Hercules Twin Puller 66" and 78" Building Instructions

The EPP Hercules Twin Pullers are some of the toughest BIG FPV planes on the planet. They are unique because they can take off the ground without wheels. They are low drag larger flying wings that can fly slow and carry a lot of FPV equipment and resist tip stall. We build them like combat planes. 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 them strong while protecting batteries and radio. The plane is designed to use low cost off the shelf motors, ESCs, servos and batteries. The main difference in the planes below is the added extensions to increase the wingspan from 66" to 72" to 78".

Specifications

a) **Center of gravity is back 10" (25.5 cm) from the nose of the plane on all three plane designs.**
b) Front spars are back 2.5" (6.5 cm) with a spar section across the front of the extension both top and bottom of the wing
c) Center spars are back 10" (25.5 cm) from nose of plane on both the top and bottom of the wing on all three wings.
d) We now recommend standard elevon mixing.
e) 2 or 4 elevons can be used with one servo on each elevon. Pictures above show 4 servos with split elevons.
f) Spars are tied together with wire joiners and reinforced Scotch Extreme Tape over the top to prevent separation.
g) We recommend that you build and laminate the plane before you install the radio
h) All of the radio and linkages are on the top of the plane to prevent damage when landing.
i) Motors are mounted so nose cones are back of leading edge of center of wing.
j) Flying wings will not fly tail heavy so you will need to keep the batteries and radio far forward.
k) 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.
l) Target all up weight 5-8 lbs (2.3 to 3.7 kilos). Lighter always flies better.
m) A 9x6 prop on twin 3530-1400 KV motors recommended (2 motors needed).
n) Each 3530-1400 KV motor needs its own 60-80 amp ESC (2 ESC's needed).
o) 10,000-20,000 mAh 3S lipo batteries mounted as needed to get proper CG.
p) Standard sized servos recommended for any plane with a motor capable of over 20 amps.
q) Speed range 15-90 mph (25-145 km/hr) with suggested motor and standard build.

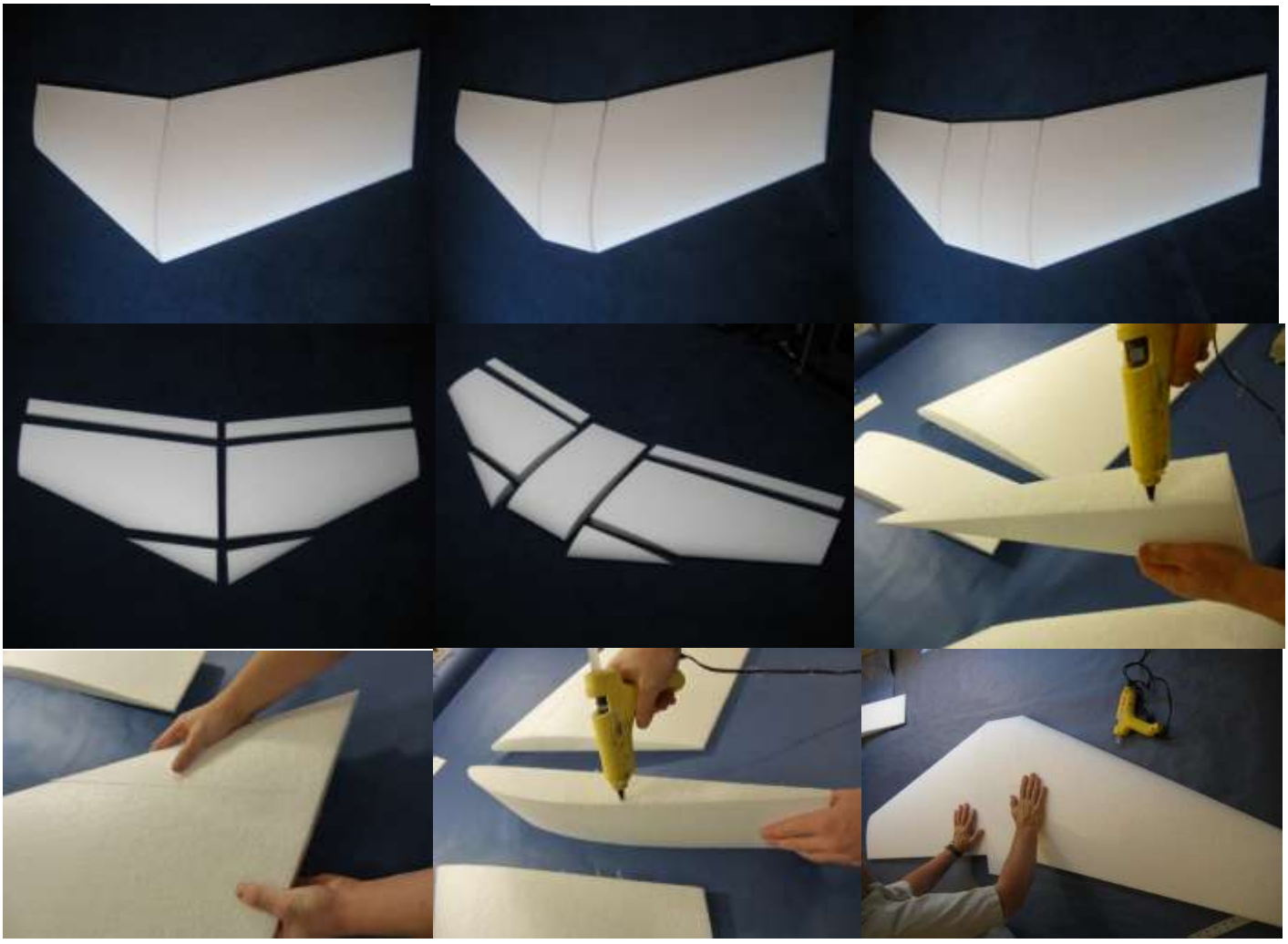
Equipment needed

a) Low-temperature hot glue gun and low-temp rated glue (or "Goop" brand glue) and thin viscosity CA glue.
b) Screws (size #6 x 3/4") to attach motor mount to wood motor mounts.
c) Scotch Extreme Tape (2" (5cm) bidirectional) 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 Twin Puller Building instructions

