

The

WITCH

A RADIO CONTROLLED EXPERIMENTAL FUN FLIER

Designed by Mike Buzzeo

© Mike Buzzeo 2011 All Rights Reserved

Building Notes and Random Thoughts from the Designer - Please read.

The Witch is a great little project that is easy to build and fun to fly, but it is really not intended for beginners, therefore I did not go into a lot of detail on simple things like control horns and pushrods. There is also very little in its construction that has to be exact. For example, the main wing spars on some of my prototypes were made from 1/4" wooden dowels, later versions used 1/4" Fiberglass (available at www.kitebuilder.com) and 1/4" Carbon Fiber dowels. If you choose to use wood, you might want to beef the dowels up to 5/16".

The Witch's body on the later prototypes was made of 1/2" Midwest Model foam which worked very well and is easy to cut if you have a wire foam cutter. However, I was poking around Office Max one day looking for black Foam Board when I found a black, Tri-Fold display board that consisted of a foam core sandwiched between two sheets of heavy-duty paper. This proved to be perfect and was used for the body and tail feathers on the final version. As an added bonus, this tri-fold display board is large enough to cut out two complete sets of parts.

In the later prototype stages (once I had shaped the body to look like a witch) I found that the Witch's head caught a lot of air and made turning difficult. By using a second servo (tapped into the rudder channel with a "Y" cord) to make her head turn opposite the rudder, the problem immediately went away and she turned beautifully!

The final version of the Witch used one standard servo for the wing and three micro servos (one each for elevator, rudder and the Witch's head). I chose to mount the micro servos right next to the control surfaces with mounting tape, but you can mount them however you choose, or you could use standard servos mounted to the body and connect to the control surfaces with longer pushrods.

Since wheels would severely detract from the realistic looks, I skipped using them altogether, but without a stable platform on the bottom, she tips over on landing. This caused me to strip the wing servo gears on one of the early prototypes. To avoid stripping gears, the wing is now connected to the servo using rubber bands instead of pushrods to act as a strain relief.

The nylon sail material is attached to the side dowels with "Gorilla Tape". However, if you have someone who sews, rather than use the tape, you could add enough excess material to the two sides of the sail to sew a pocket for the dowels.

For the broomstick, I used a 1/2" Fiberglass tube which I purchased from an on-line Kite Supply store. You can get by with a slightly smaller diameter, (anything close will work) or even a wooden dowel, but the broom stick is about 42" long, so if you use wood, you may have to splice two pieces together. All of the fiberglass tubes can be found at www.kitebuilder.com. It might be worth poking around their site.

I made my Witch all black because I liked the silhouette effect that it gave, but it also makes it difficult to orient, even to a seasoned flier like myself, so if you choose, you can paint a face on her, or give her a colored cape or broom or decorate her however you prefer.

The bottom line is that you have a lot of options as to how you choose to do things. As long as you get the correct angles and positions of the Wing, Broom, Tail Feathers and the Motor Mount, you can pretty much get away with a lot of changes (like, maybe you'd prefer more of a "Babe-Looking" witch, or even a Flying Monkey!)

Now, let's get started. I hope you enjoy it! - Mike Buzzeo

Main Supplies needed:

1 Yard - Rip-Stop Nylon (Available at Fabric Stores or at www.kitebuilder.com)

3 ea. 1/4" x 24" Fiberglass, Carbon Fiber or Wood Dowel (If wood, increase to 5/16")

1 ea. 1/4" x 22" Fiberglass, Carbon Fiber or Wood Dowel (If wood, ditto)

1 ea. 1/2" x 42" Fiberglass, or Wood Dowel (Carbon Fiber would be too expensive!)

2 ea. 3/32" x 1/4" x 16" Balsa Stiffeners (Size can vary)

4 ea. 1/8" x 1/4" x 6" Hardwood Doublers (Size can vary)

2 ea. Nylon Zip-Ties (approx. 3/16" wide)

1/8" music wire (for elevator "U" joint)

Foam board (for the body and tail feathers - see text)

Gorilla Tape (A brand of "Duct Tape" from the "Gorilla Glue" people which is available in Home Stores - This tape is very strong and sticks VERY well. It is also black which works well if you go with the all black color scheme.) The Gorilla Tape will be used for hinges and to attach the broom to the body, and the sail to its frame.

Epoxy (5- 15- or 30-minute)

Foam-Safe CA with Kicker

Spray Adhesive

3 ea. 2-56 Screws w/ washers and nuts

2 ea. DuBro Swivel Links

3 ea. Control Horns and Linkages

Velcro

***Plywood Parts Note:** The motor and servo mounts can be made from 1/8" Plywood. Other parts can be made from 1/16" or 3/32" ply. If you have no plywood on hand, you could just purchase a 6" x 12" plywood sheet of either of the thinner sizes and double it up for the mounts.*

Electronics:

Radio: Basic 4-ch

Motor: RPM/V 1250 w/ 10x6 Electric Prop

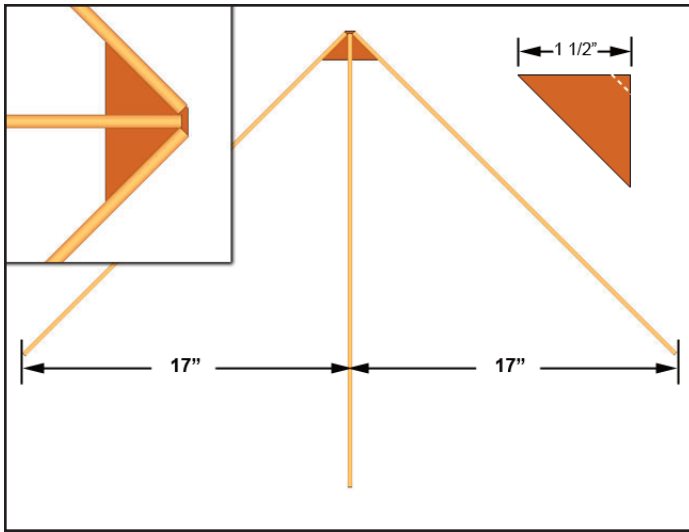
ESC: 25A

Servos: 3 Mini or Micro (Rudder, Elevator, Head) 1 Standard ("Aileron")

Battery: 3s 1500 - 1800MAh LiPo

Additional: Extensions for Motor wires and Servos will be necessary plus a "Y" cord. Lengths of extensions will depend on your particular setup.

