

Building a light indoor foamy aircraft



“THE PLUG”

The statistics for this foamy airplane are:

Wing Span: 31”
Wing Area: 288 sq/in
Aircraft Flying Weight: 168grms (6.01oz)
Wing Loading: 3oz/ft
Building Material: 3mm Depron foam
Motor: Axi 2203-46.....18.4 grams.
Prop: GWS 7 X 3.5 Slow flyer.....2 grams.
Speed control: Castle Creations Phoenix 10.....6 grams.
Receiver: Castle Creations Berg Stamp 4L.....4 grams.
Servos: 3 X Dymond D47.....4.7 grams each.
Battery: Kokam 350Mah 2S1P.....22 grams.

This article has been written to assist the indoor modeler in building a light weight indoor airplane. I have seen many foamy indoor aircraft and although there are several good examples, most are built too heavy. Heavy and indoor don't go well together. There is no way to build a foamy airplane that will crash well. By the time you make it robust enough

to handle any crash, all it will do, is crash. You will have to fly it so fast that nothing short of an indoor football stadium will be big enough to fly it in. Since most indoor venues are the size of a high school basketball court, speed and weight are big concerns. You will need to be able to fly slowly and in control at all times. Light weight planes allow you to do this with ease.

The method described in this article is by no means the only way to build a light aircraft. However, it is a way that I have found to be both easy and inexpensive. Also, it is guaranteed to fly well.

I have broken it down into three sections. The first section is dedicated to selecting an airplane design, selecting equipment, cutting it out and finally, giving it your favorite paint scheme. The second section will cover the basic construction with several building tips along the way. And finally, section three is the addition of the drive system, radio gear and rigging the plane for flight. I will discuss trimming and mixing at the end of this phase as well.

The plane I have chosen to demonstrate my method is called “The Plug”. It is an F3P model. F3P is the official class of indoor competition.

Section 1:

Choosing a design

There are several good F3P designs out there. Either, talk to your local indoor club members and see what they like, or surf the net until you find one that catches your eye. There are a few things to keep in mind when you are choosing your design. The airplane should be somewhere around the 30” to 40” wingspan. The plane should be made with a maximum of 3mm foam. Anything thicker will be too heavy. Three servos is fairly standard, one on ailerons, one on rudder and one on elevator. However, there is nothing wrong with using a 4th servo, allowing you to use one per aileron. If you are planning on doing 4D flying, you will need the fourth servo for the propeller. Resist buying a servo just because it is cheap. Servo centering and torque is more important than inexpensive. Just try to buy ones that weigh less than 8 grams. Any three, four or five channel receiver designed for indoors is acceptable. Again, one that has the case removed to keep the weight down to less than 10 grams is preferable. A good Outrunner motor with a brand name speed controller is a good investment. The weight should be no more than 25 grams for the motor and 5 grams for the speed control. Some people like the brushed geared motors. That is a personal choice. However, I have found that there is a huge weight penalty for this style of motor. Batteries are one of the areas that most people over buy, consequently adding a lot of unnecessary weight to their model. Most hobby store sales staff tries to sell you what they have in stock and not what you really need. The batteries you choose should have a high “C” rating. Basically this means that your battery can pump out high amps during discharge to give your motor a lot of “oomph” without killing the battery. This is necessary to get yourself out of trouble in the gym. I guarantee that you will get yourself in trouble and power is your friend. You will not fly more than about 10 to 12 minutes indoors due to the concentration required. So a large Mah rating is not needed. Anything less than 640 Mah with three cells should be ok if the weight is less than 50 grams. I find that I have been leaning towards the lighter 2 cell high discharge packs lately. I am still getting 10 minutes of 3D flight time with these smaller, lighter

packs. Although admittedly they don't have the same power as a 3 cell pack, I can still drill the ceiling if I go to full throttle on an up line. And, they weigh only 23 grams. I must also inform you at this time, the weights I have given you for the radio gear are a maximum and a guideline only. Anywhere you can save weight is good. Note in the "statistics" section on the previous page, the weights of the equipment that I use. All this equipment was purchased at local hobby shops. None of it is a special order. I'm sure with a little research that you can find the same equipment or better for less of a weight penalty.

