

# **EPPYak55**

## **Build Guide**

**Written by Leadfeather**

### **Introduction**

The EPPYak55 was created to fill a gap in my RC plane fleet. I wanted a plane that was an excellent indoor 3D machine like the Fancy Foam Yak55, but I needed something much more durable to get me through the learning curve of indoor 3D flying. The obvious decision was to try to recreate something similar to the Fancy Foam Yak55 but designed from the ground up to be built from EPP. With a lot of development work and with help from many others, the EPPYak55 has turned out to be a very durable, forgiving and capable flying machine.

Although it was originally designed as an EPP indoor flying machine, it has been successfully built from Depron, and Bluecor. It has also been flown successfully outdoors with only minor changes to make it fly well outdoors at higher speeds and in light winds.

Good luck with your build. For more information about this plane please visit the EPPYak55 thread on RCGroups.com; electric airplanes; scratch built forums at this link: [EPPYak55 thread](#)

The build guide below is for a “standard” build Yak. The thread linked above has more information on the many variations and alternate build techniques that have been used by others with success.



## **Suggested material, equipment and tools**

### **Material**

9mm thick, 1.3# (1.3 lb./cu. ft.) epp foam

Welders glue

Hot glue and gun

CA glue and kicker

1/16" carbon rod

1/8" carbon tube

1/32" music wire

heat shrink

Spray 77 adhesive

Poster board

### **Equipment**

Motor, 1500 kV Blue Wonder out-runner

Motor mount, Black square plastic tube mount from Hobby King

ESC (electronic speed controller), 10A Hobby King SS

Receiver, light weight 4 channel

Servos: 2 HXT500 and 1 HXT900 for a standard build

4 of HXT500 for dual aileron servo option

3 of HXT500 very light indoor build, 5 oz or less AUW

Control horns, 4 plywood type

### **Tools**

Sharpie fine point marker and/or ball point pen

Straight edges, 12" and 24" to 36"

Exacto knife with spare blades

Utility knife with sharp blade

Scissors

Soldering iron

Bic Lighter

Needle nose pliers

Screwdrivers

## **Making the templates**

The easiest way to make template ready drawings (drawings kindly prepared by Ken dz1sfb) is to print the full sheet plans at you local print shop. With the full sheet plans there is no “tiling” or joining of sheets, so it is the least work and the most certain way of getting an accurate full size drawing.

The EZ tiled drawing were made by Ken to minimize the tiling effort should you chose to print and tile at home.

To go from drawing to template is pretty easy. Just cut out the individual airframe parts; leaving a small border around the drawing; the spray them with the 3M Spray 77 adhesive and apply the drawing to the template material. By holding two far ends of the drawing, it can be held in a nice arc over the template material. This allows the drawing to be lowered onto the template material and adhered easily with no wrinkles.

There are many choices for the template base material such as:

- Poster board for easy to make templates

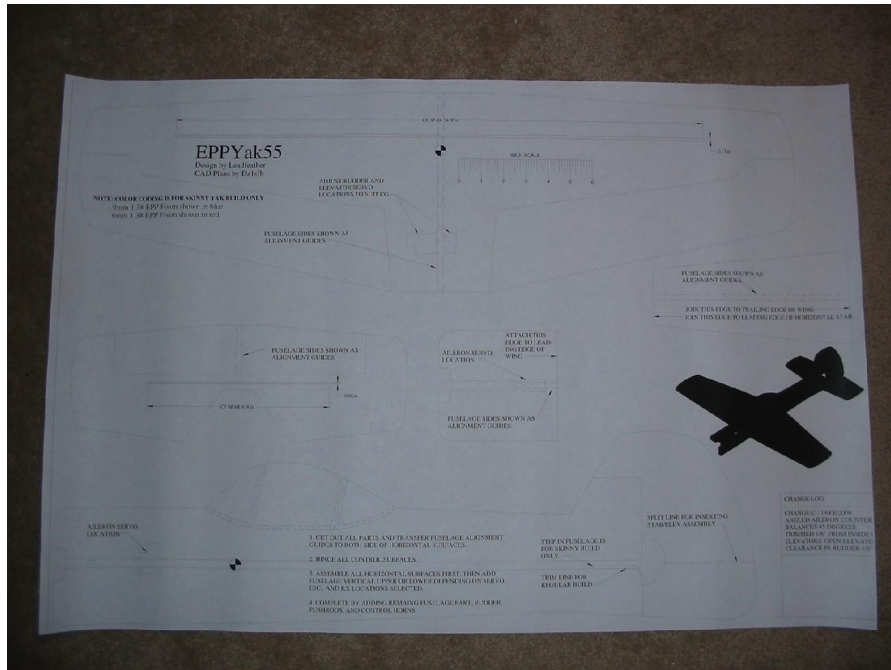
- Foam board for longer life templates

- Hard board (peg board, no holes) for hot wire capable templates

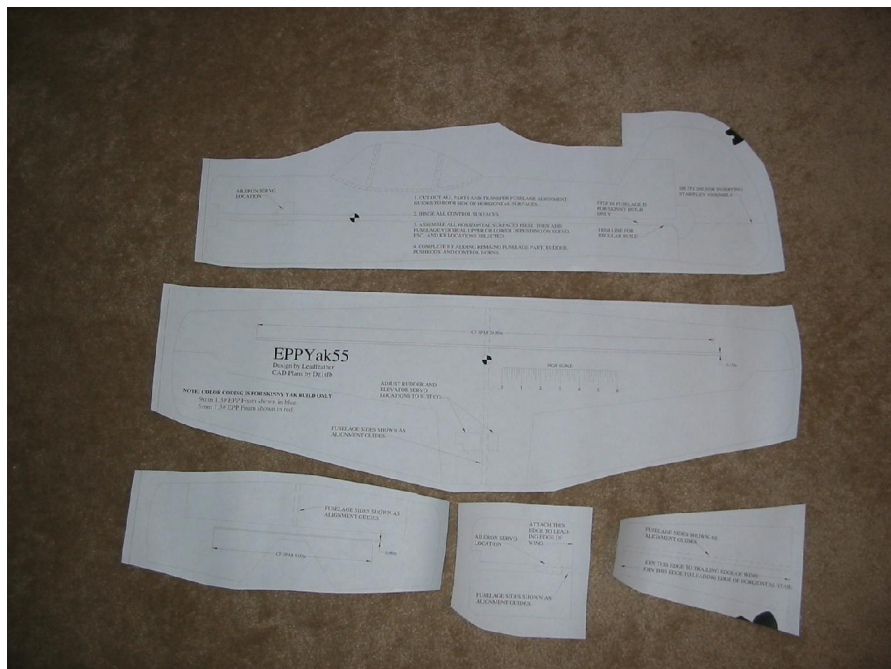
I use poster board for most of my templates. The big advantage is that after gluing the Yak drawing to the poster board you can cut the templates out with ordinary scissors. Just handle and store the templates carefully to avoid bending them and making wrinkles.

