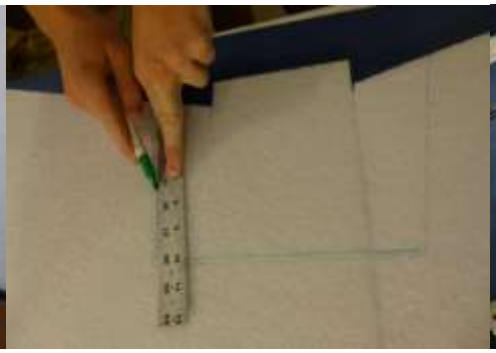
a) Cut the spar slots with a soldering iron and a metal straight edge (as shown).
b) Cut the tip of a soldering iron off to 1/4" or slide a 5/16" wheel collar on the shaft of the soldering iron to set the depth.
c) 6" wires are bent to fit in the spar slots to keep the spars from separating during a crash.
d) Enlarge the slot slightly where the wire will be installed to give spars room to lay flat over the wires.
e) Glue the angle wires in the slots before gluing in the spars to prevent shearing and separation at the spar joining points.
f) Hot glue the spars in the slots making sure they are well secured to the angle wires.



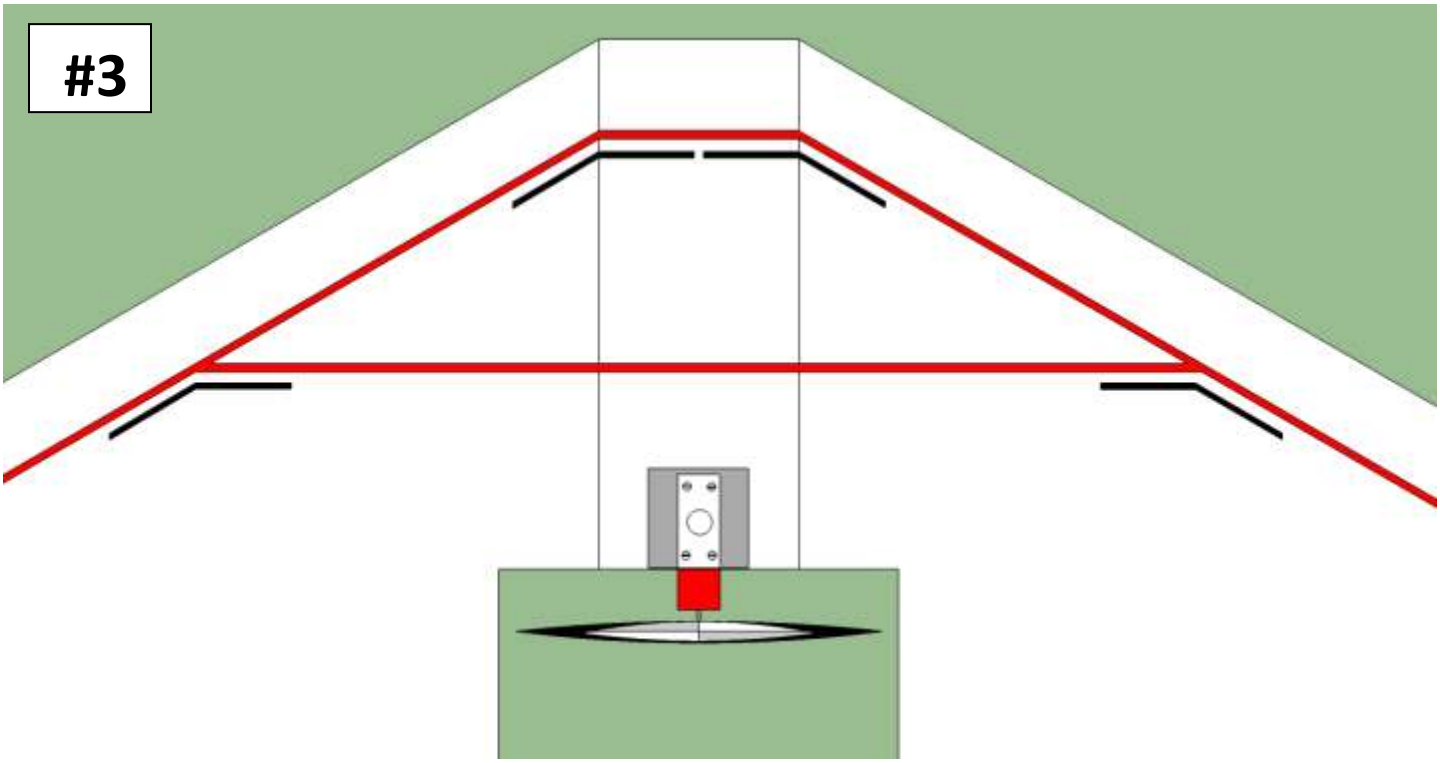
4. Cut Wing for Mounting the Motor

a) Measure back 16" (40.5 cm) from the blunt nose of the extension (or front of plane) and cut a section of foam out of the core that is the 1" wider than your prop. This will give you 1/2" (1 cm) clearance on each side.
b) Use a sharp new razor blade to make the cut for the cleanest cut.
c) The construction photos show widened the opening at the trailing edge 2" (5 cm) for looks.