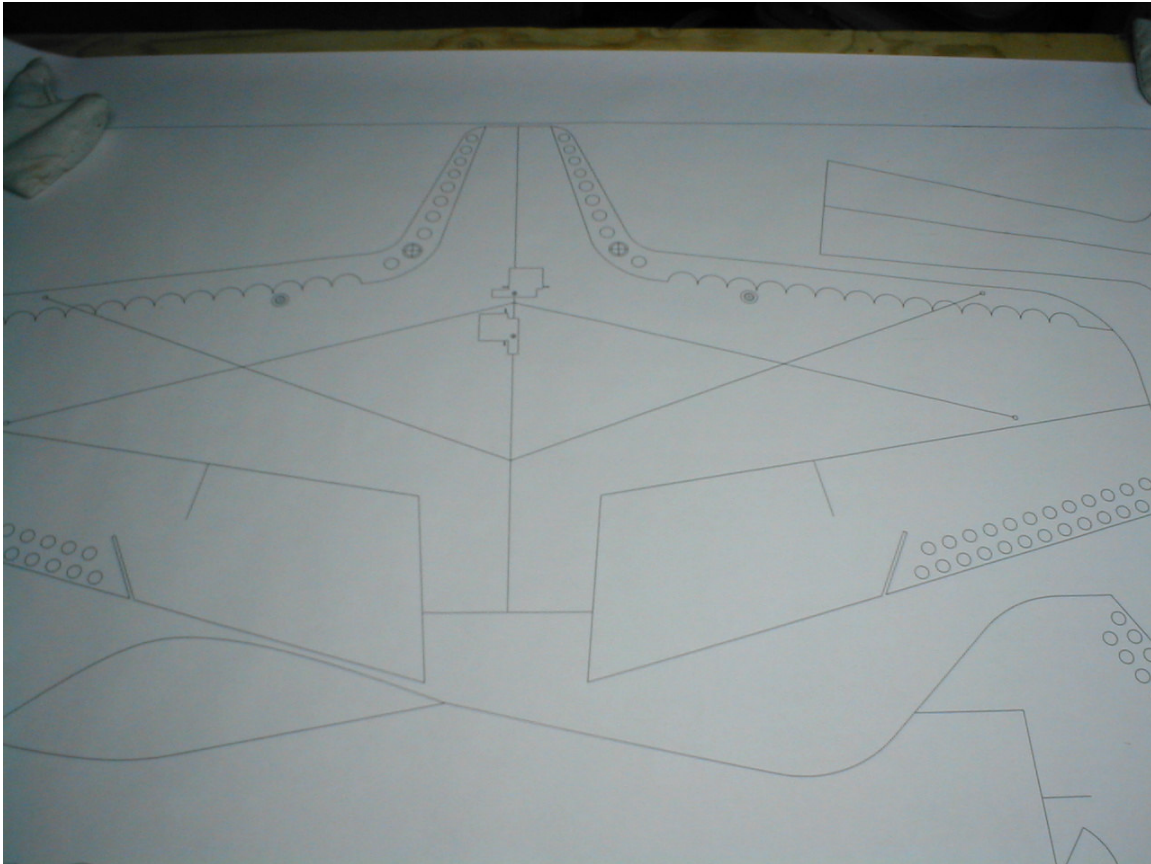
Section 2:

Construction

Buy a piece of 24" x 36" 3mm Depron foam. If your plane selection is a big one, buy two pieces. Select a set of plans. With your favorite plans you now need to get the design from the paper to the foam. You can free hand the plans onto the foam or cut up your plans and use them as templates or make wood templates. If you have a kit that is already cut out, you are a head of the game. I like to get a second copy of the plans. I then cut up the second copy to make wood templates with. I do this by spraying contact cement (3M's spray 77) on the back of the plans, then placing the plans on a sheet of 1/8th light ply. A 1/8" door skin works well too. Many people have come up with other suitable materials for the templates. They just need to be stiff and reusable. I then cut the pieces out with my scroll saw. Sand the edges smooth so the knife won't catch an edge. With a little work, you can have a set of templates in an hour or so. Now you can make many copies of your favorite plane in minutes. At this point, I simply place the templates on the foam and start cutting out the parts. The idea is to kit the plane.