The foam board is nice for a more durable template. The advantage of the foam board is that it can be sanded to get all the curves and contours 100% accurate. It is just a little more work to cut it out and make it ready for use compared to the poster board.

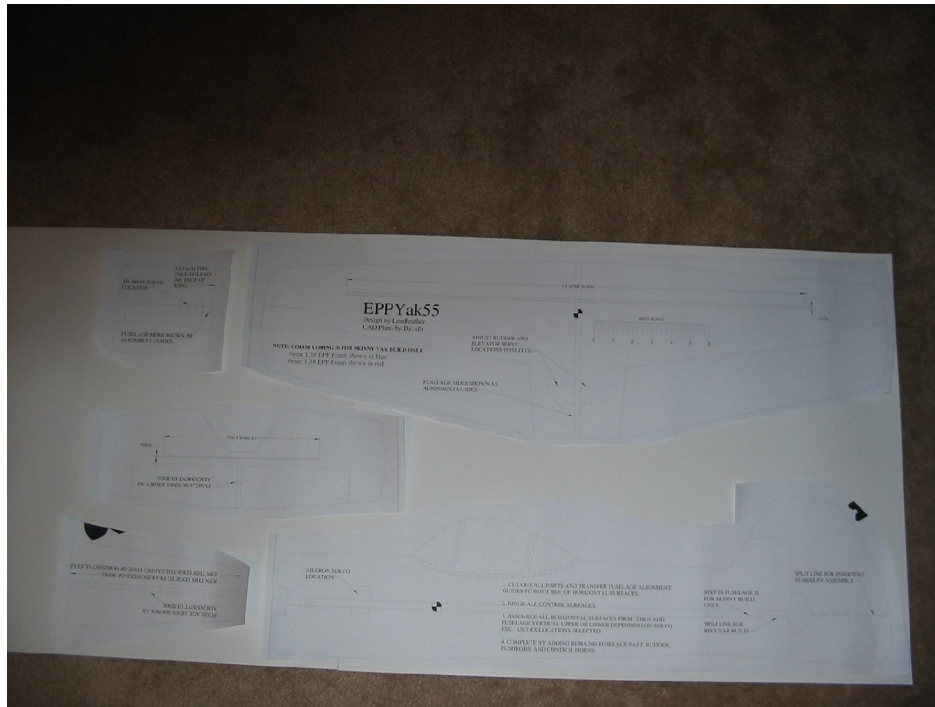
Below is a photo sequence of the templates being made.



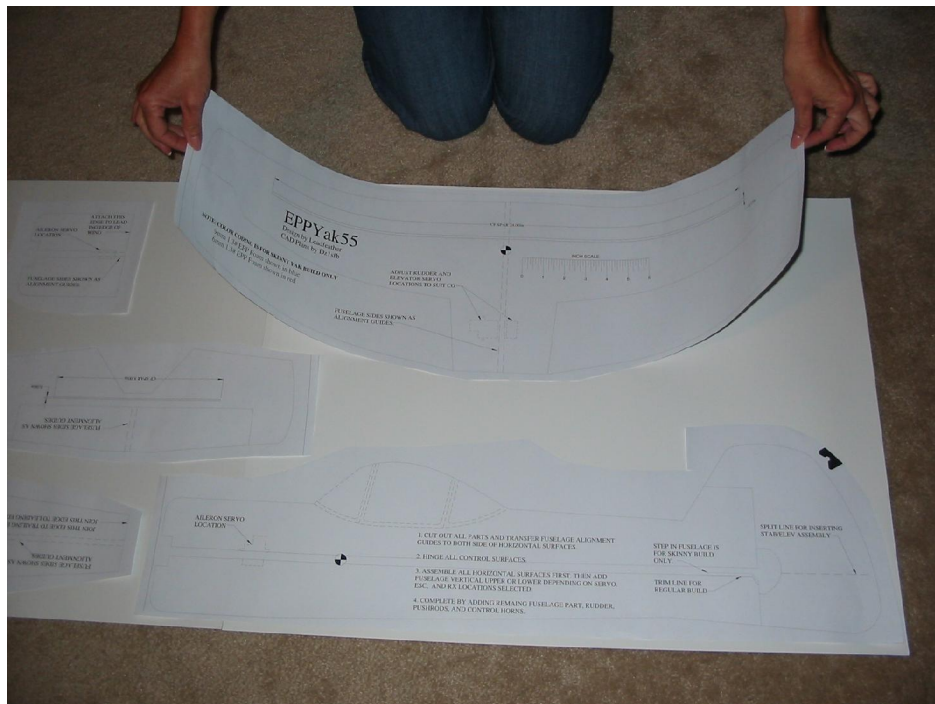
Full sheet printed



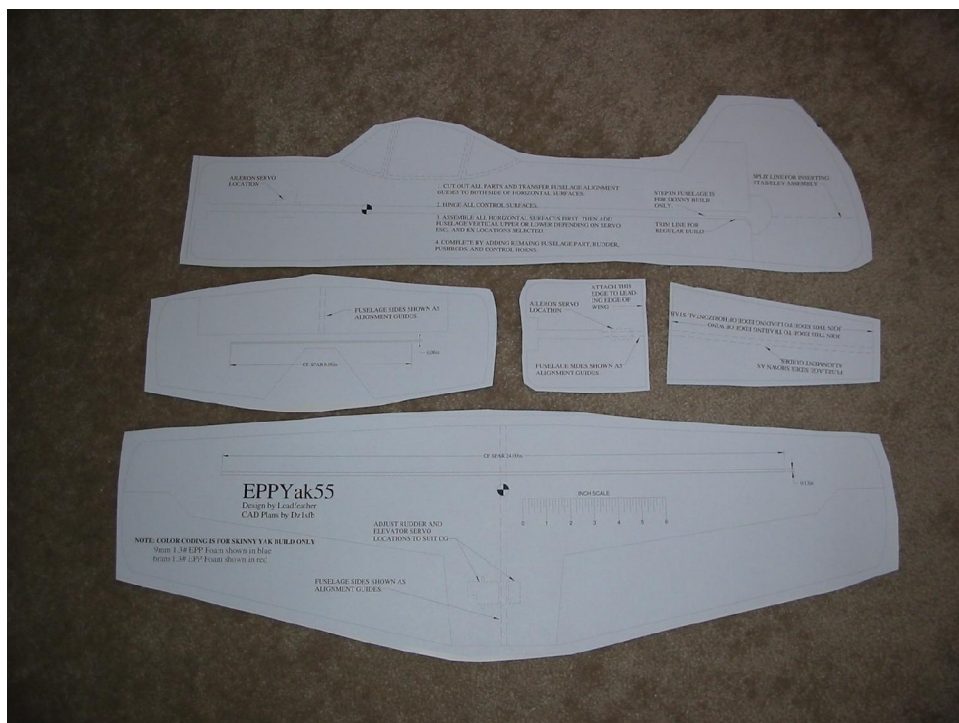
Printed plans rough cut prior to gluing.