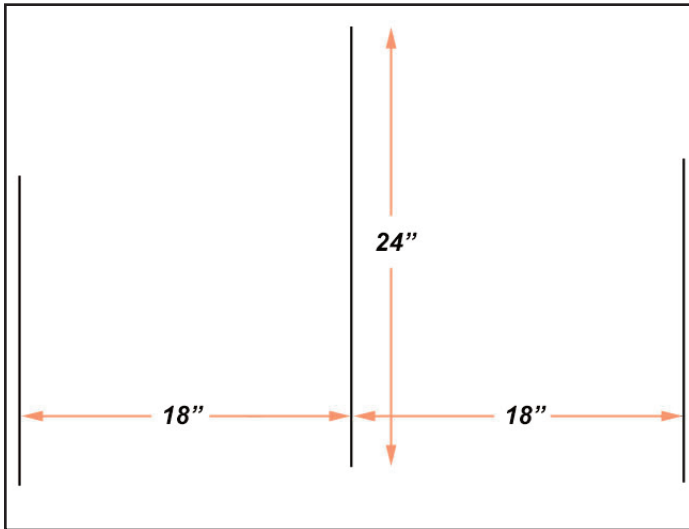
Step 1 - Building the Sail Frame:



Note: if you plan to sew the sail cloth rather than tape it, you will need to attach the two outer spars with a single screw at the front instead of glue.

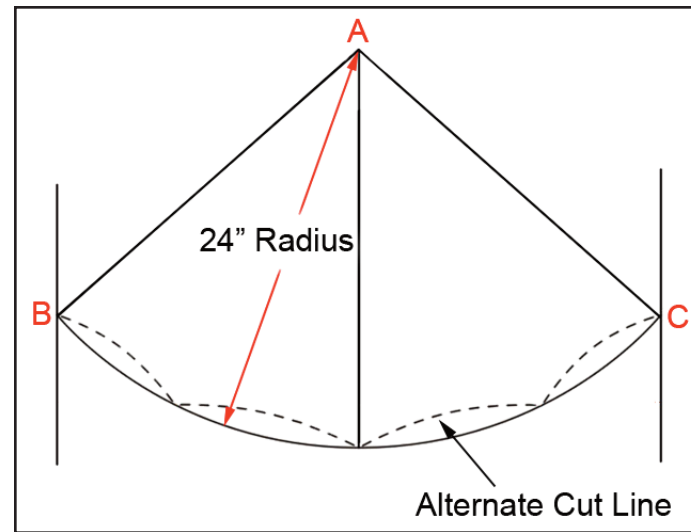
Cut a triangular piece of 1/16" Ply so the two square sides are approximately 1 1/2" long. Trim about 3/8" off the forward corner.

Glue the three, 24" spars to the plywood as shown above. Be sure to keep both side spars equal distances from the center spar.

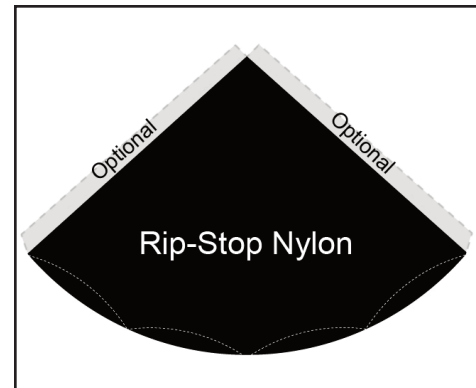


Step 2 - Cutting the Sail:

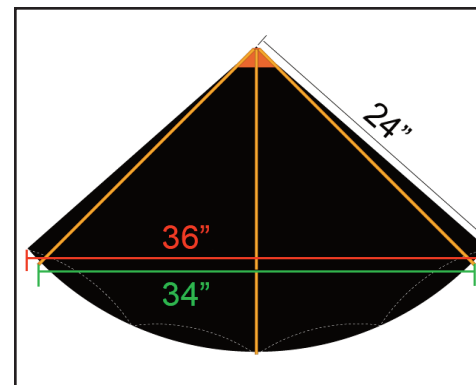
Now you need to make a pattern so you can cut the cloth for the Sail. On a large sheet of paper, draw a 24" centerline and a parallel line 18" on each side of center.



Using one end of the centerline as the pivot (A), draw a 24" radius arc from one side line to the other (B & C), then draw a straight line from "A" to where the arc crosses each line (A to B and A to C). Cut out the shape you have drawn and use it as a template to cut your Sail.

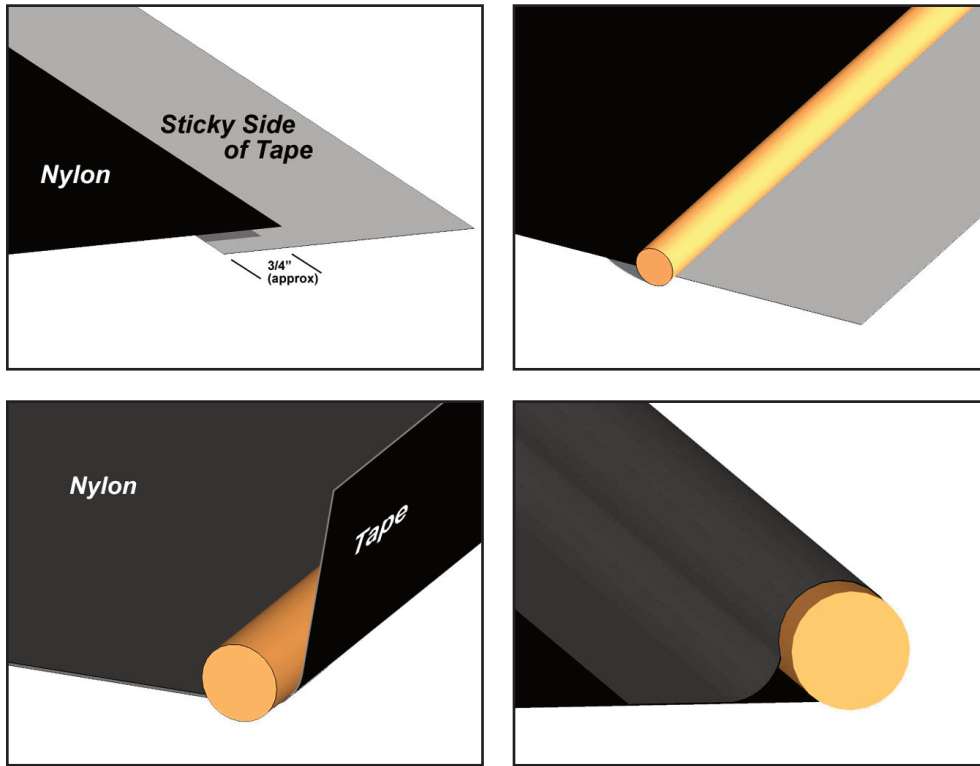


Note: If you would rather sew a pocket for the two outer spars, you will need to leave about 1 1/2" of extra material to each of the straight sides. You can plan this before cutting, or make the pockets separate and sew them on afterward.