1. The Herc can be built with none, one or two extensions in the center of the plane as shown below.

a) Due to the large size of the plane the wing cores are cut as shown below to make shipping possible.
b) Clean loose fibers off cores by rubbing the EPP parts together.
c) Glue the main core sections together as shown with HOT GLUE or Goop.



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

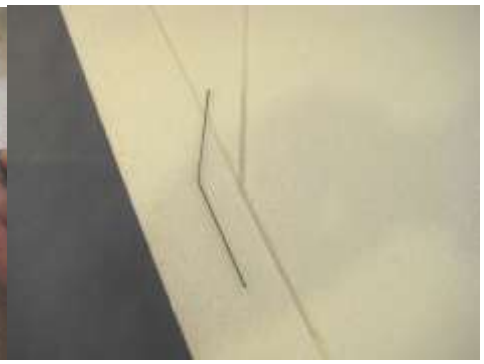
a) The motor blocks are mounted in the bottom of the wing as shown below.
b) The spars (red) and wires (black) are installed the same on both the top and bottom of the wing.
c) The front spars are back 2.5" (6.5 cm) from the leading edge of the wing and across the extension in the middle. (shown in red)
d) The center spars are installed across the center of the wing back 10" (25.5 cm) from the nose of the plane.
e) The wires (black) overlap the joints where the spars come together to prevent tearing or separation of the foam between spars.
f) You will see us use black spars in many of the pictures but white spars are included in most kits.
g) In the drawings below the plane is shown with motor center line 8" (20.5 cm) from the center or edge of the extension for prop clearance.
h) Wood motor blocks are shown at 12" (30.5 cm) long but can be cut to 9" (23 cm) to save weight.

3. Spar Slots - Cut the spar slots but don't glue the spars in until the motor mount blocks have been installed on the bottom of the wing.

a) Lay out the spars on the wing with the front spars back 2.5" (5 cm) and he center spar back 10" (25.5 cm)
b) Cut the tip of a soldering iron off to 1/4" (.6 cm) or slide a 5/16" (.8 cm) wheel collar on the shaft of the soldering iron to set the depth.
c) Cut the spar slots with a soldering iron and a metal straight edge (as shown).

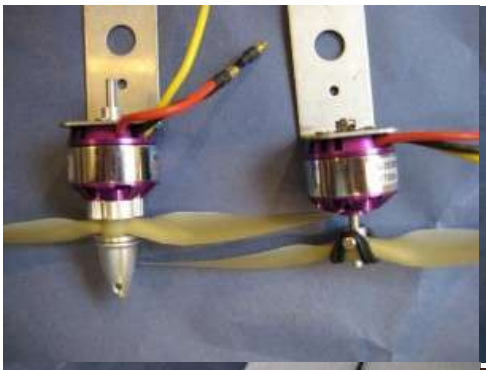
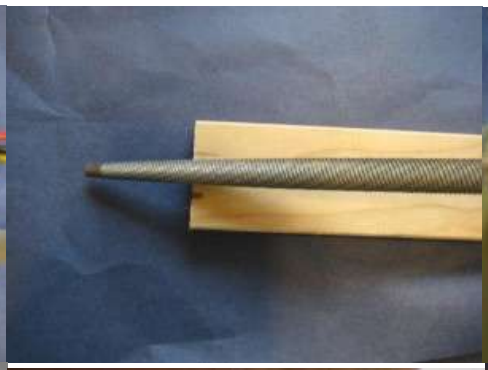
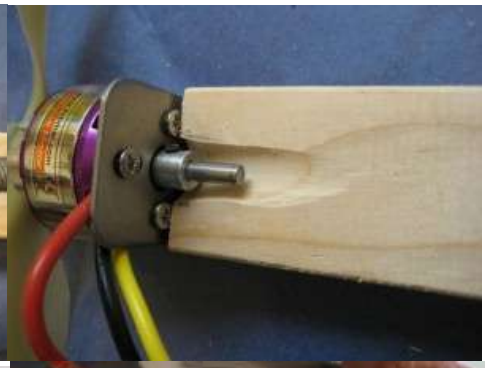
d) 6" (15 cm) wires are bent to fit in the spar slots to keep the spars from separating during a crash.
e) Enlarge the slot slightly where the wire will be installed to give spars room to lay flat over the wires.
f) The motor mounts have to be installed before gluing in the bottom spars!!!
g) Glue the angle wires in the slots before gluing in the spars to prevent shearing and separation at the spar joining points.