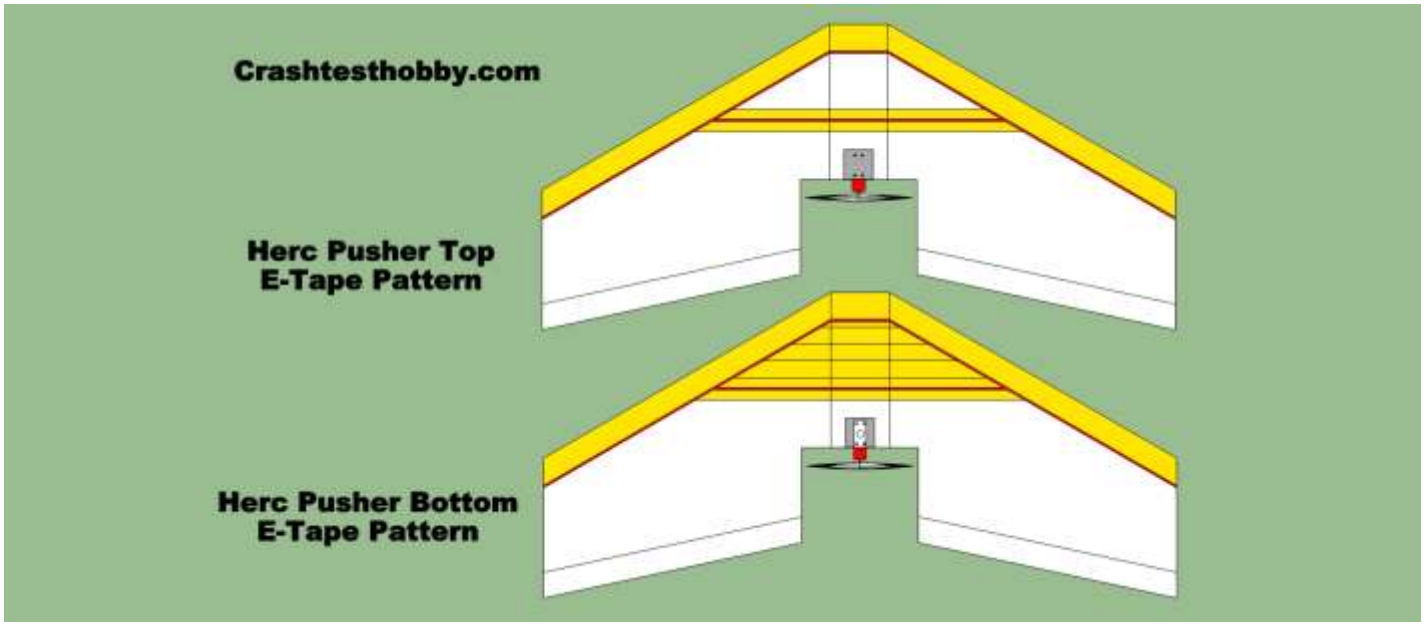

5. The Formica plates attach the motor mount to the spar system across the center of the plane.

a) Formica plates are glued on both the top and bottom in the center of wing directly over each other.
b) Put the hot glue on the foam or it will cool too fast on the Formica.
c) The metal motor mount will be installed on the bottom of the wing after the plane is laminated.
d) The flat back edge of the foam on both sides of the motor mount should be tapered to decrease noise and drag.
e) Use a sharp razor blade or box knife and an iron as needed to smooth the taper cut.
f) Longer bolts can be put through the metal mount and bottom and top plates to help strengthen the mount with the bigger motors.



6. The shock cord keeps the plane from tearing between the elevons in a forward impact

a) Cut a 1/4" (.5 cm) deep slit around the entire perimeter of the wing with a brand new clean razor blade to get the best cut.
b) Rub baking soda into the string to accelerate the setting of the CA glue
c) Put the shock cord around the plane starting at the nose. Make sure to get the string inside the motor cutout on the back of the wing.
d) Push the shock cord in the slit with a small Phillips screwdriver and tie securely at the nose of the plane.
e) The bulb syringe in the picture below is full of baking soda.
f) Glue shock cord in place with thin CA glue. Watch out for fumes when using CA with baking soda. We recommend gluing outside for safety.