At this point, if you lay the spars on top of the cloth, you should have about 1" of extra material at each of the aft ends of the spars. This is to allow room for the Sail to bow upward into the familiar Rogallo Wing shape.

Step 3 - Attaching the Sail:



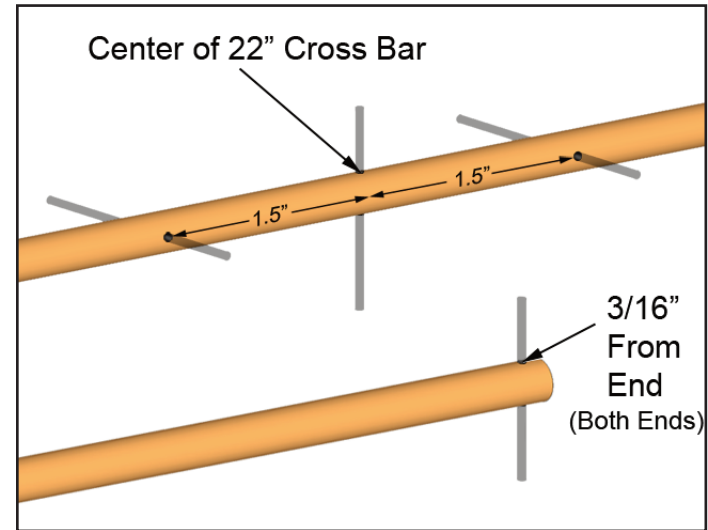
Cut a 24" long piece of Gorilla Tape and lay it sticky-side-up on a flat surface. Holding the two ends of one of the straight Sail edges, align it about $3/4"$ over the edge of the tape and carefully press it down. Try to avoid wrinkles.

Align the forward end of the spar assembly with the forward edge of the sail cloth then rotate it so one spar sits just on the tape side of the seam. If the rear ends don't line up perfectly, that's ok.

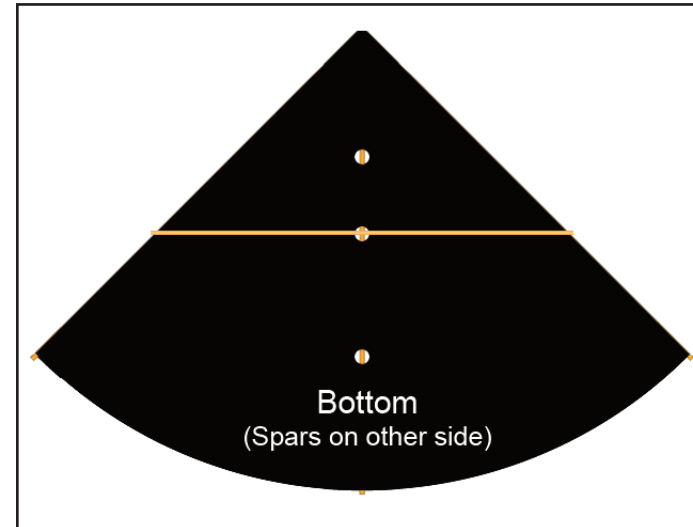
Now carefully roll the tape up and around the spar until it contacts the top side of the sail and seal it. Again, try to avoid wrinkles (having a second set of hands helps), but if you get a few, it's not the end of the world. Repeat on the other spar.

Note: Since the cloth has a wider span than the frame, the cloth will "bunch up" in the center. This is normal. Align the edge of the cloth with the second spar as you did on the first spar.

Step 4 - The Crossbar:

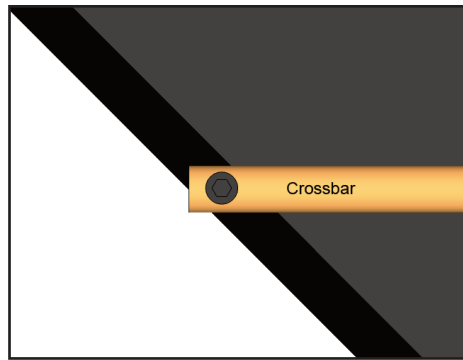
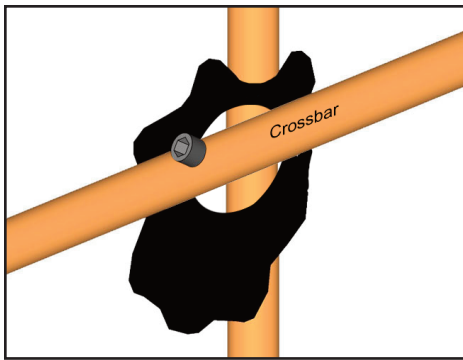


Take a 22" dowel and using a $3/32"$ bit, drill 3 vertical holes - One in the center and one about $3/16"$ from each end. Rotate the Crossbar approximately 90° and drill two more holes $1\ 1/2"$ (one and one half inches) from center. It is not critical if the holes are not exact, but do try to keep them centered in the spar.