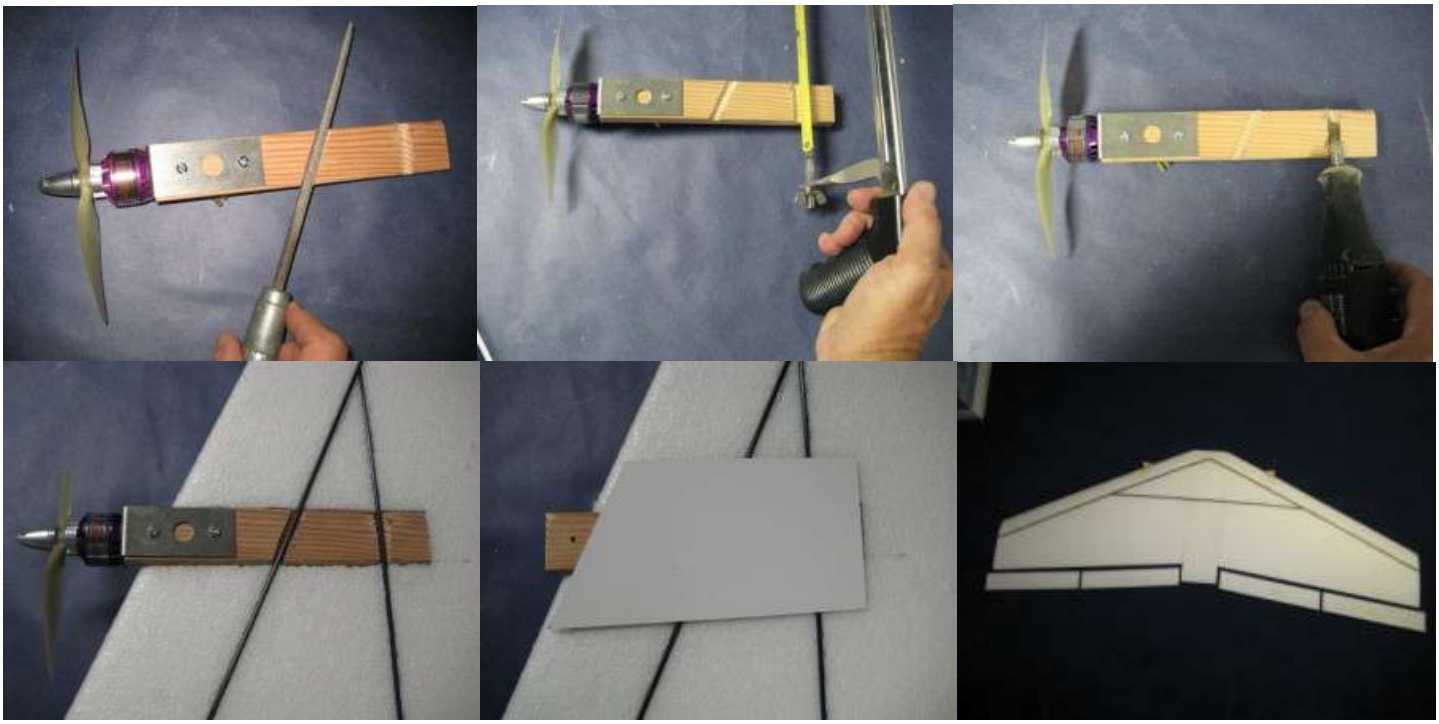




4. Mounting the Motors

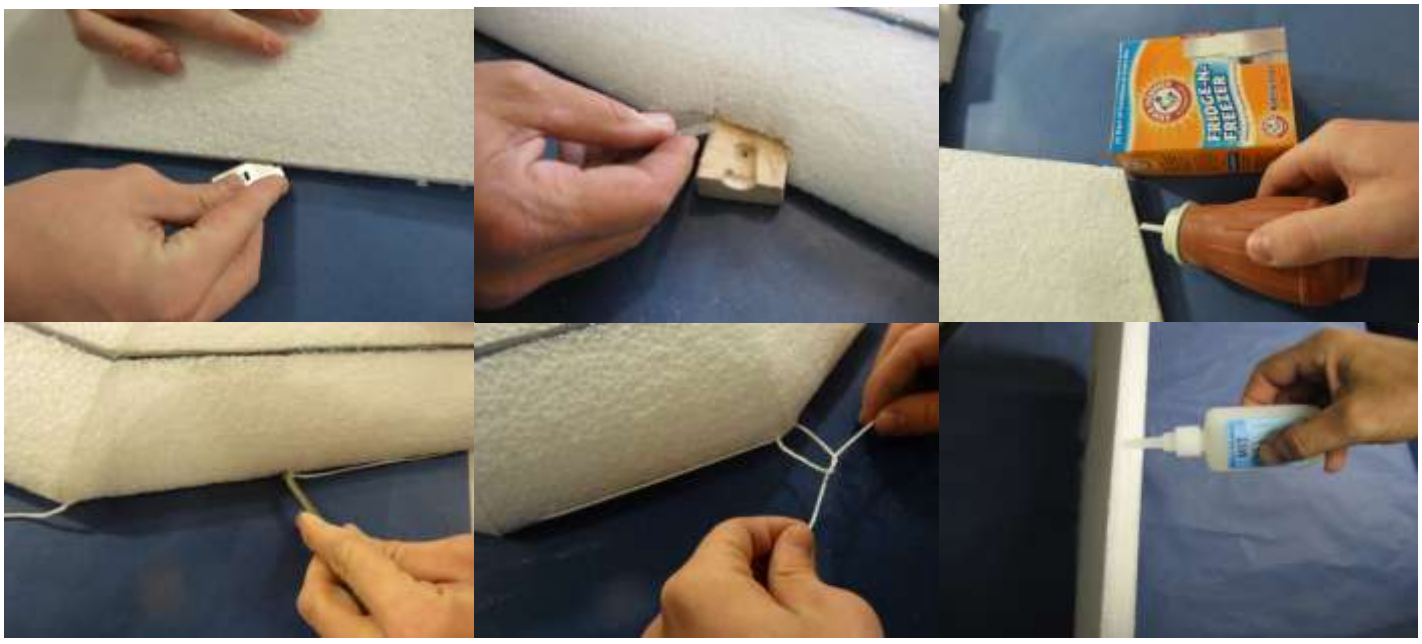
a) Mount the propellers on the motors.
b) Mount the motors on the stainless steel motor mounts.
c) Use a file, hack saw or Dremel to shape the wood so the shaft on the back of the motor will not rub on the wood when the motor is running.
d) Drill pilot holes then screw the motor mounts to the wood post with large thread flat head screws.
e) The center line for each motor block is 8" (20.5 cm) from the center line of the wing without the extension or 8" (20.5 cm) from the edge of the extension.
f) Draw the outline of the wood motor mount on the bottom of the wing slightly smaller than the wood motor block for a tight fit.
g) Use a box knife and a soldering iron to cut the bottom of the foam wing. Make sure the prop will not hit the foam.
h) Cut spar slots across the wood mount with a file, saw or Dremel the wood mount so it will not interfere with the spars.
i) Glue the wood mount into the wing.
j) **Glue the spars into the wing and the motor mount block.**
k) Always apply hot glue to the foam not the wood or Formica so it doesn't cool before it is properly positioned.
l) Remove the stainless steel motor mount and glue the Formica plate over the wood motor mount and spars to increase the contact area with the foam and to add surface area for the Extreme Tape to secure the motor mount to the wing. The motor can be added again after lamination.