Here is a tip for cutting foam. Depron foam is a very course material. X-Acto blades become dull in a very short period of time. I generally go through about five or six number eleven blades just to cut out one plane. This may sound excessive to some however, I never get tear out. When the blade becomes dull, the foam will tear or snag causing a tear out. This leaves a mangled edge that can destroy the look of your new plane. If it is a critical part, such as wing slots, tear out can destroy the part completely. Then you have to buy more foam. I get nice clean edges by simply replacing the blades as soon as I feel any kind of snag or blade catch, no matter how light. If it is an important cut, as mentioned above, I just replace the blade before I begin. I may go through over 100 blades in one season. Then again, I will build about 18+ foamies in a season. If you are proficient at sharpening blades, you will save yourself some money by reusing them over and over again. Maybe even enough to buy some more foam for another few planes.

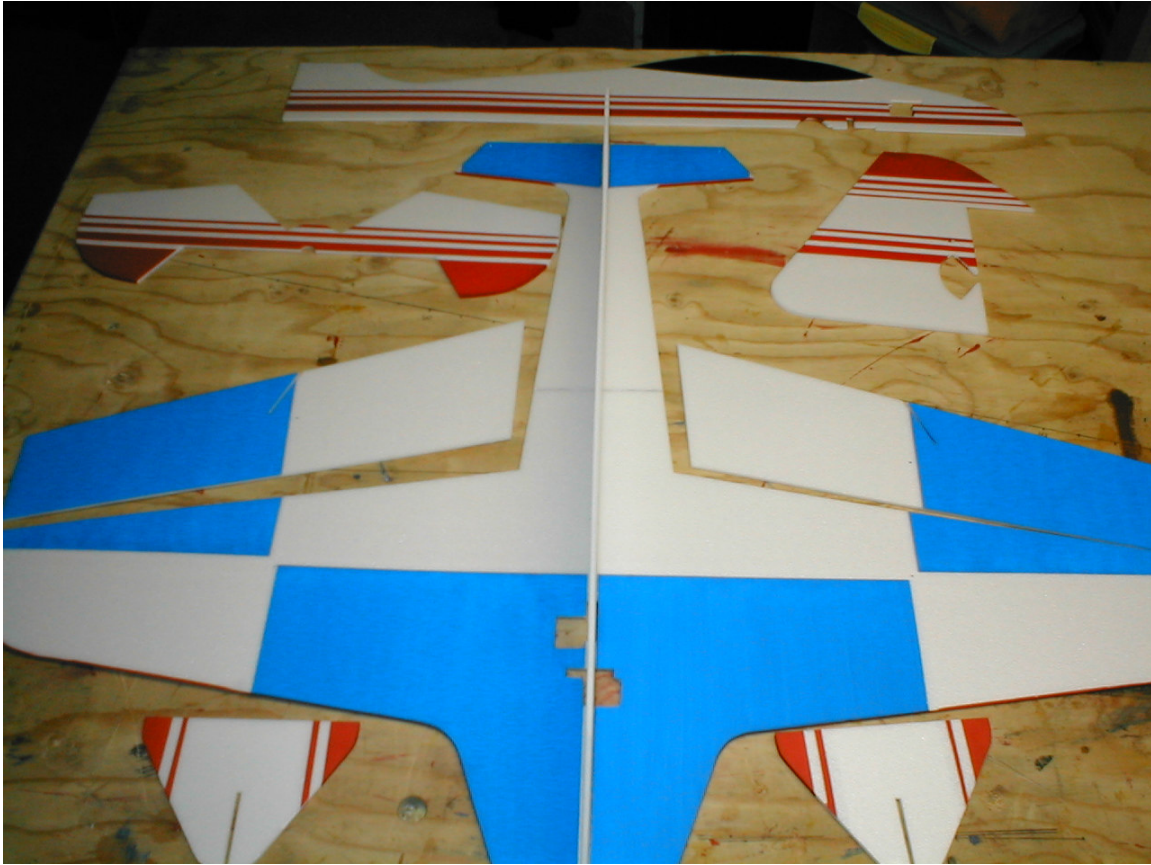
Here is a copy of the plans for “The Plug”.



Now it is time to start kitting “The Plug”. Cut out all the pieces and get them ready for paint. Using painter’s tape, layout your paint design on the foam pieces. Try to keep it simple at first. If you make your plane too pretty, you won’t want to crash it. The idea of foamy flying is to make inexpensive planes that are cheap and easy to **replace**. That way you won’t feel bad if you have a mishap. And, you **will** have a mishap. Have you ever noticed how well you can fly a simulator? Without the fear of crashing, ones mind is clear to concentrate on the maneuver, not the crash. So make your first few paint designs simple, keeping in mind that they are disposable planes. This way your learning curve will be incredibly steep. Plus, your flying will become much more enjoyable. You will notice the paint design that I have chosen is very simple and quick to do. I paint the foam with an inexpensive acrylic paint that I purchase from Michael’s art supplies. I apply it with cheap foam brushes. The paint sells for about \$2 for 8fl.oz bottle.