7. The top image above shows the pattern for the reinforced tape on the top of the wing.

a) **ALL REINFORCED TAPE MUST BE COVERED WITH LAMINATE TO PROTECT FROM UV RAYS THAT DESTROY ITS ADHESIVE.**
b) The E-Tape is **YELLOW** in the picture. Foam is **WHITE** and spars are colored **RED** for identification.
c) Scotch Extreme Tape will stick to EPP without a spray adhesive if the foam is clean and dry.
d) The E-Tape should be tight enough to give strength but not so tight it warps the wing.
e) A strip of E-Tape should be over the spars to increase plane strength.
f) Wrapping the E-Tape around the nose of the wing, spar to spar, adds strength to the front of the plane.

8. The bottom image above shows the bottom of the wing and the reinforced tape pattern and motor mount.

a) Extreme Tape across center of wing directly over the spar.
b) The batteries will be held in by this layer of tape on the bottom of the wing.
c) Put 2" (5 cm) strips of Extreme tape from the bottom spar forward.
d) Wrap 2" E-Tape around leading edge of wing to tie in all the cross pieces on the top and bottom of the wing.
e) For maximum strength you can wrap E-Tape from front spar on top to front spar on bottom.
f) Wrap 2" reinforced tape from tip to tip along the leading edge of the wing.

9. OPTIONAL PAINTING --- The cores below were painted after the E-taping and before the plane was laminated with Krylon Fusion paint for Plastics. The laminate was applied as soon as the cores could be handled 30 minutes after painting and has stuck well to the EPP foam.



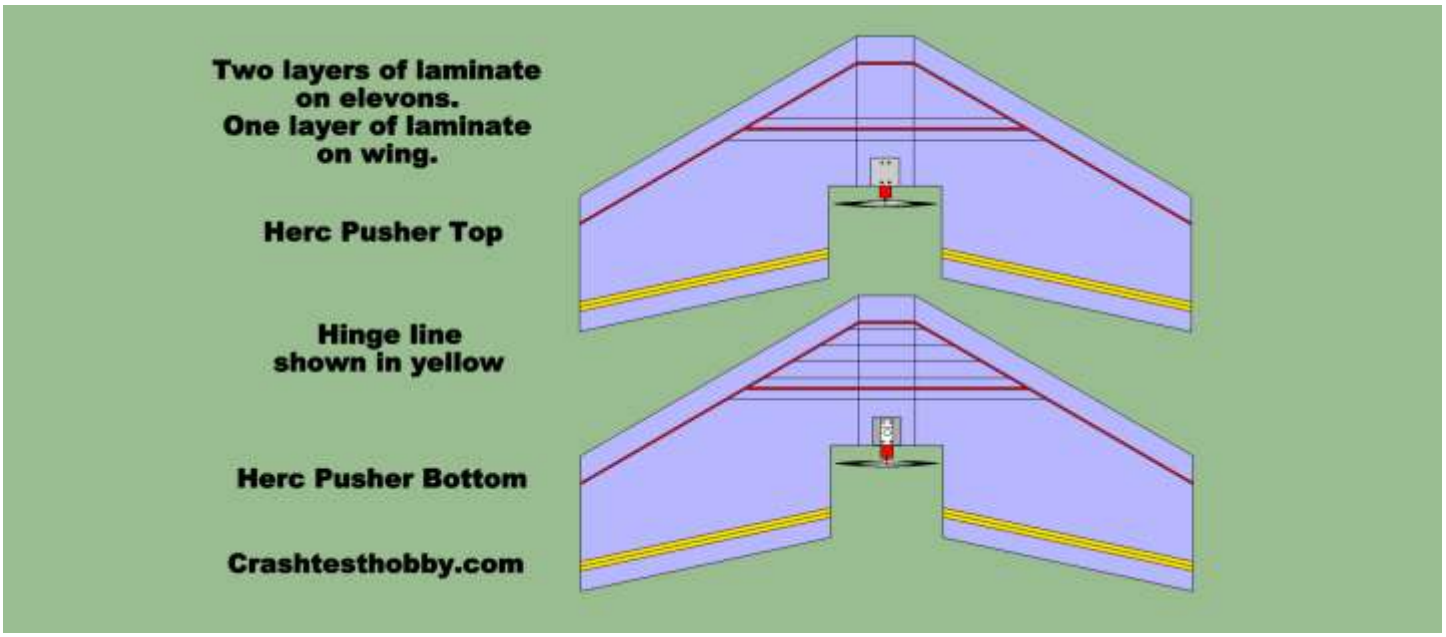
10. Laminating the wing. You should put a single layer of laminate on top and bottom of wing over foam and tape

a) Cut laminate pieces that will cover 1/2 of one side of the wing with a 2" (5 cm) overlap. Lay the laminate flat on the wing with the rough side against the foam and take a single stroke down the middle of the wing trying not to leave wrinkles.
b) Work from this line and iron towards the edges avoiding wrinkles or too much heat.
c) Wrap the edges and ends to get a great look.