5. 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 thin viscosity CA glue.
c) Put the shock cord around the plane starting at the nose.
d) Cut over the top of the motor mount blocks to keep the shock cord in a single piece.
e) Push the shock cord in the slit with a small Phillips screwdriver and tie securely at the nose of the plane.
f) The bulb syringe in the picture below is full of baking soda.
g) Watch out for fumes when using CA with baking soda. We recommend gluing outside for safety.
h) Glue shock cord in place with thin CA glue.



6. Extreme Tape (bidirectional reinforced tape) all foam wing surfaces ahead of the front and center spars both top and bottom on the planes.

a) **ALL REINFORCED TAPE MUST BE COVERED WITH LAMINATE TO PROTECT FROM UV RAYS THAT DESTROY ITS ADHESIVE.**
b) Scotch Extreme Tape will stick to EPP without a spray adhesive if the foam is clean and dry.
c) The E-Tape should be tight enough to give strength but not so tight it warps the wing.
d) Wrapping the E-Tape around the nose of the wing, spar to spar, adds strength to the front of the plane.
e) Put a solid layer of Extreme Tape on the bottom of the plane from the back spar to the front.

**7. 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.

8. 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.
b) 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.
c) Lay the laminate flat on the wing with the rough side against the foam.
d) Make a single stroke down the middle of the wing trying not to leave wrinkles. (See picture in middle below.)
e) Work from this line and iron towards the edges avoiding wrinkles or too much heat.
f) Wrap the edges and ends to get a great look.

9. Iron 2-3 layers of laminate on the elevons to make them stiff and strong

a) You can build with one elevon per side or split your elevons on each side to prevent flutter and give redundancy in case of servo failure.
b) All of the planes in the first photos have split elevons but testing shows that both single and split elevons fly well and are effective.
c) If you build with split elevons you use a Y connecter on each side so the elevons move together with standard flying wing mixing.
d) Cut the elevons to the size of the trailing edge.
e) Be careful not to warp the elevons during lamination.
f) Place one of the elevons under one edge of the laminate, so that the rough side of the laminate is facing the EPP foam.
g) Wrap the laminate end up over the elevon and make sure the elevon is straight before ironing.
h) 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.
i) Fold the laminate over and continue ironing until the elevon is completely covered with two layers of laminate.
j) Check the elevon frequently with a straight edge to make sure it is straight.
k) Cut the extra laminate on the ends of the elevon to fold over neatly. Repeat process with other elevon.
l) Too much heat and laminate shrinkage can warp the elevons. Start cool with your iron and then seal with higher temperature.
m) If needed, re-heat and straighten the elevon, then hold it flat while it cools.
n) The elevons will still be bendable until they are hinged to the back of the wing.



10. 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 over the top 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" (2.5 cm) strip of E-Tape on the bottom of the hinge line.

11. 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.

a) **12. THE MID RUDDERS NEED TO MOVE FOR STEERING ON THE GROUND (they have little effect in the air)**

b) Measure 3" for the rudder. The rudders are installed behind the motors in the prop wash for best steering effect.

c) Use caution so you don't cut all the way through but only cut one side of the Coroplast rudder.