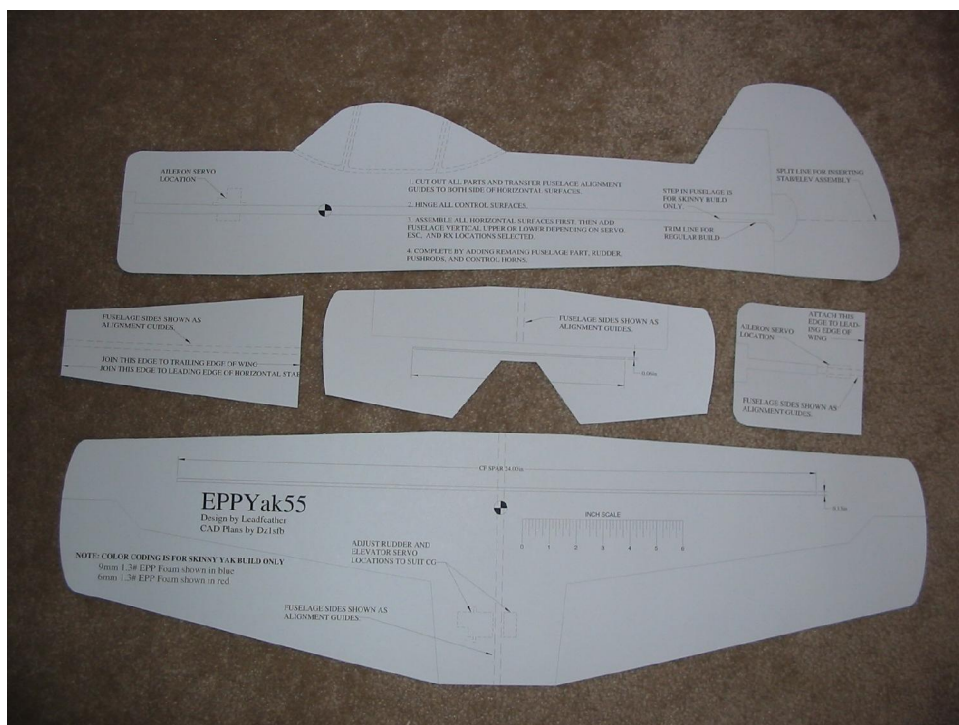
Lay out pieces on poster board prior to gluing.



Spray the back of the printed pieces with 3m Spray 77 and carefully place on poster board. Smooth down carefully working from the center out.



Rough cut the template pieces.



Finish cut the template pieces.

## Marking and cutting the foam

By carefully arranging the templates on your foam you can figure out how to minimize the waste...save that extra foam for repairs or your next airplane. Once you have all the template pieces arranged on the foam, pin them in place using T pins or straight pins. This will keep the templates from shifting as you trace them out. Below is a photo showing careful arrangement of the airframe pieces on the foam.

Next, trace out all of the pieces. I suggest a dark colored, fine sharpie or a ball point pen to trace the templates onto the foam. A fine but easy to see line will help you make accurate cuts.