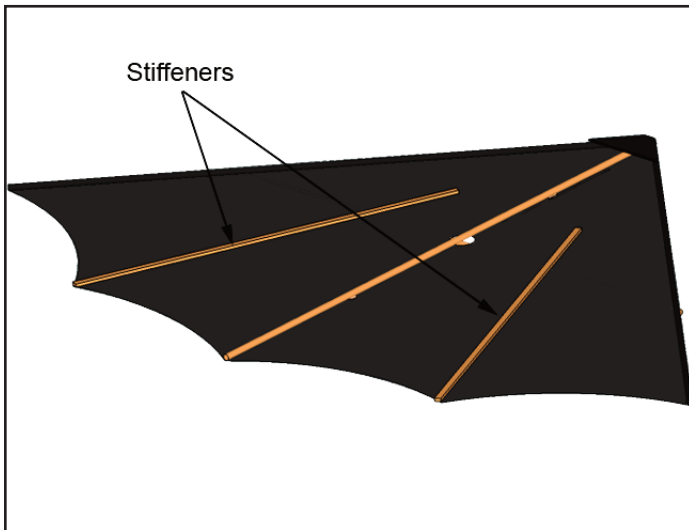
Note: An easy way to make a hole in the nylon is by melting it with a soldering iron. If you like, you can also melt a hole 4" forward and 6" aft of the Crossbar for the two nylon Zip Ties which will be added later.

Lay the Wing assembly on a flat surface, spar-side-down. Position the Crossbar on top so that it is square with the center spar and so that all three vertical holes line up with the spars. Cut a small hole in the Sail where the Crossbar meets the center spar, replace the Crossbar and, using the hole as a guide, drill a $3/32"$ hole through the center spar.



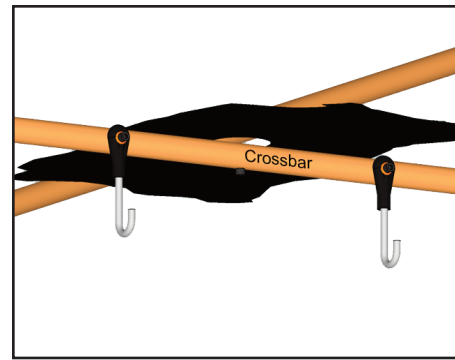
Secure the center with a 2-56 screw and nut.

Making sure that the Crossbar is square to the center spar, use the hole in the crossbar as a guide to drill through the center of the outer spar and secure with a screw and nut. If you need to move the spar in or out a little to align the hole in the center, this is ok. It is much more important that the Crossbar remain square to the center spar.



Add a balsa Stiffener to the center of each half of the Sail. The Stiffeners should start at the trailing edge and point forward toward the nose. I attached them using a spray adhesive, but you could use almost any type of glue. Do not omit the Stiffeners. Without them, the nylon will “flap” creating a lot of drag resulting in a major loss of lift.

Note: In the list of items needed, I said these should be 3/32” x 1/4” x 16”, but anything that will prevent the Sail from flapping will work. Just be sure they are securely fastened to the sail.



Attach two DuBro Swivel Links to the two horizontal holes in the Crossbar. Cut the pushrods so only about an inch protrudes and bend each one into a hook for the rubber bands.

For the servo, you’ll need a 3 inch servo arm, or you can make one from 1/8” plywood and screw it to a standard servo arm. The arms will need a hook cut into the bottom to secure the other end of the rubber bands.

This completes the Wing assembly.