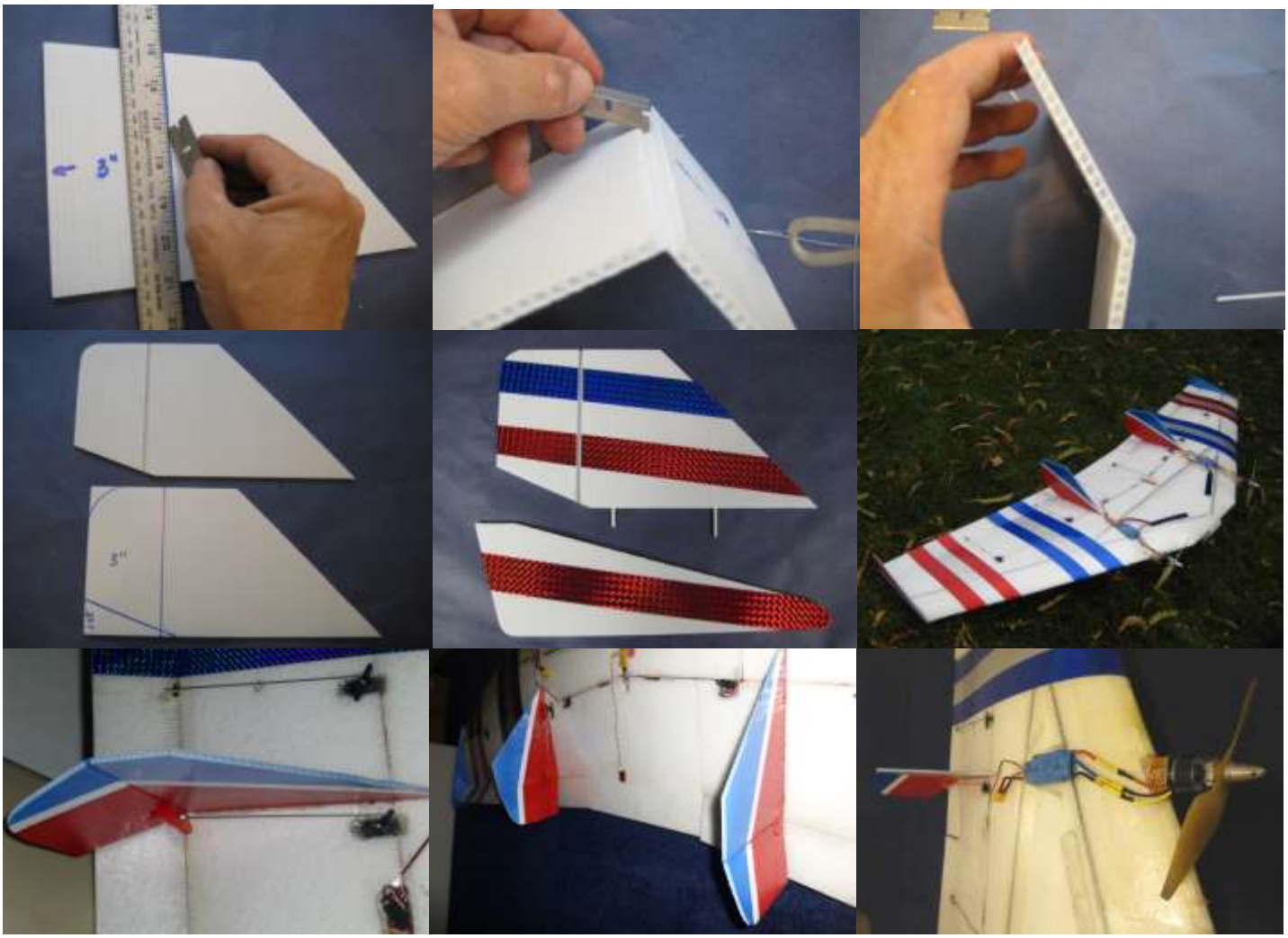
d) Split one side of the Coroplast between the ribs which will allow the rudder to bend.

e) Trim the edge so that the rudder can bend both ways.

f) Trim the bottom of the moving rudder so it clears the elevons when they are in the up position.

g) Notice the fiberglass rod scraps glued in the bottom of the rudder to help strengthen the glue joint.

h) Two servos (one on each rudder) need to be installed with a Y connector to the ESC to move the rudders.



13. INSTALLING THE TIP FINS The tip fins are part of the landing gear keeping the elevons 1" (2.5 cm) off the ground

a) Position the fin on the end of the wing aligning the front of the fin and wing and the rear of the fin 1" below the wing.

b) Still holding the fins in place against the ends of each wing tip, and make marks back 1/3 and 2/3 of the fin, where it meets the top and the bottom 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.

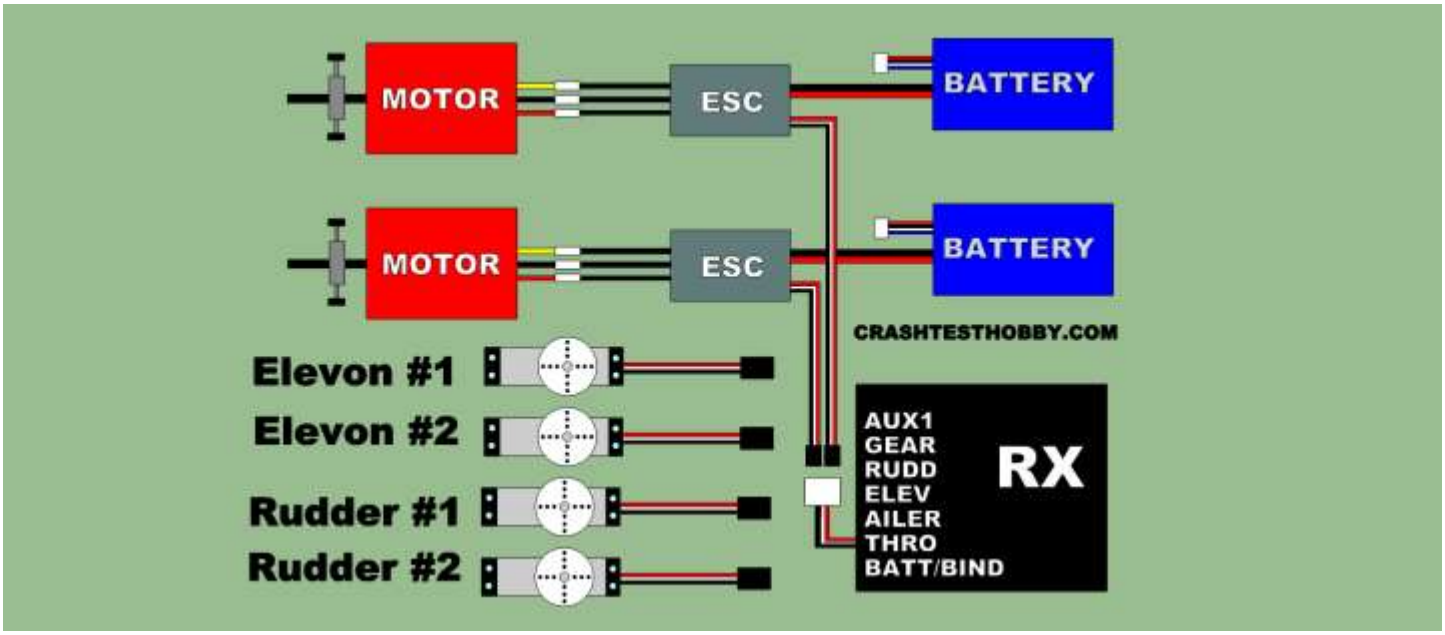
c) Shape the nose and top of the fin as desired.