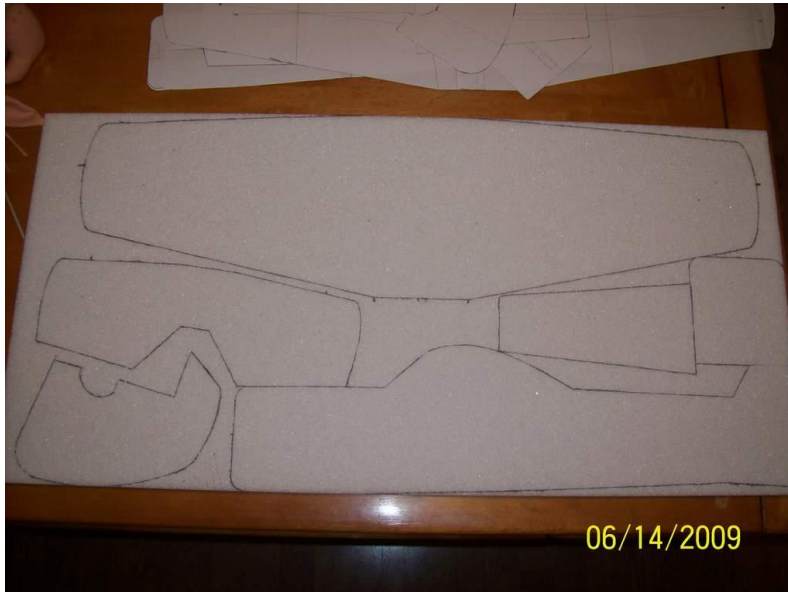
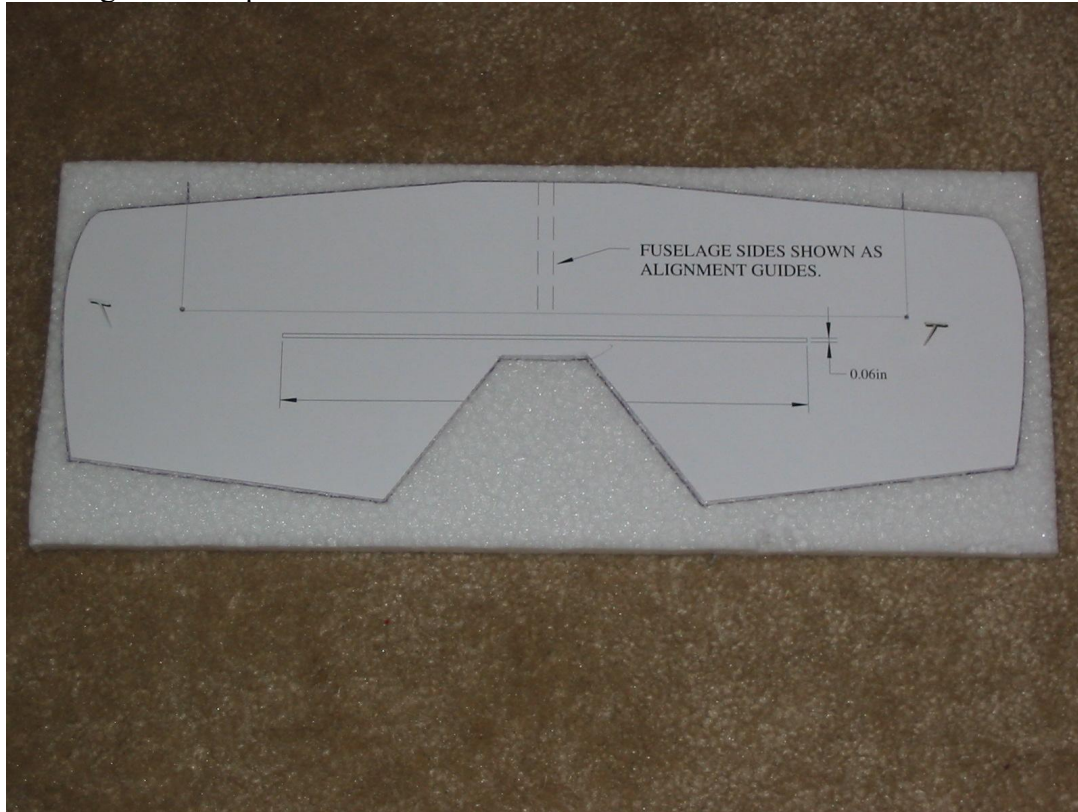
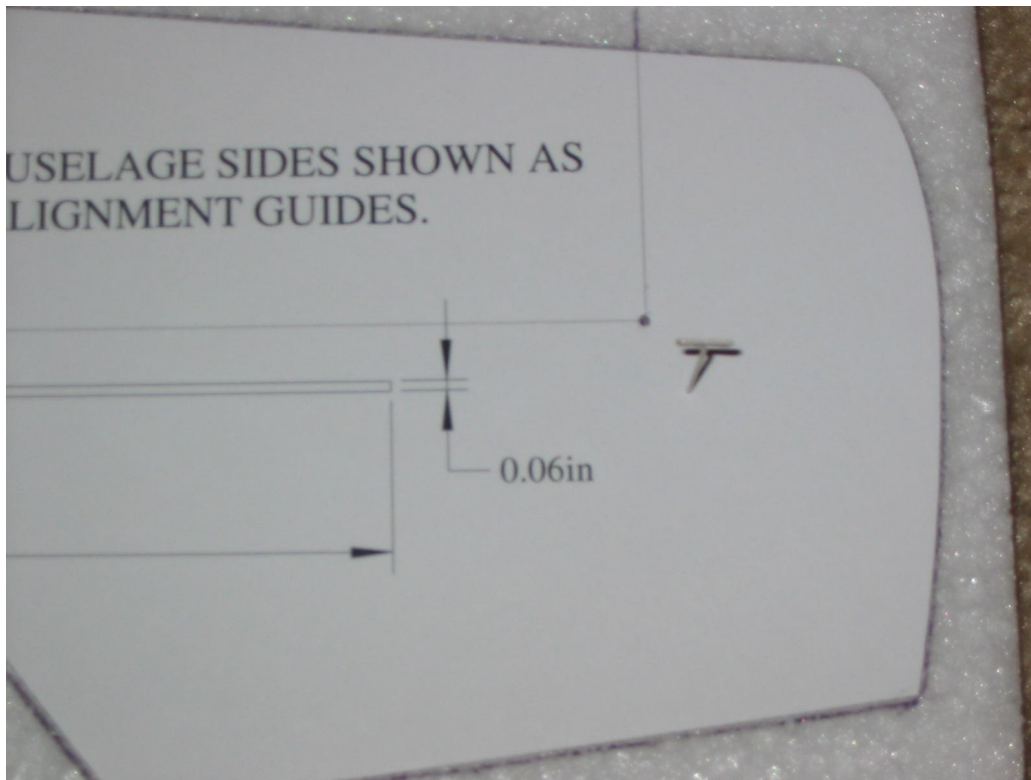


Photo by FlyingLakland showing airframe arranged with little waste.

Marking the foam photos:



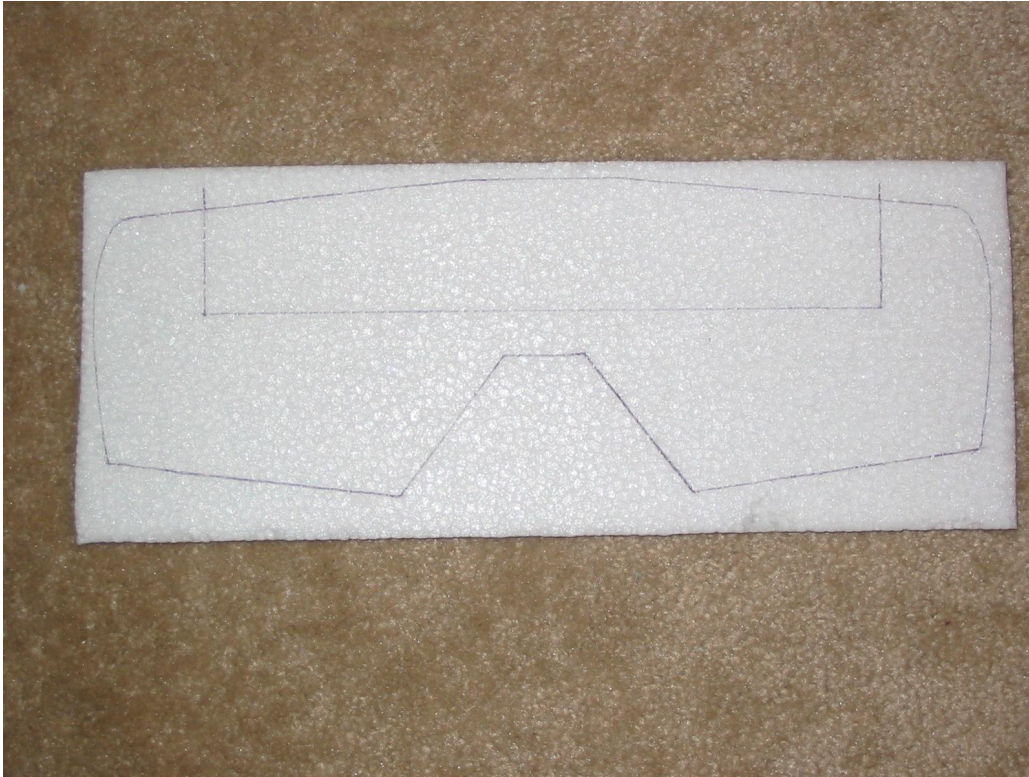
Notice T pins to hold the template in place. Also note the marks for the stab and the holes to create small marks at the back corners of the stab (horizontal stabilizer).



Close up showing small hole for marking the back corner of the stab.



Part is traced, including the marks for the stab.



Connect the marks to draw the stab. Don't forget to draw the lines for positioning the horizontal fuse, do this top and bottom.

Cutting: I usually do a rough cut to separate all of the individual pieces. This makes the individual pieces easier to handle and also prevents accidental cuts into adjacent pieces.