11. Images (below) show bottom and top details of the laminated wing and the mounting of the motor.

The BLUE color represents the clear laminate we include in the kit which is ironed onto the core over the foam and tape. The yellow represents the 1" (2.5 cm) wide E-tape hinge line. You need to put laminate over all of the tape to protect it from UV rays, even the tape in the hinge line. UV light will break down the adhesive and rot the tape in a matter of a few hours in the sun without protection. The Scotch Extreme Tape will stay white if protected with the laminate. The laminate we include in the kit does NOT need a spray adhesive to get it to stick.



12. Iron 2 layers of laminate on the elevons to make them stiff and strong

a) Test the temperature of your iron with a scrap of laminate on the cardboard box. The laminate should stick and slightly shrink but the iron should not be so hot it changes the shape of the foam. This is important on the elevons because they are thinner so they more sensitive to the heat.
b) Cut the elevons to the size of the trailing edge.
c) Be careful not to warp the elevons during lamination.
d) Place one of the elevons under one edge of the laminate, so that the rough side of the laminate is facing the EPP foam.
e) Wrap the laminate end up over the elevon and make sure the elevon is straight before ironing.
f) Use your iron to stick the laminate to the foam. Begin at the center and work your way outward to avoid wrinkles as much as possible.
g) Fold the laminate over and continue ironing until the elevon is completely covered with two layers of laminate.
h) Check the elevon frequently with a straight edge to make sure it is straight.
i) Cut the extra laminate on the ends of the elevon to fold over neatly. Repeat process with other elevon.
j) The heat and laminate shrinkage can warp the foam.
k) If needed, re-heat and straighten the elevon, then hold it flat while it cools.
l) The elevons will still be bendable until they are hinged to the back of the wing.

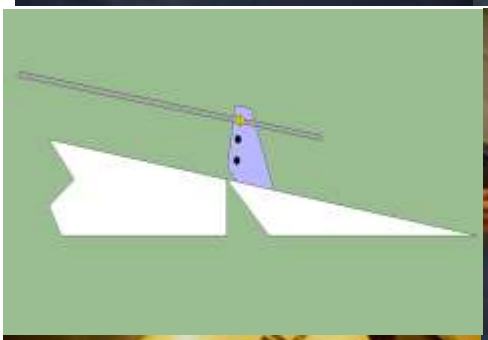
13. Make a hinge for the elevon with a 1" (2.5 cm) strip of E-Tape on both the top and bottom of the wing.

a) The Extreme Tape has bidirectional reinforced fibers making a strong hinge line.
b) The E-Tape hinge line will also need a layer of laminate to protect it from UV light.
c) Position your elevons so the hinge line (sharp angle on the elevon) is on the top of the wing
d) Tape the top side of the elevon first.
e) Cut strips of the Scotch Extreme Tape 1" (2.5 cm) wide by sticking the tape to a piece of glass or Formica and using a new razor blade and metal straight edge.
f) Leave a 1/16" (.15 cm) gap between the elevon and the wing core.
g) Put the tape the entire length of the elevon.
h) Fold the elevon up over the wing and put a 1" strip of E-Tape on the bottom of the hinge line.

14. Iron 2" (5 cm) wide laminate strips over tape on both the top and bottom of the hinge line to protect the tape from UV light.

a) The hinge will not lay flat until you iron the laminate on the hinge line in both the flexed up and flexed down positions.
b) Look down the elevon and make sure it lays flat and is not warped.



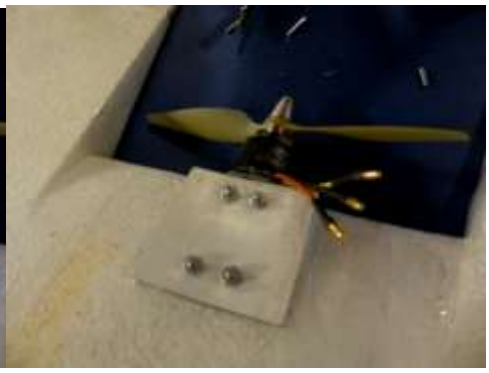



16. MOTOR – We like the 3536-1800 KV motor. The 3530-1400 KV motor will give longer flights but have less power. Both use the 9x6 prop.

a) Use 3mm bolts to mount the 3530 or 3536 motor body to the back of the bracket.
b) With the wing upside-down, place the motor mount on the Formica plate, and mark where the holes will be drilled
c) Drill pilot holes through the Formica plates and plane.
d) Melt or drill a hole for the shaft of the motor to go back in the foam of the wing big enough the shaft won't rub on the foam.
e) Screw the bracket to the Formica plate using #6 x 32 x 3" bolts with lock nuts, being careful not to over-tighten and crack the Formica.
f) You can leave the motor mounted to the bracket to properly measure the Center of Gravity later, but remove the prop for safety purposes.