d) Place a 1" (2.5cm) wide strip of reinforced tape through the slots in the fin, so that the tape attaches to both the top and bottom of the wing.

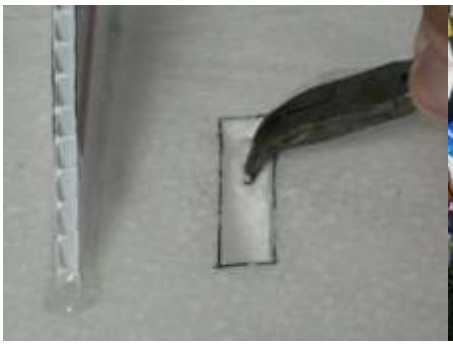
e) Wrap a 1" (2.5 cm)wide strip of reinforced tape around the nose of the fin and 2" (5 cm) along the leading edge of the wing.

14. INSTALLING THE ELECTRONICS

a) You will need two matching motors and two matching speed controls.
b) Your speed controls (ESCs) will need to have built in BECs or you will need a separate BEC to power the radio.
c) You will need a servo plug "Y" connector to plug both ESCs into your receiver throttle plug.
d) You will need battery Y connectors and plugs that will provide power to both ESCs from your batteries.
e) You will need servo extensions which may include a "Y" connector for each side of wing if you are using split elevons.
f) Pre-test the motor, batteries, ESCS, receivers and servos that you plan to install to know everything is working.
g) 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 in 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.



h) Install your motor and mount and fins on the tips of the wing before you adjust the CG by installing the batteries.
i) Flying wings and deltas tend to be tail heavy. The diagram shows 2X 5000 mAh 3S batteries for longer flights and balance.
j) The suggested locations in the pictures below should be close to the best location to get the CG at the suggested 10" (25 cm) back. If you don't balance to the correct CG, you will be adding more batteries or lead to balance the plane.
k) Plug all of the wires from the radio components together and lay them out on the top of the plane.
l) **Make sure you know where the wood motor mounts are so you don't hit them while cutting out servo and ESC compartments.**
m) Look at the length of the battery, ESC and servo wires. This often will influence where you can install the radio. Many extensions to these plugs are available and can be used to increase the distance.
n) Spread your servos wide enough apart so that the servo arms will have a good angle to the horns on the elevons.
o) Install the servo arms facing away from the center of the plane for maximum width.
p) The wing is stronger if you leave no empty space in the wing so cut out compartments that fit each part snuggly.
q) The one exception is the ESCs need to have airflow around them or they will over heat.
r) Cut holes for the separate compartments for the batteries, ESCs and receiver. Outline the cut (slightly smaller) with a new razor blade or soldering iron to make it easy to extract the foam cleanly.
s) Connect the compartments with razor blade slits for the wires.
t) Press the wires for the servos and ESCs to RX (receiver) and RX to Sat RX into the slit.
u) We recommend the satellite receiver for these big planes. The satellite receiver will increase your range.
v) Put clear shipping tape or laminate over any slit or slot with wires. It will not show on the clear laminate.
w) 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.
x) You can use Velcro straps to secure the battery, ESC and receiver as needed
y) Elevon throws are 3/8". Trim both elevons up 1/4" (reflex).
z) Secure all parts so they can't fall out or get knocked out in an accident.



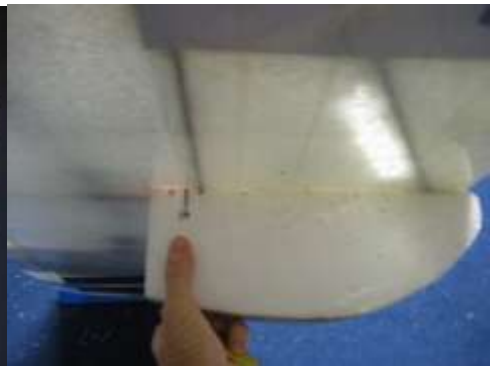
15. BUILDING THE EPP SKID

The skid is a solid piece of foam that acts like a shock absorber for your FPV and camera gear. It allows you to take the plane off the ground without wheels on most surfaces. It is a great place to hold on to the plane for hand launching. It helps to orient you to the position of the plane in the air at a distance. The skid is installed at the nose of the plane in front of the CG so the plane does not flip on landing. The wing tips slide on the fins on the ground.