Next do all of the fine cutting of the airframe pieces. The most important advice for cutting EPP well is to use a very sharp knife. A sharp knife will make clean smooth cuts and will help avoid the knife from pulling and distorting the foam while cutting. A dull knife will create tears on the lower surface of the foam as you cut. If your blade starts to dull part way through cutting out the pieces either sharpen it or replace it...avoid the frustration of poor cuts.

Another tip for cutting is to use a cork backed straight edge if possible to help prevent the straight edge from slipping on the foam during cutting. Avoiding this slipping of the foam relative to the ruler during cutting is really important; especially during beveling to end up with really straight cuts.

I like to make all the long straight cuts first using a straight edge. Then I link these cuts with the free hand "curvy" cuts. For some of the really tight curves sometimes it helps to use a little bit of a sawing motion on the blade.

Sanding can fix some of those minor cutting errors. EPP can be sanded; the trick is to use very light pressure to avoid tearing the foam. With patience EPP can be sanded quite

nicely if required. If you really goofed up a cut, don't worry. Just cut out the bad area splice a new piece of EPP in place. If you do this carefully the splice will be nearly invisible, and with Welders glue, the joint will be as strong as the foam.

### **Beveling the control surfaces**

In order that the control surfaces can move properly they must be beveled. The suggested method is the single straight edge top down cut. To make a good bevel cut:

- 1) Use a sharp knife!!
- 2) Use a cork backed straight edge so that the foam doesn't slip while cutting. If the foam slips, you'll notice that the cut is curved along the length of the hinge line.
- 3) Bevel both mating sides of the foam. This allows free hinge movement for the large control surface movements used on the Yak.
- 4) If you are beveling the top surface of the wing and aileron, place the wing and the aileron right side up for the beveling cut.
- 5) Then carefully line up the straight edge with the hinge line. Hold the knife at about a 45 degree angle and then cut. The angle of the cut does not have to be perfect, but the cut must end up as a straight line along the length of the hinge.

Use the same technique on the other control surfaces.

***Practice on scrap foam until you are confident in your technique before beveling the airframe parts. Save your good scrap bevel cuts to practice the hinge.***

I prefer to hinge the top surface of the wing and stab and the left side of the rudder. Hinging the bottom is OK too. Usually the control horn goes on the same side as the hinge...hinge on top, control horn on top.

You can also hinge on top and put the control horn on the bottom. If you do you will probably need longer servo arms and possibly slightly longer control horns to clear the foam.

[Bevel cut video](#) by Motorhead

### **Hinging the control surfaces**

I highly recommend the Welders glue hinge method. This technique uses the glue itself to form the hinge. Welders glue sticks very, very well to EPP and it is flexible...perfect for a hinge. It is also very light, paint-able (paint won't flake off like it does on tape), durable and easy to repair.

Here is how I make the hinges:

- 1) Butt the aileron to the wing snugly
- 2) Apply a very small bead of Welders glue along the hinge line.
- 3) Smooth the glue down using your finger tip or a stick or piece of plastic. Make sure the bead of glue is smeared onto both halves of the hinge line.
- 4) Scrape or wipe away most of the glue. The first time you do this you will be tempted to leave too much glue on the foam and the hinge will become too stiff when the glue is dry
- 5) Pull the two mating pieces apart and fan them for one or two minutes. This greatly speeds up the drying process.
- 6) With the glue now semi dry, line up the two halves of the hinge and push them together. Welders is a contact cement. If you let it dry a lot you won't get it apart easily if you misaligned the pieces. However with a minute or two of drying, the parts will hold together pretty well but the glue is still wet enough to allow repositioning of the parts if needed.
- 7) In about 15 minutes, the parts can be handled carefully. By the time the last of the 4 hinges has been formed, the first hinge is probably dry enough for careful handling.
- 8) I do the aileron hinges first, then the elevator, then the rudder hinge
- 9) On the rudder, do not hinge the lower portion yet. This unglued hinge portion of the rudder provides a slit for assembly of the elevator into the rudder cut out.
- 10) After hinging, you will need to trim a little bit of foam from the control surfaces so they do not rub the airframe when they move. Just take off enough for clearance but not too much to create big ugly gaps.

***Practice the hinge technique on scrap foam first.***

Welders hinge video by Trouble Maker: [hinge video](#)

## **Creating channels for the embed spars**

There are several techniques for creating the spar channels in the foam. The three most common techniques are the Scratch and Peck, the Dremel tool, and the Soldering iron.

The objective of creating the spar channel is to have a snug fitting groove for the spar. The channel should be deep enough so that the spar is just barely below the surface of the foam when installed.

The Scratch and Peck technique forms the crudest channel but it doesn't require any special tools. Just make two light cuts the width of the spar; about 1/16" deep; in the foam. Then take a small screw driver and scrape or peck the foam away between the cuts. It is actually very easy and surprisingly quick to do. This technique creates lots of foam bits that can be a bit messy.

The Soldering iron technique is performed by melting the spar channel by using a soldering iron. Put a depth stop on the iron tip and then simply drag the iron along a straight edge to form the channel. Make sure the soldering iron tip is shaped properly to give a snug fitting channel for your spar. This technique creates fumes so do this technique in a well ventilated area. [Video](#) by TaSaJaRa

The Dremmel tool technique is similar to the soldering iron technique except the Dremmel tool mills the foam to create the slot. Again choose a Dremmel bit that creates a snug fitting channel. This technique creates lots of foam bits that can be a bit messy. [Video](#) by TallFlyer

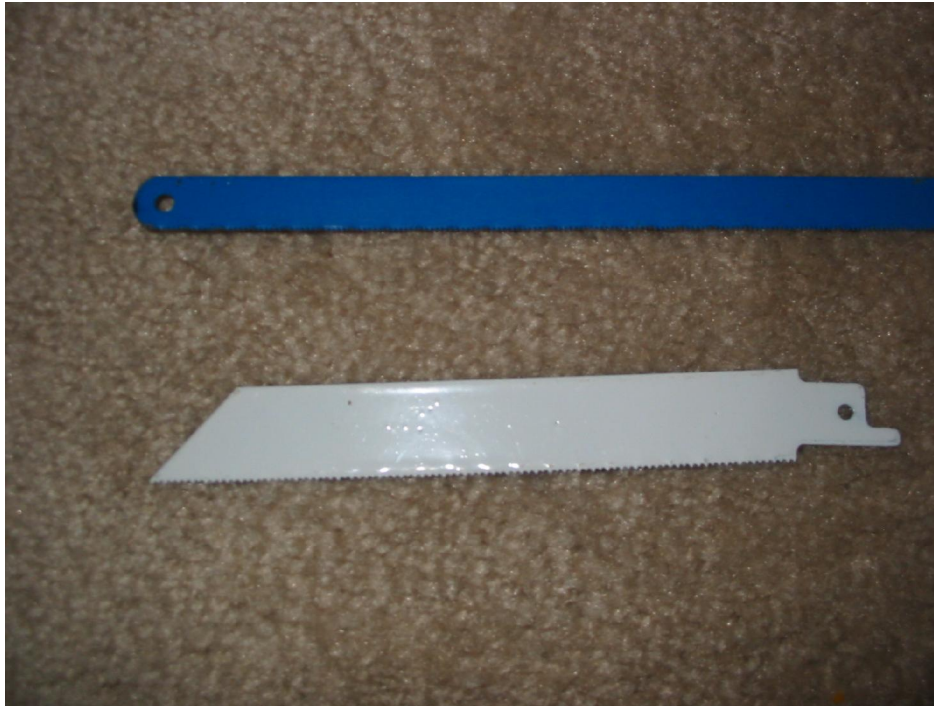
***Whichever technique you choose, practice on scraps of foam first!***

Below is a photo of the Dremel technique variation I use.