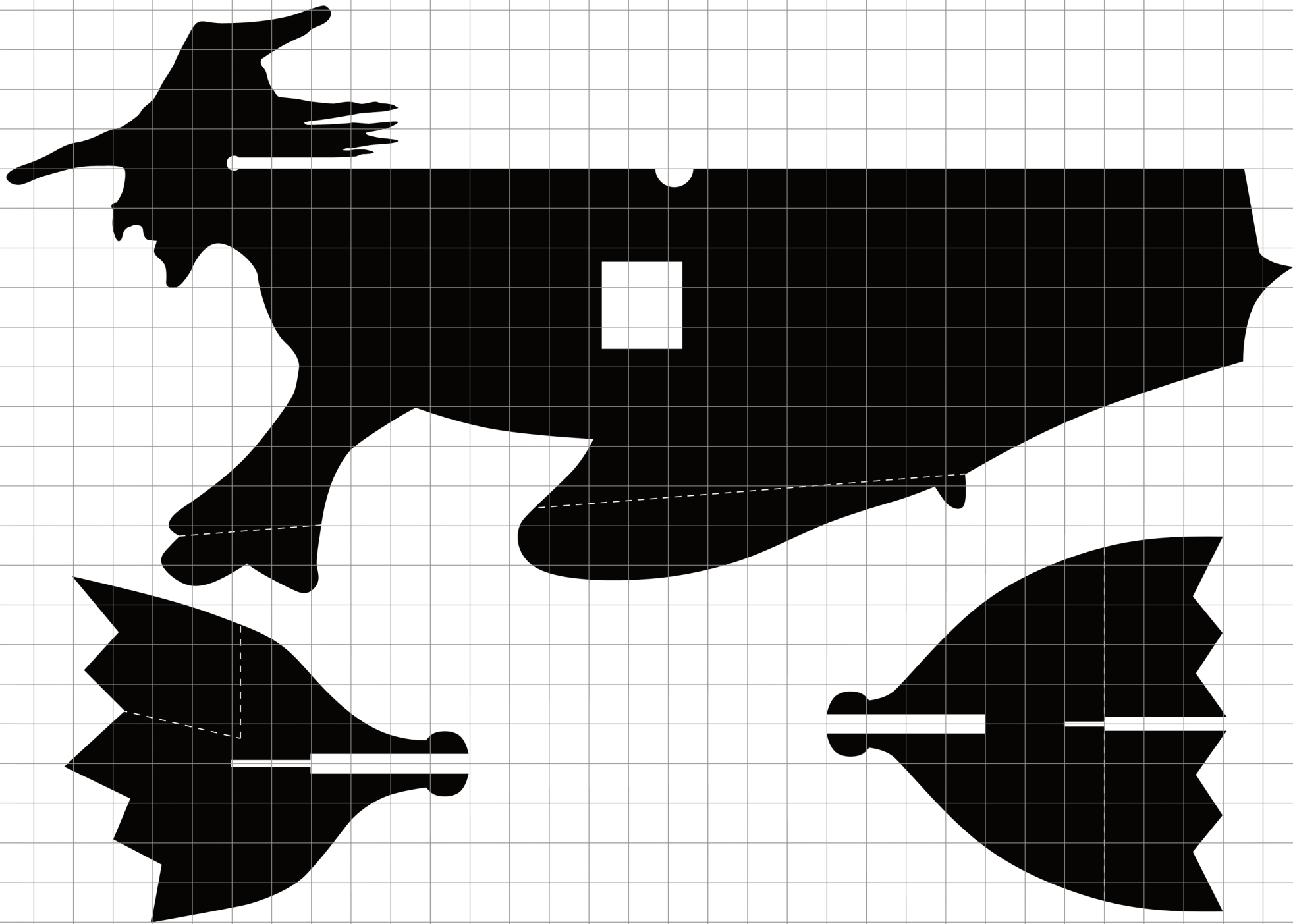
BODY

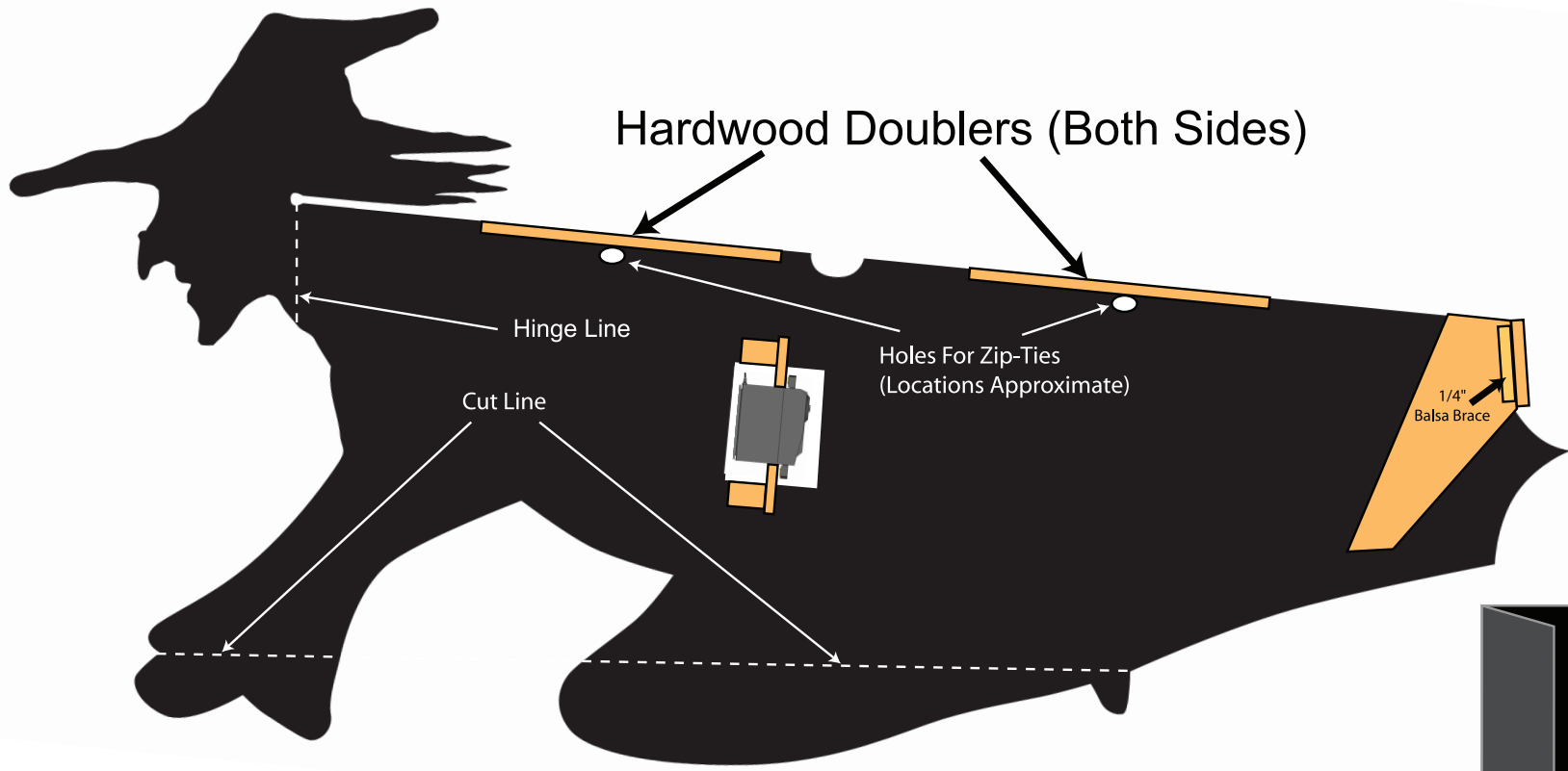
If you have access to a large printer, or care to go to a commercial printer like Kinko’s or Office Max, you can download the Full-Size body and tail PDF document and have them print it for you.

Other options are to print the PDF on a standard printer which will print out several pages that you can tape together, or you can use the following page to draw it freehand by drawing 32 vertical lines and 26 horizontal lines 1” (one inch) apart on the foamboard or on a large roll of paper and using the squares as a guide, draw the profile of the witch and tail.

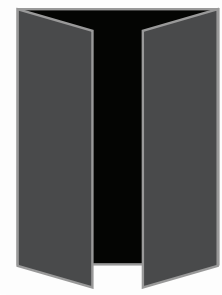
However you choose to do it, once you have a full-size drawing, transfer it to the foam board and cut out the shapes.

Note: In the template, the slots in the front of the tail feathers are drawn for a 1/2” diameter Broomstick. If you are using a different size, cut the slots accordingly.

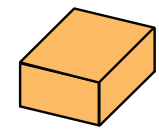
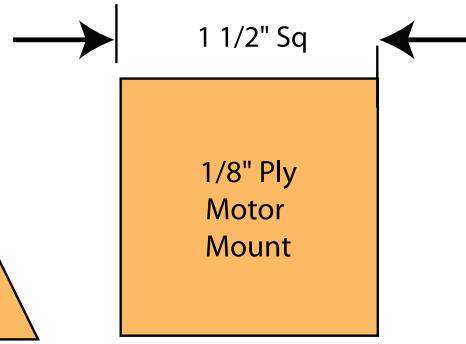
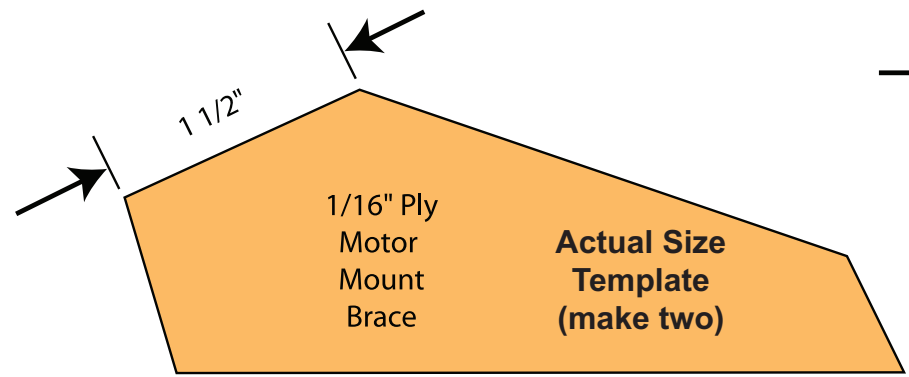