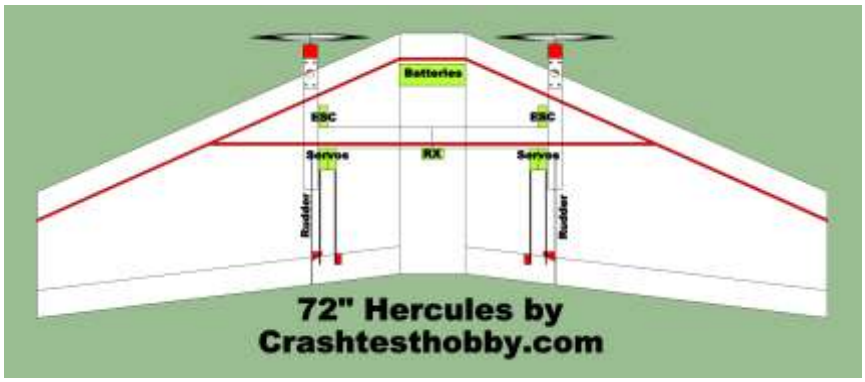
a) Get a flat sided 2 liter pop bottle. Don't use a Coke or sprite bottle because of their shape.
b) Punch a hole with a hobby knife and using scissors cut a 3" wide piece around the center.
c) Apply a layer of Household Goop or Shoe Goo to the surface of the foam and the skid.
d) Goop is messy and has dangerous fumes. you will need to ventilate your room or glue it outside.
e) Position the surfaces how you want them and press them together.
f) Use #64 rubber bands to hold the pop bottle plastic in place around the skid while drying.
g) While the Goop is curing roll out any air bubbles.
h) You can use a hot iron to smooth out sharp edges if needed.
i) Attach the skid to the wing with Velcro or
j) Permanently by punching many holes through the laminate with a soldering iron and glue it on with Goop.
k) Don't accidently damage batteries while installing the skid. We recommend taking them out during installation of the skid.
l) For added strength and to keep the skid clean put laminate or more pop bottle plastic on sides and back of skid.