Once the channels are created glue the spars in full length using Welders glue. Do not just tack the wing spar in place as it may result in wing twist during rolls which will result in noticeably slower rolls and less roll authority.

For the rear spar you'll need a much more narrow channel. To create this channel is just use a hack saw blade or something similar and carefully drag it along the straight edge to get the slot I need. Use very light pressure and let the teeth of the blade do the work to avoid tearing the foam. If one blade doesn't make the slot wide enough, just use two together at the same time.



### **Preparing for the motor mount**

The plans are drawn for the 10mm square plastic motor mount. The plans also accommodate a recessed motor. The recessed motor is a very typical motor mount configuration for foamy planes. I think the recessing is supposed to hide the motor??

An alternative configuration that is simpler and is more durable for the foam is to not recess the motor. Just cut the slot for the plastic motor mount so that the end of the mount is slightly ahead of the nose of the plane. The motor will be in front of the foam. Looks about the same in my opinion, stronger for the foam and a little simpler to do.

Another alternative that some prefer is to recess the motor even further than shown on the plans. The benefit is that the motor is more protected, but the foam is more vulnerable. There are always tradeoffs in these design choices...you just have to decide what is good for you.

If the motor you are going to use has a firewall mount it gets even easier. Don't notch or slot the foam at the nose at all. Cut an approximately 1 1/2" disk of 1/16" thick plywood. Pre-drill the holes for the screws to hold the motor then after the airframe is assembled simply glue the plywood disk to the nose. Make sure there is no up/down or side thrust and the disk is on the centerline of the airframe.



Plywood disk simply glued to the front of the nose. Drill the holes for the motor screws before gluing the disk on!

### **Preparing for assembly check list:**

Control surfaces hinged and do not rub.

Spars imbedded in wing and elevator.

Alignment marks in place on top and bottom of horizontal nose piece, wing, horizontal fuselage piece and horizontal stabilizer.

Preparations for motor mount have been made.

### **Gluing the horizontal surfaces**

Lay a piece of wax paper on your flat building surface.

Start from the nose and glue the horizontal airframe pieces together using Welders glue.

The best way to apply the glue is to spread the glue on one piece, push this piece into the mating piece and slide around a little to ensure there is glue completely covering both

surfaces to be joined. Wipe up any excess glue that gets squeezed up. Separate the pieces for about a minute to allow excess solvent to evaporate. Re-mate the pieces carefully so that the alignment marks line up perfectly.

If you are using the square plastic tube motor mount, now is the time to glue it in place in the horizontal nose piece.

After all of the horizontal pieces are joined and you've double-checked the alignment of each piece, let the glue dry for a couple of hours at least so that you can handle the assembly without damaging the joints.

With all of the horizontal pieces joined and the fuse and rudder hinged (top of rudder only) now is the easiest time to paint and decorate your plane.

### **Painting and decorating**

I have to admit that I used to dislike painting. However I have been lucky enough to have a flying buddy that has taught me how to do a pretty good job without too much trouble. Here is the thread Adreher created for [painting foamies](#). This thread has great "how to" videos and instruction and will provide you with lots of ideas for your paint scheme.

Almost any type of paint can be used on epp. To be safe always test your paint on a scrap of foam first.

I now use an airbrush for painting my planes. Now here is something that is kind of unexpected. Epp is hard to stick things to. Most tapes will not stick well for instance. Also the cheap water based acrylic paint doesn't stick well to most surface. However the cheap acrylic paint airbrushed onto the epp sticks very, very well...go figure.

### **Gluing the rest of the airframe together**

This is where it gets fun because your work is finally taking shape.

- 1) Split the fuselage. I simply cut it down the middle; some prefer to cut the 9mm strip as shown on the plans.
- 2) Trial fit it on the horizontal surfaces and check for motor mount clearance/interference and also check that the tail surfaces move freely and the cut outs for the rudder and the elevator are adequate.
- 3) Glue the lower fuse first using the glue techniques described earlier in this guide. Make sure the fuse is straight along the alignment lines and that it is perpendicular to the horizontal surface and that the nose aligns perfectly with the nose of the horizontal surface. Allow this joint to dry thoroughly before moving on and recheck the positioning several times as it dries.

- 4) Now glue the top fuselage in place in the same manner as the lower fuse. Make all the same checks and in addition check that the lower rudder is in line with the lower vertical stabilizer.
- 5) Complete the lower rudder hinge using Welders glue

When gluing the upper and lower fuse, be sure to glue the full length. If you tack glue these pieces in place you will likely have tail twist when maneuvering.

### **Installing the electronics**

Before installing the electronics I hook up all of the servos, esc and motor to the receiver and make sure everything works well. Make sure the servos are centered, do not jitter, center well etc. If you have a bad servo now is the time to find out before you install. Make sure the motor turns in the correct direction (do not put the prop on when doing this!!).

Here is the order I suggest you install the electronics

- 1) Motor, screwed or bolted to the mount
- 2) Esc on left side, Velcro or Welders glue in place
- 3) Aileron servo(s) (hot glue or Welders) and pushrods
- 4) Receiver (Velcro in place) also on left side in a place that will reach all of the esc and servo leads.
- 5) Now position the tail servos so that the plane balances on the cg.
- 6) Battery Velcro at the cg on the right side. Prime the epp with a thin layer Welders glue so that the Velcro's adhesive will stick well to the epp. Hint; I don't prime the foam with Welders until I have the final exact position of my battery located after test flying. Once the Velcro is stuck to the foam with Welders it isn't coming off without a lot of foam stuck too it.
- 7) Fasten the radio antenna in place. Make sure it can't get sucked into the prop under any circumstance.

When using Velcro to hold parts to the plane I use this convention: The fuzzy loop side goes to the components, the stiffer hook side goes on the plane. This way your batteries will not be as likely to collect a lot of fuzz and threads and stuff when they are in your pocket, flight box etc.