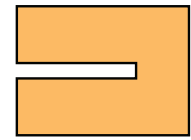
4 ea. 1/4" x 1/8" x 6" Hardwood Doublers (4 Required)



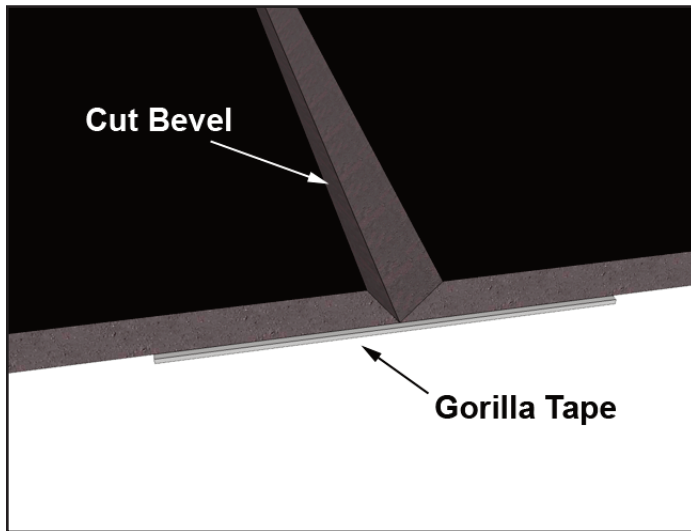
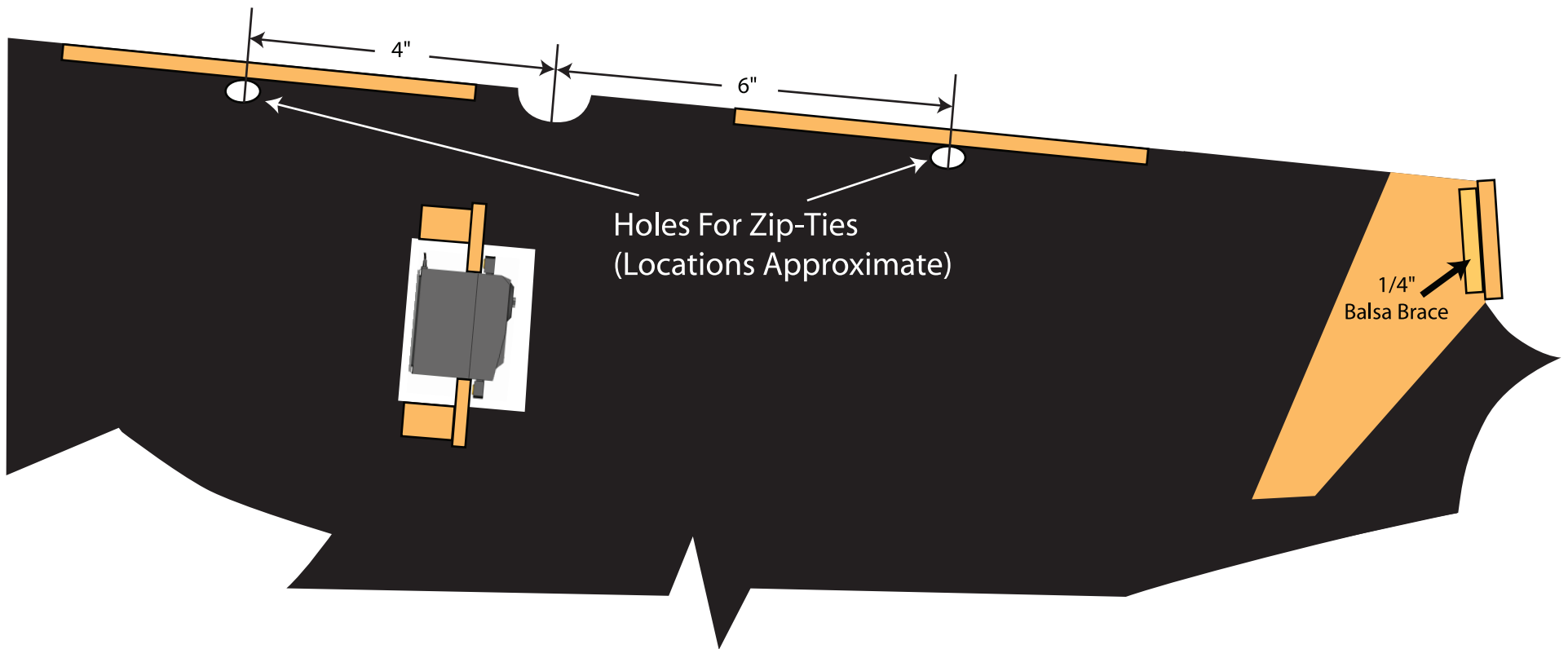
Witch's Body and Tail Pieces Cut From a Black, Tri-Fold Display Board (Available at Office Max) Or Black Foam Board



4 ea. 1/2" x 1/4" x 3/4" Hardwood Blocks



1/8" Ply Servo Mount (2 Required)



Step 1 - Hinges:

Once the pieces are cut out, cut a bevel in one side of each of the hinge lines (Elevator, Rudder and Head) and reinforce the opposite side with Gorilla Tape (or any other hinge tape you might prefer).