17. INSTALLING THE FINS (fins below are lightly painted with black Krylon Fusion Paint for Plastics.)

a) Hold the fins in place against the ends of each wing tip, and make 1" (2.5cm) marks back 1/3 and 2/3 of the fin, where it meets the top of the wing, then use your razor blade or soldering iron to cut out a 1" (2.5cm) slot as shown below in the fin.
b) Shape the nose and top of the fin as desired.
c) Use Goop (or Shoe Goo) to glue the fins to the ends of the wings, with the slit just above the top of the wing.
d) Place a 2" (5cm) wide strip of Extreme Tape along the entire bottom of the fin, wrapping around to the bottom of the wing. Cut 1" (2.5cm) wide strips of Extreme Tape and feed them through the slits in the fin, so that the tape attaches to both the top and bottom of the wing, around the bottom portion of the fin.

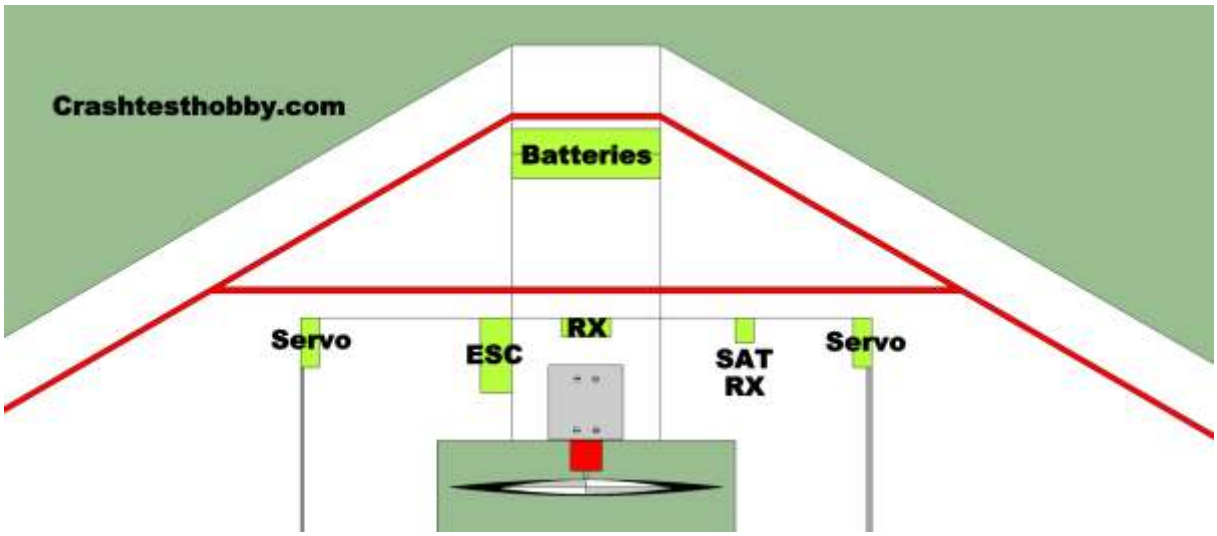


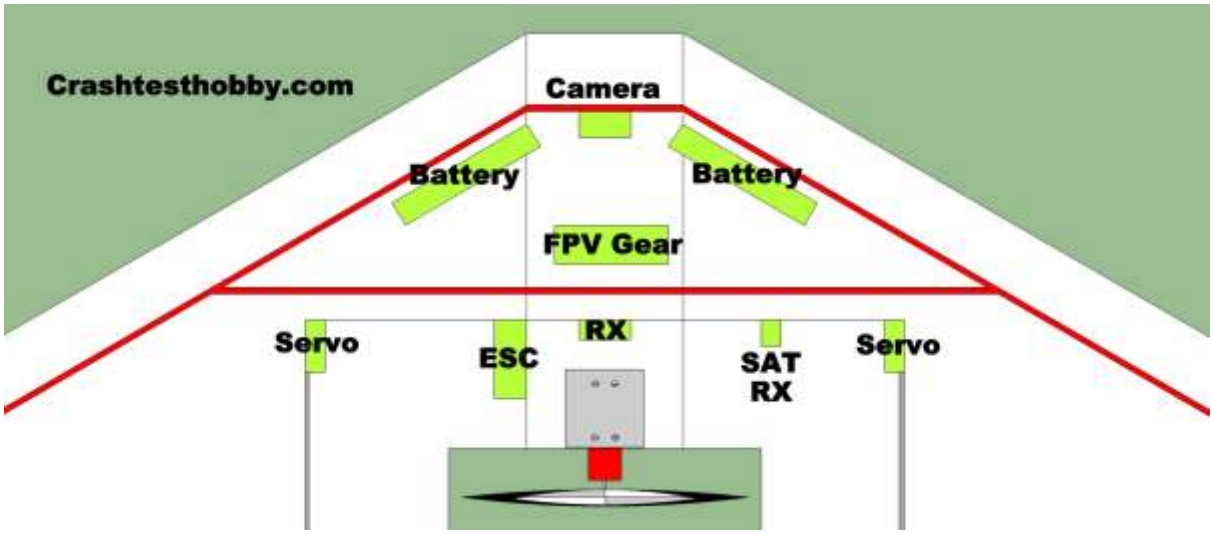


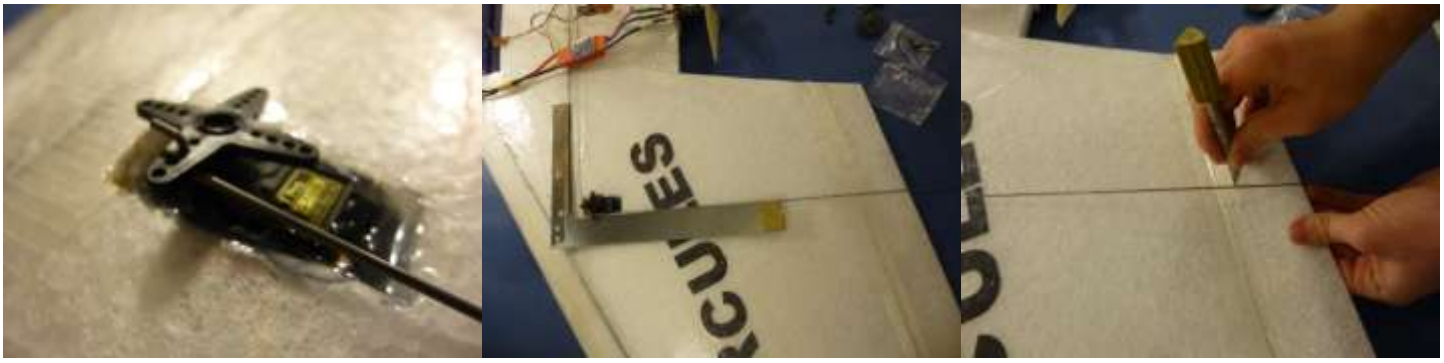

18. INSTALLING THE ELECTRONICS

a) Pre- test the motor, batteries, ESCS, receivers and servos that you plan to install to know everything is working.
b) Servos are plugged into the aileron and elevator plugs on the RX and then mixed with a V-tail mixing, delta mixing or elevon mixing on the transmitter. In some cases you have to go to the mixing options on your transmitter and mix your own elevons. Consult your owner manual.
c) Install your motor and mount and fins on the tips of the wing before you check the CG.
d) Flying wings and deltas tend to be tail heavy. The diagram shows 2X 5000 mAh 3S batteries for longer flights and balance.
e) The suggested locations in the picture should be close to the best location to get the CG at the suggested 11.5" (29 cm) with the extension and 12" (30.5 cm) back without the extension. If you don't balance to the correct CG, you will be adding more batteries or lead to balance the plane.