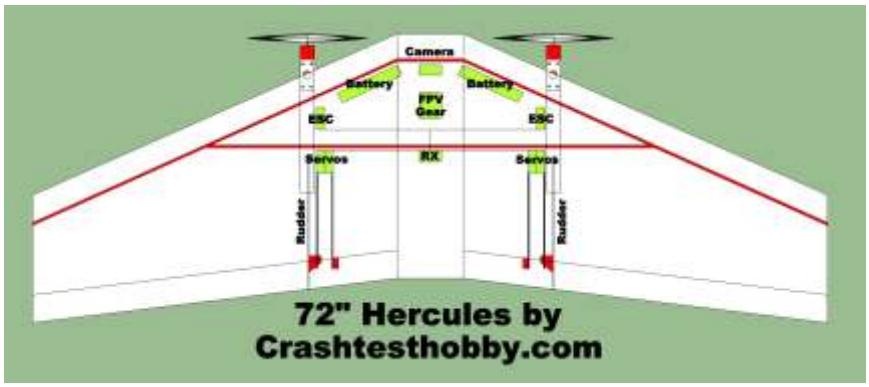


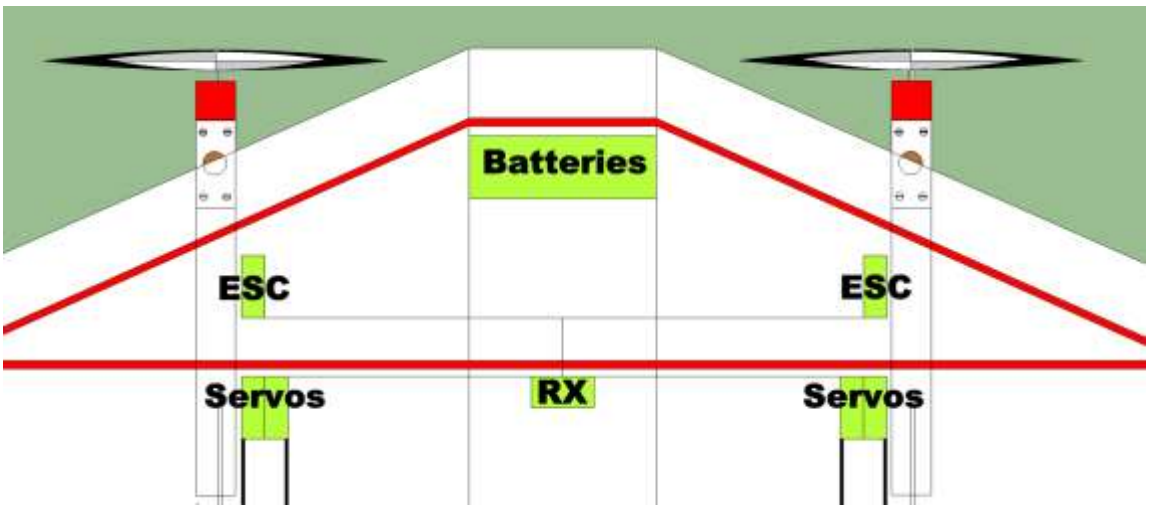


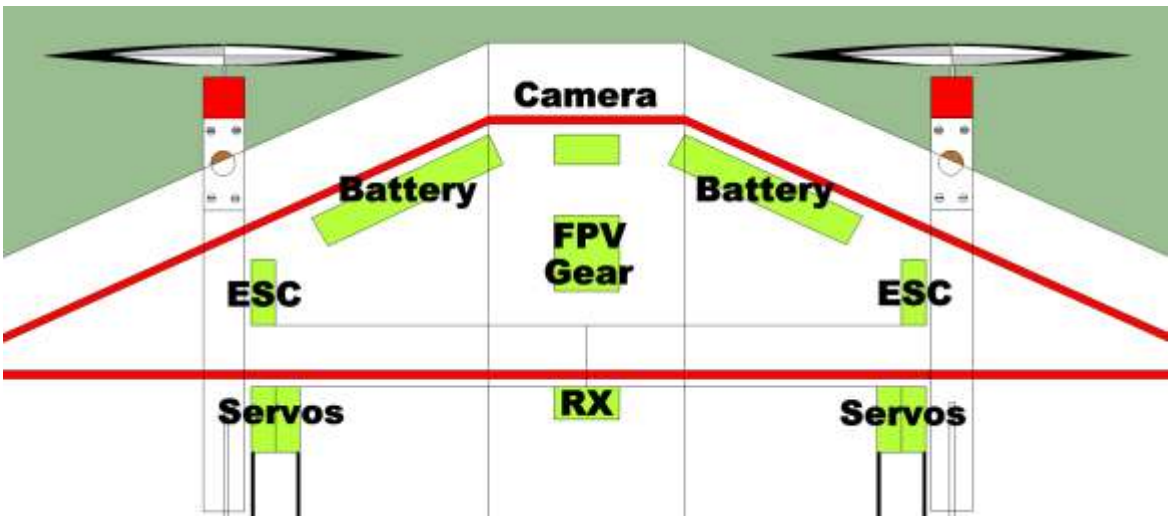


16. Images below shows suggested radio installation with four servos, two ESCs, two elevons and two rudders.



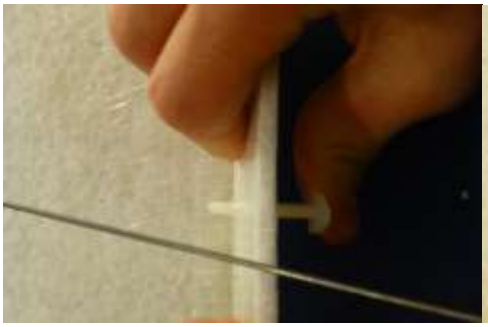




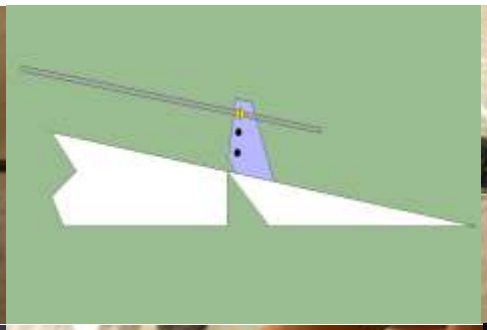
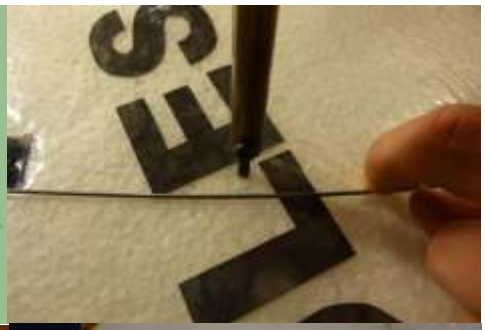


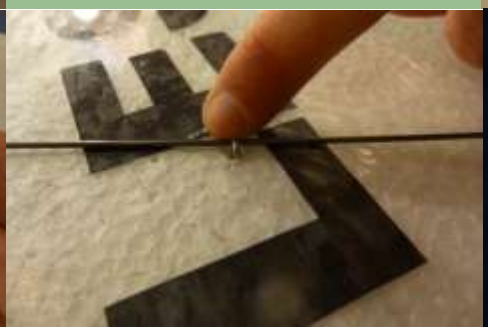
17. PUSH RODS AND SERVO HORNS

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) Remove the extra tab that comes attached on the back of the servo horns. We do not use it.
d) Mark the elevon for the control horn by putting the push rod straight back from the hole in the servo arm.
e) 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.
f) You can recess the base of the horn as needed for proper height of horn.
g) Push the servo horns up through the bottom of the elevon so that the base is flat against the bottom of the elevon.
h) 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.
i) Your horns should point towards the servos, and the front of the horn should be directly over the elevons hinge.








j) Attach the EZ Connectors with a pair of pliers to the top hole in the control horn.
k) Remove the servo arms, slide the push rod Z-bend through the 2nd hole from servo in the servo arm.
l) 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) Use your soldering iron to melt holes at the marks you just made.
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.

18. BATTERY BAY – VELCRO RETENTION STRAPS

a) After the skid is mounted, the fins are installed, and the radio is installed, move the batteries as needed to get proper CG.
b) Cut the battery bays for the batteries. **Make sure your CG is correct before you do this or you will end up with unnecessary weight to balance your plane.** If you need more weight in the nose, move the batteries forward or add more batteries.
c) An easy way to hold the battery and battery wires in place during flight is with a Velcro strap.
d) Cut a slit through the bottom tape and laminate in front of the battery hole and one through the bottom behind the battery then feed the velcro through and fasten it on the top of the wing. A camera and other FPV gear can also be Velcroed in place.

19. 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 position and tighten the EZ connector.
f) The top of the elevon should be angled up about 1/4" (.5 cm) at the tip. This is called **REFLEX** and is used on all flying wings and deltas.
g) Repeat on other elevon and set it at the same angle.
h) 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, ESCs, and the slots you buried wires in, with clear tape and/or laminate to keep the radio from ejecting in an accident. ESCs 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 motors are 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!

20. LAUNCHING

This is a unique plane design and will take off grass if the grass is short enough it doesn't interfere with the propellers, you have enough power and your CG and throws are correct. Hit the throttle and let the plane build speed and gently pull back for takeoff. See the videos on our web site.

21. 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.**