Step 2 - Doublers

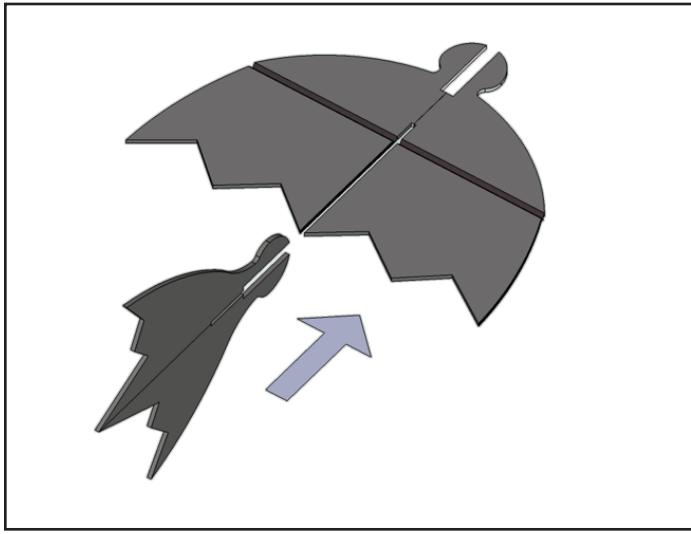
The Wing is attached to the body with two, nylon Zip Ties (Cable Ties). The attachment points are not critical, but they will be approximately 4" forward of the Crossbar and 6" behind it. Mark those locations, but do not cut the holes yet. Epoxy the four, 6" hardwood doublers (two per side) centered on the marks you made and level with the top. Once the epoxy has cured, cut or drill a small hole just below the center of the doublers.

Step 3 - Mounts

Using the template on the previous page, cut two plywood Motor Mount Braces and epoxy one to each side of the body keeping the top and rear faces aligned with the body. Epoxy the motor mount to the rear of the braces and add some scrap 1/4" balsa to the corners.

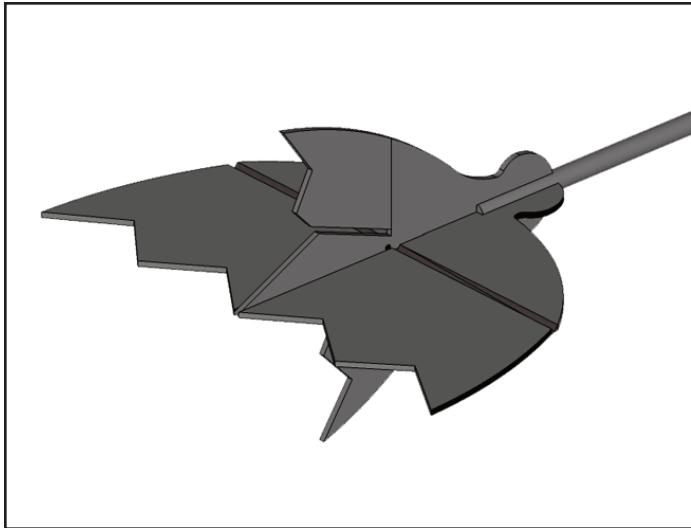
Epoxy the Servo Mounts in place to fit the servo you will be using and brace them with wood blocks on each side. Leave any excess room on the top side of the servo to allow for removing the servo arm should it ever become necessary.

BROOMSTICK

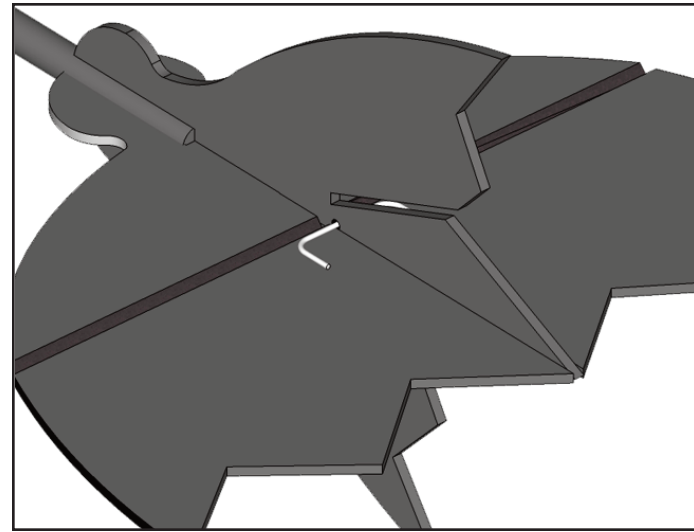


Step 1 - Tail:

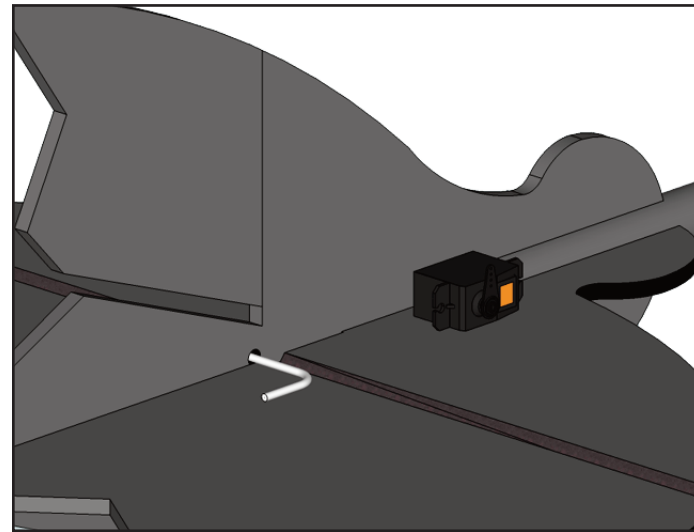
Slide the Fin and Stab together and, making sure they are 90° to each other, secure them with epoxy or Foam-Safe CA.



Slide the Broomstick into the slots in the front and glue it in place, again using epoxy or Foam-Safe CA..

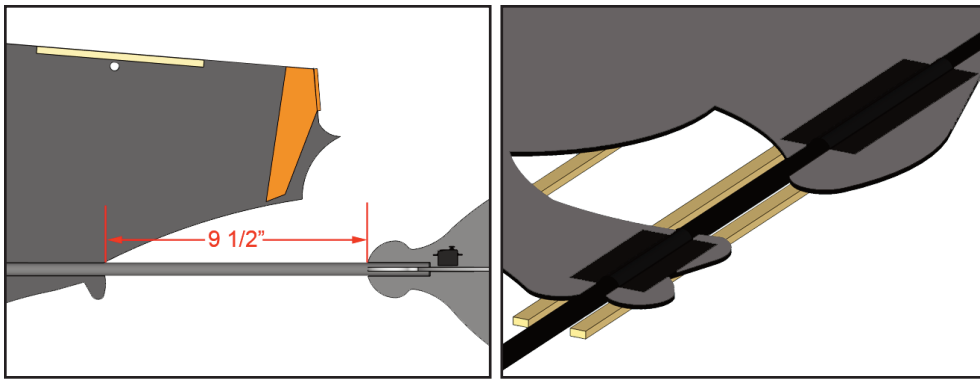


Bend a piece of 1/8" music wire into a "U" shape. Make a hole in the Fin for it to go through and epoxy it to each of the two Elevators.