f) Plug all of the wires from the radio components together and lay them out on the top of the plane.
g) Look at the length of the battery, ESC and servo wires. This often will influence where you can install the radio.
h) Spread your servos wide enough apart so that the servo arms will have a good angle to the horns on the elevons.
i) Install the servo arms facing away from the center of the plane for maximum width.
j) Move the battery forward or back to get the CG at 11.5" (29 cm) back with the extension or 12" (30.5 cm) back without the extension.
k) The wing is stronger if you leave no empty space in the wing so cut out compartments that fit tightly.
l) Cut holes for the separate compartments for the battery, ESC and receiver. Outline the cut (slightly smaller) with a new razor blade or soldering iron to make it easy to extract the foam cleanly. Connect the compartments with razor blade slits for the wires.
m) Press the wires for the servos and ESC to RX (receiver) and RX to Sat RX into the slit. We recommend the satellite receiver for this plane as it can get farther away than you think due to its size. The satellite receiver will increase your range.
n) Put clear shipping tape or laminate over any slit or slot with wires.
o) Once all components are installed, hot glue **the servos** securely in place with only glue around the sides and not under the servo so you can remove it later if needed without damaging the plane.
p) You can use Velcro straps to secure the battery, ESC and receiver as needed (this can be done later, see step 22). To do this, cut a slot in front of the batteries and in the radio slot all the way through the bottom of the plane to feed the Velcro through so it can wrap around. In some cases I have used clear tape to secure the radio but make sure the ESC has adequate ventilation so it doesn't overheat.
q) Elevon throws are 3/8". Trim both elevons up 1/4" (reflex).
r) Secure all parts so they can't fall out or get knocked out in an accident.