### **Installing control horns**

Installing the recommended plywood control horns is pretty easy. Just cut a slit in the foam in the correct position, dry fit the horn into the slit, remove the horn and apply a little Welders glue and reinsert the horn into the slit.

The general guidelines for the horn position are:

The hole for the pushrod should be directly over the hinge line.

The horn should be in line with the direction of the pushrod and approximately perpendicular to the hinge line.

The holes for the aileron pushrods should be exactly the same height above the foam.

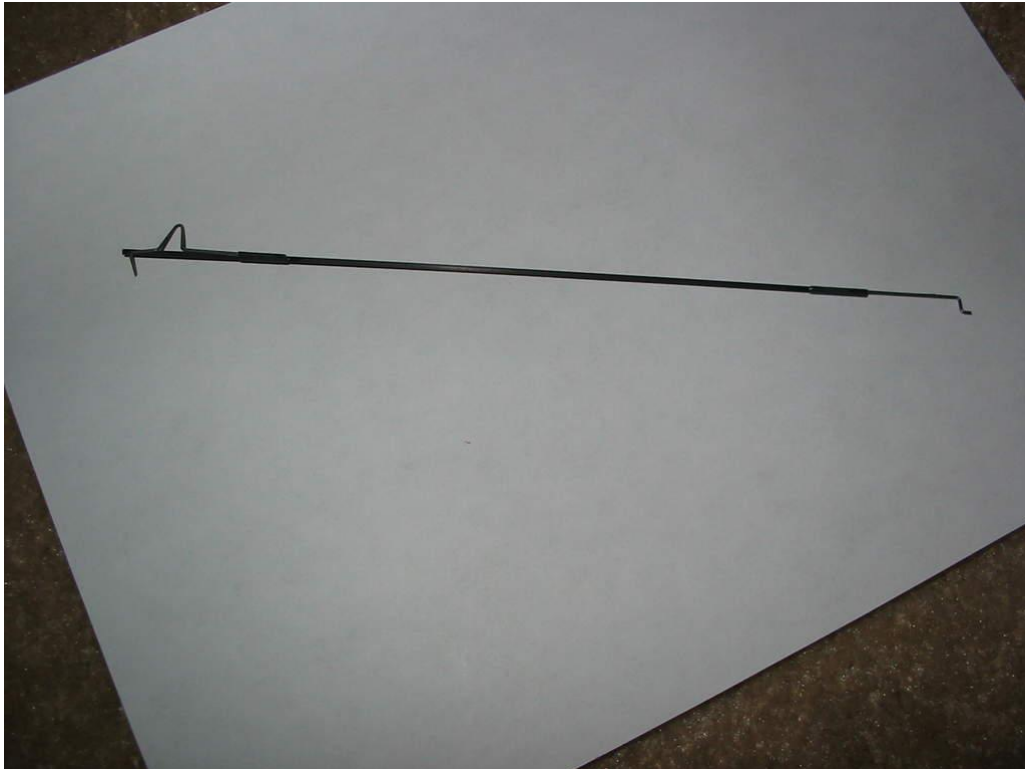
### **Making and installing control push rods**

For the standard build Yak55, 1/16" diameter carbon rods with .032" wire ends should work well for all of the pushrods.

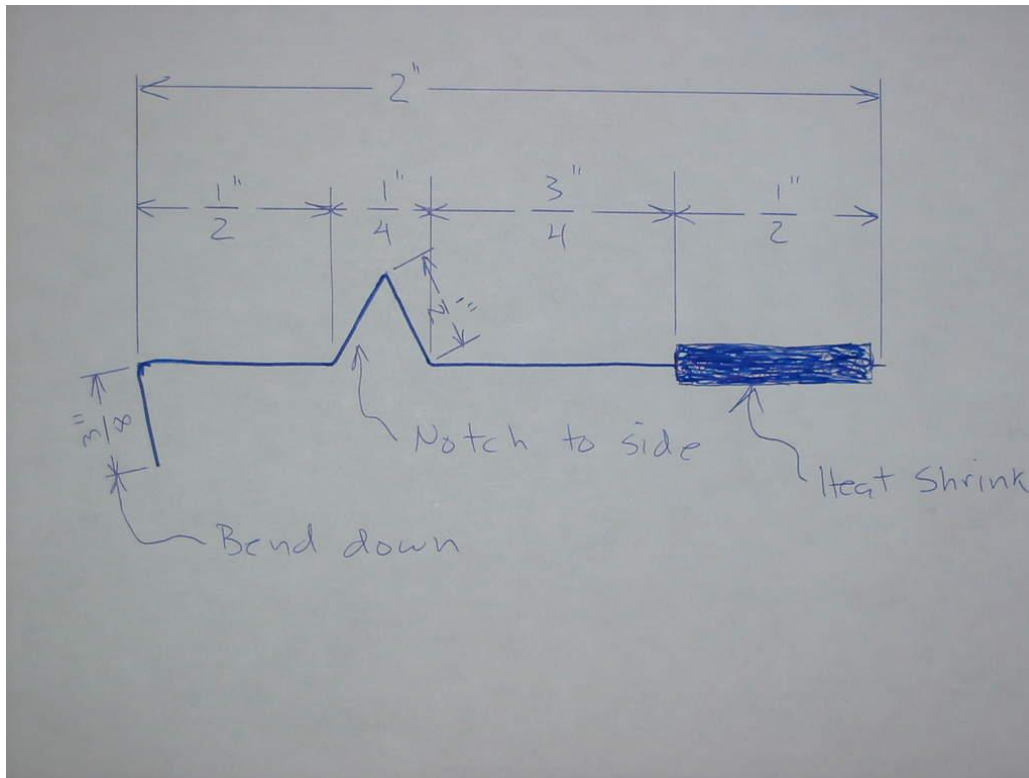
The wire ends are held in place with heat shrink. After fine-tuning the position of the wire ends on the carbon rod, add a drop of thin CA to each end of the heat shrink. The CA will wick in to the heat shrink and will make the joint of rod where heat shrink is permanent.

Below are some photos and a sketch for my suggested pushrod design. This particular design is cheap, easy to make, adjustable, and allows quick connect/disconnect and also quick servo arm adjustment.