The two aft micro servos can be mounted to the tail with servo tape. Add a control horn to each surface and connect pushrods with Z-Bends and/or EZ Connectors.

The servo for the Head can be attached in a similar manner. Be sure to mount the servo so the head and rudder move in the same direction (When the back of the rudder moves to the left, the front of the head also moves to the left),

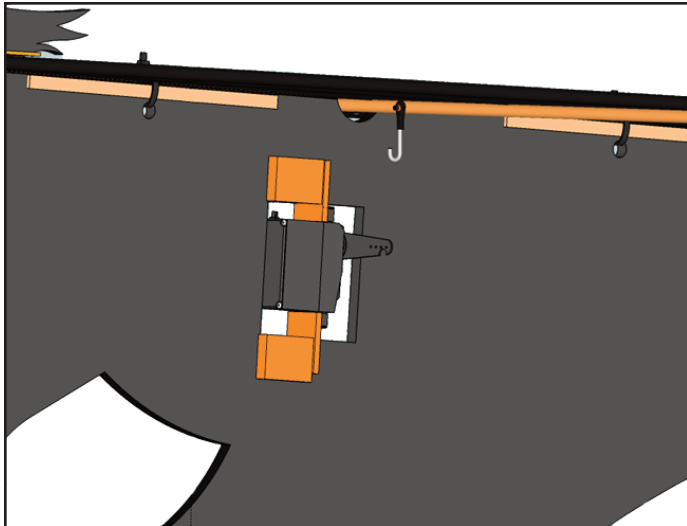


Cut the body at the “Cut Line”, block it up with scrap so that it meets the Broomstick near the center (Close is close enough) and so the broom protrudes 9 1/2” from where the Broomstick meets the aft part of the body to the front of the Tail Feathers. Tape the Body to the Broomstick with Gorilla tape.

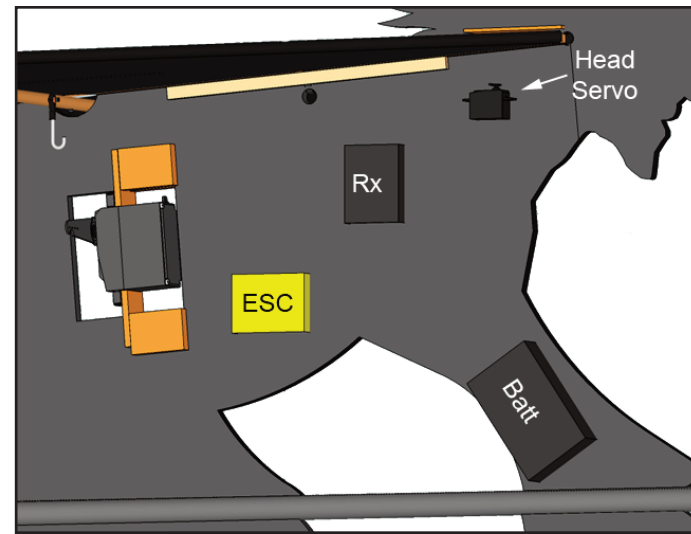
Flip over and tape the other side.

Note: When you cut off the bottom and re-attach it to the broom, it will be 1/2” lower than it was. This will cause the body lines on the bottom to no longer match the top. Do not worry about this. It is not necessary that they match nor will it be noticeable.

ATTACH THE WING



The Wing is attached to the Body using two Zip Ties (Cable Ties). Make them snug, but don't over tighten them! If you like, you can also attach the rubber bands for the Wing control. Leave the rubber bands as loose as you can without them coming off.



Now you can mount your Motor, ESC, Receiver and Battery. The locations for the ESC and Receiver above are only a suggestion, you can mount them wherever works best for you. I mounted the Rx, ESC and Battery with Velcro and added a Velcro strap around the Battery and her arm.

Once all of the wires are connected, you can secure them to the broomstick and/or the body with Cable Ties or Gorilla Tape.

Assembly is now complete!

Balancing: The Witch should balance so the Broom sits level when you pick her up by the center spar with your fingers just behind the Crossbar. If you need to add weight to balance, you can wrap solder around the broom and cover it with Gorilla Tape, or if you've used a fiberglass tube for the Broom, you could epoxy weight inside the front.

Setting the Controls: You want some serious control surface movement. As an example, when the elevator is at full UP deflection, it should just clear the bottom of the rudder. The Rudder and Head should move about the same, as should the Sail.

I fly my Witch with a Tactic TT404 2.4GHz radio, which is a very basic 4-channel radio that has no end-point adjustments or dual rates - The Witch doesn't need them!

Flying:

The Witch is a breeze to fly. In fact, it flies even more gently than most trainers. However, due to the fact that it is difficult to orient its direction at times and that coordinated turns are often used, it should be left to the more experienced fliers.

Launching: The Witch is hand-launched. Just point her into the wind, crank up the power and toss her slightly nose up.

Flying: Due to the high lift of the Rogallo wing combined with the low Center of Gravity, the Witch is extremely stable and almost impossible to get into a bad situation with. She flies extremely well on calm days or even in a fair breeze. I have even flown her in a fairly stiff wind, but that is best left to fliers who don't mind a challenge.

Landing: To land the Witch, just keep the nose up as you lower the power and she'll settle in on her tail and flop down on the broom, and then tip over on her wingtip. If you prefer, you could have an able assistant catch her. Since the prop is in the rear, she can be easily caught by the Broomstick. The third method of landing is to do like you might want to do with a bad blind date... Ditch her in some high weeds!

All in all, I think you'll find the Witch to be as much fun to see in the air as it is to fly. Get yours ready before Halloween and you'll be the hit of the local Park!

I hope you find this project as enjoyable as I did. If you have any questions, feel free to email me at mbuzzeo@gettingairborne.com and I'll try to help out any way I can. - Mike Buzzeo