18. Images below shows suggested radio locations for sport and FPV basic installation on the top of the wing.



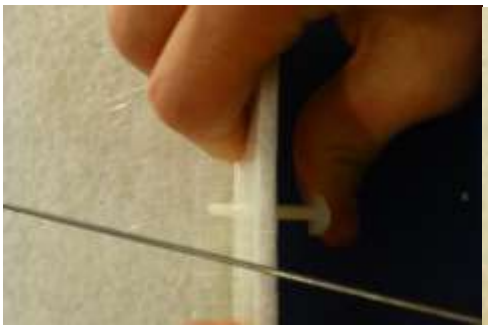




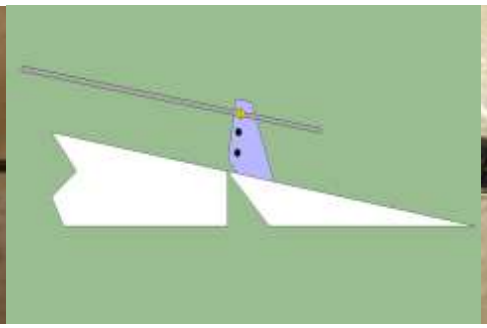
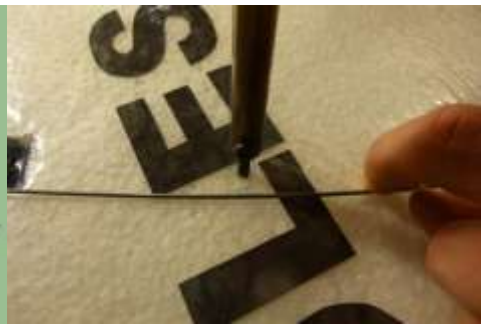
21. PUSH RODS AND SERVO HORNS

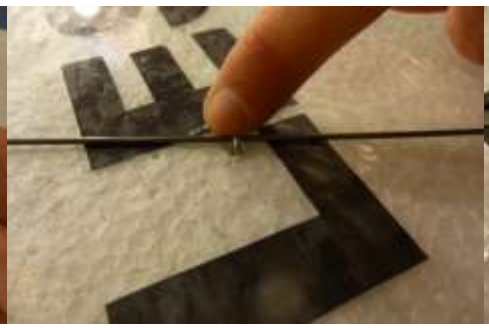
a) Install the servo arms facing outwards.
b) Install the pushrod in the second hole out from the center of the servo arm for maximum leverage.
c) Mark the elevon for the control horn by putting the push rod straight back from the hole in the servo arm.
d) Use a sharp blade and cut a slit completely through the elevon just to the side of the push rod and just behind the hinge line for the servo horn. This will leave room for the EZ connectors to be directly in the path of the push rod.

e) Remove the extra tab that comes attached on the back of the servo horns.
f) Push the servo horns up through the bottom of the elevon so that the base is flat against the bottom of the elevon.
g) Use hot glue along the base of the servo horn, and down through the melted slot, around the horn, to keep horn in place. As the hot glue cools, make sure the horn is facing straight forward.
h) Your horns should point towards the servos, and the front of the horn should be directly over the elevons hinge.

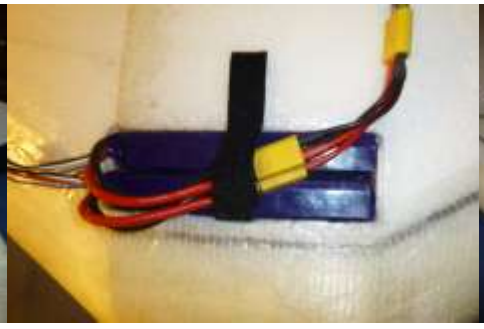









i) Attach the EZ Connectors to the control horns with a pair of pliers to the top hole in the control horn.

j) Remove the servo arms, slide the push rod Z-bend through the 2nd hole from servo in the servo arm. Place the end of the push rod through the EZ Connector, then set the servo arm back on the servo.

l) Mark two points on the wing, 1/3 and 2/3 of the way between the servo and the elevon, directly underneath the push rod.

m) Remove the push rod, and use your soldering iron to melt holes at the marks you just made. This hole should be wide enough and deep enough that the push rod guide (the metal staple included in the kit) can sit in it, and extend just over the push rod.

n) Fill the hole with hot glue, and set the push rod guide (staple) in place. Hold it there while the glue cools.

o) The staple keeps the push rod from flexing to the sides/up and down to keep the rod more stable.

p) Permanently attaching the push rods from servo arm to servo horn is best done later. This allows you to properly set the sub trim once all electronics are installed. It also keeps the rods out of the way as you finish the build.