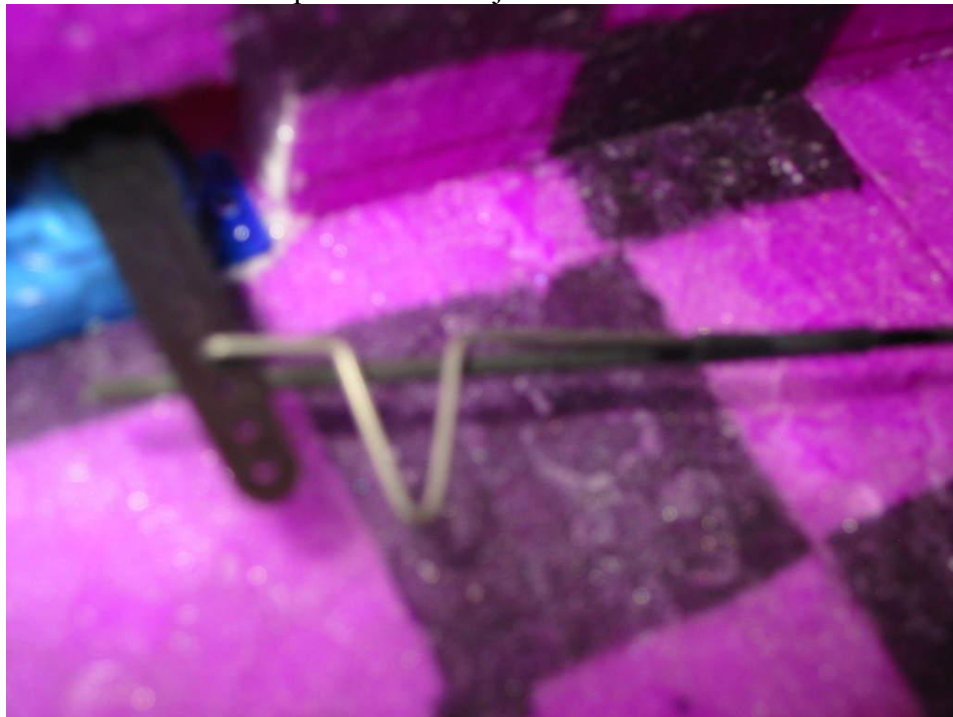
The V notch allows for independent adjustment of the aileron positions since both ailerons are operated from one servo. The V notch is not needed for the tail push rods.



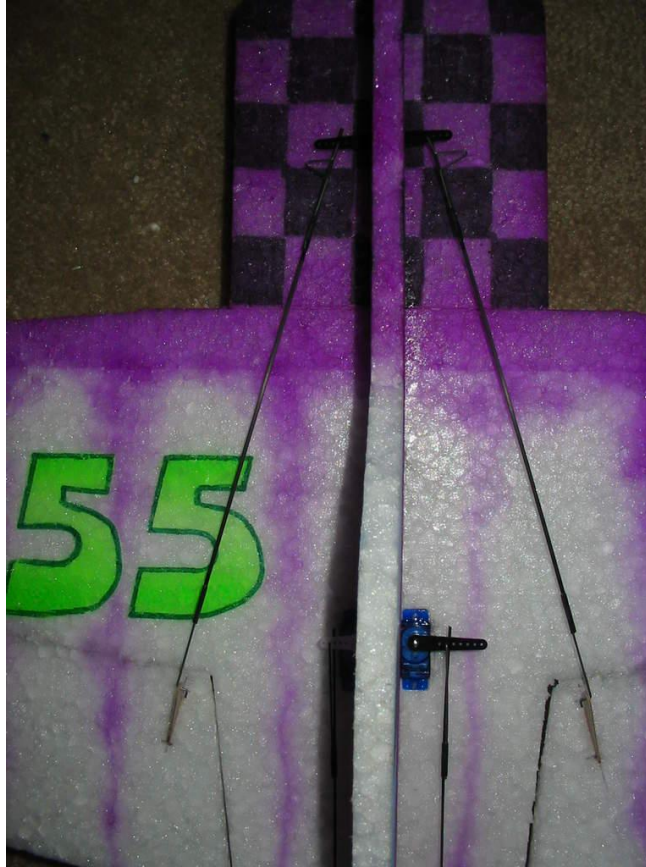
Complete pushrod. The end with the Z bend goes into the control surface control horn.



For the tail pushrods the adjustment V is not needed.



Close up of installed control rod.



Aileron pushrods installed.

[Video of push rod being installed on servo arm](#)

**Preflight Check:**

- 1) All controls move in the proper direction when you wiggle the sticks.
- 2) Motor/prop turns in the correct direction.
- 3) Cg is correct
- 4) All batteries; including transmitter; are charged.
- 5) No loose components, pushrods, servos, motor mount etc.
- 6) Range check your radio
- 7) Weather conditions are good.
- 8) Have some kind of flight plan.

**Advice For First flights (assuming you are a beginner or new to 4 channel flying)**

- 1) Outdoors, lots of space, zero or very low wind
- 2) Get ready to do all of your turns using the rudder. Only use the ailerons for trimming your turns...at least at first.

- 3) Have an experienced pilot help you if possible.
- 4) Launch into the wind, about ½ throttle with a nose high attitude.
- 5) Get it flying about 20 to 30 feet up at a modest speed. Determine if any trimming is needed. Trim as required.
- 6) Keep the plane away from trees, people, hard objects etc.
- 7) If a crash is unavoidable, cut the power.
- 8) Have some kind of flight plan. Thinking your flight out ahead of time will help you keep the plane out of trees etc.
- 9) The Yak flies with very little power. Keep the power and airspeed down at first until you get the feel for the Yak. Flying slower gives you more time to think and react as situations come up...and they almost always do.

### **Advanced maneuvers**

Check out these links:

[Bonedoc's 3D Clinic Thread](#)

[AirBorne AZ's 3D training videos](#)

And the 3D, F3P and other forums on RCGroups.

### **Variations**

Indoor vs outdoor.

If you fly primarily indoor, the aileron counterbalances are helpful at increasing roll rate at really low speed and it keeping the speed in check for indoor flying. Low speed, controlled flight is very desirable for flying indoors. Building lightweight is always a good idea but it is especially important to keep the wing loading low for indoor flying.

If you fly primarily outdoors you can eliminate the aileron counterbalances since they can create flutter at very high speeds. Also for outdoor you may want to use a 3s 360 mAh battery instead of the lighter 2s 360 mAh battery. This will give you more speed and power and make windy flying more practical. You may even choose to use a bigger battery altogether.

Patsy 2 Shoes came up with [this variation](#) to keep the counterbalances, but to reinforce it in a clever way to help prevent fluttering at high speeds.

### **Other Help**

One very handy tool on RCGroups.com is the search function. You can search for any information you need in a thread, in a particular forum or over the entire RCGroups. Click on the search button, enter the key words that describe the information your looking for and you'll be surprised at all the great info you'll come across.

Find a guru. If you are lucky enough to find an experienced builder/pilot in your area you will have a great resource that can help you avoid mistakes, prevent you from wasting time and money and a new flying buddy...it's always more fun to fly with others.

Trouble Maker started this terrific [Yak Owners Thread](#). Be sure to get on the [Map](#). Maybe it will help you find other pilots in your area.