22. BATTERY BAY – VELCRO RETENTION STRAPS

1. To hold the battery and battery wires in place during flight, you can install Velcro strap. A simple way to do this is to cut a slit through the bottom front of the battery hole and one through the bottom in the middle of the slot that contains the radio and then feed the Velcro through and fasten it on the top of the wing. The Velcro over the wires will help hold the receiver and ESC in place along with securing the battery. See photo above.

23. PUSH RODS & ELECTRONICS TESTING

a) You will need elevon, delta or programmable mixing to mix the aileron and elevator channels to fly a plane with elevons.

b) Consult your radio manual for help if needed. On the Spektrum DX6i you may want to do manual mixing as described on our web site.

c) Remove the servo arms from the servos. Connect all electronics, including a battery, but for safety purposes, make sure you do not have prop attached to your motor at this point. Turn on your transmitter(tx) and allow the servo gears to "center" themselves.

d) Slide the push rod through the closest hole to the servo in the servo arm (still unattached to the servo), then slide the end of the push rod through the guide, and into the EZ Connector on the elevon. Then re-attach the servo arm to the servo so that the arm is perpendicular to the push rod.

e) With the EZ Connectors still loose, center the Subtrim function on your transmitter then put the servo arms perpendicular to the push rod.

f) Let the EZ Connector slide over the push rod as you lift your elevon so that the angle of the top of the elevon is parallel to the bottom of the wing. This is an approximate angle and may need to be adjusted during test flights depending on CG and weight. This is called **REFLEX** and is used on all flying wings and deltas.

g) Once in place, tighten the set screw on the EZ connector, and use snips to trim off excess push rod.

h) Repeat on other elevon and set it at the same angle.

i) Set the wing on a flat surface, and hold a ruler vertically next to the trailing edge of each elevon. Use your tx to set the throw (range of movement) on the elevons to 3/8" (1cm) up and 3/8" down. Make sure your stick movement translates to the proper up/down on your elevons:

STICK UP	Both elevons down	NOSE DOWN
STICK DOWN	Both elevons up	NOSE UP
STICK LEFT	Left elevon up / Right elevon down	ROLL LEFT
STICK RIGHT	Right elevon up / Left elevon down	ROLL RIGHT

ELECTRONICS COVERING, DECALS, & FINS

a) After testing all electronics, cover your receiver, ESC, and the slots you buried wires in, with clear tape and/or laminate to keep the radio from ejecting in an accident. The ESC gets hot and needs ventilation. The receiver and wires do not.

b) Add any other decals as you wish, but be careful not to add so much that it changes the Center of Gravity. *The lighter, the better!*

c) Install prop with numbers facing the plane (if prop is installed backwards, it will not give you the necessary power).

d) Test the throttle and make sure the motor is turning in the correct direction. If not, unplug two of the three connectors between the motor and the ESC and reverse them. Try again.

e) Check your CG, the throw on the elevons, your linkages and reflex (slight up trim on the elevons) before launching.

f) It's always a good idea to have someone else double check your work. Field test and range check your equipment, then launch, trim, and enjoy!

24. LAUNCHING

Launching from the tip is an art form and hard for many new flyers. In the videos you see us launch our flying wings holding the plane by a wingtip while swinging it forward. We are actually setting the plane on the air without Frisbee spinning the plane. If you spin the plane at all the outside wing will have more lift because it is moving faster and the plane will roll the opposite direction and hit the ground. If you have any trouble, launch from the center of the plane with fingers on each side of the motor and toss the plane at the horizon. Don't throttle up till your hand is clear of the propeller.

25. The most common problems we see are:

a) **CG too far back.** Flying wings will not fly tail heavy. A good sign you are tail heavy is you can't control the plane or the plane won't stay trimmed. When you try to loop the plane will roll over. Add weight to the nose to see if the problems resolve.

b) **Too much movement in the elevons** so the plane stalls on launch as you pull up on the elevator. Our planes have huge elevons to decrease drag so they don't need as much movement in the elevons as planes with small elevons.

c) **Loose servos in the foam, linkages and push rods that flex, and poor leverage with push rods not installed per plans, elevons are too soft and twisting.**