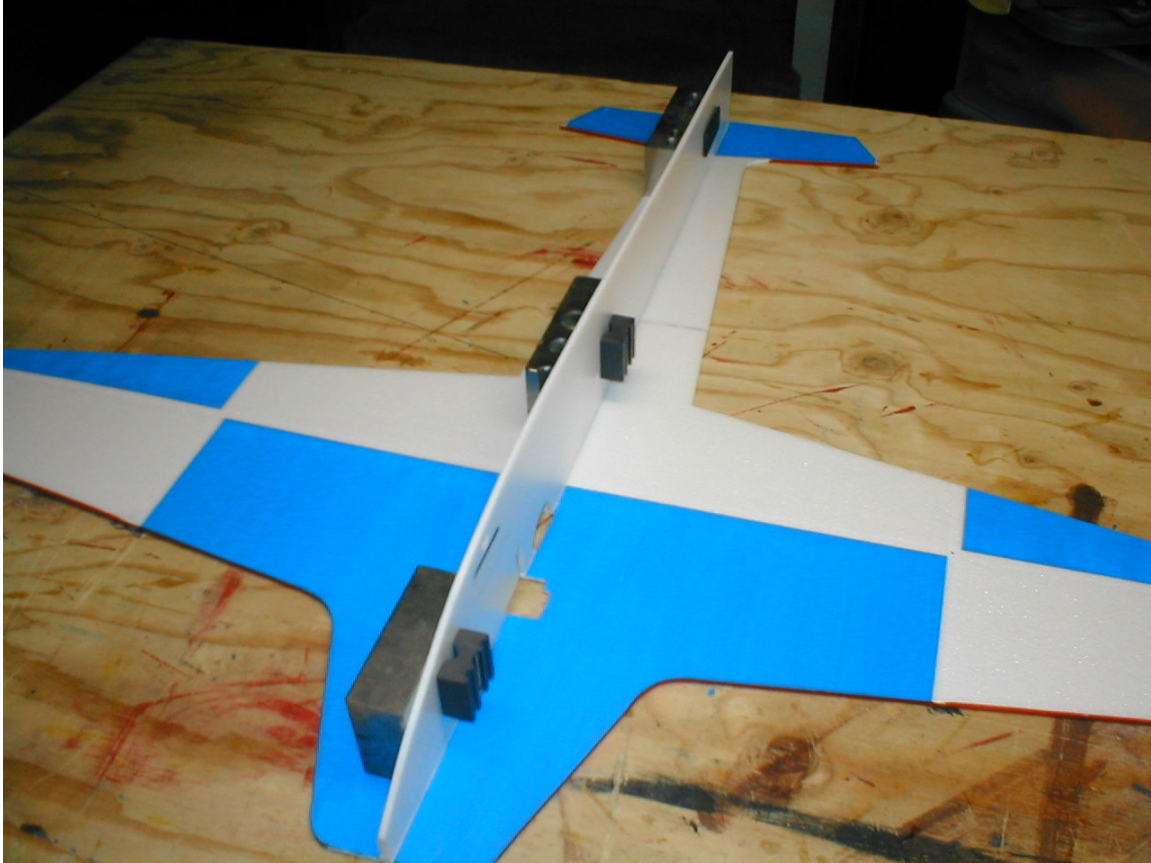
That is enough paint for many planes. The brushes run around \$0.65 a piece. If you buy the brushes in a multi pack, they will be even cheaper yet. I use about four different colors on most of my planes. Tip: Brush your paint from the tape to the foam in a very light coat for the first coat. Give this layer time to dry. That is about 30 minutes without heat. If you have a heat gun, you can dry this layer in about 3 minutes. Just be careful not to melt your foam. Apply just enough heat on a low setting to dry the paint, not heat the

foam. Foam will warp and become brittle with excess heat. The next coat of paint will usually be enough to get a nice even coat. Let this layer dry and peel off the tape carefully. If you have done it right, you will have very sharp paint lines. The key is the light first coat.



This stage took me about 2.5 hours to do. That includes painting both sides.

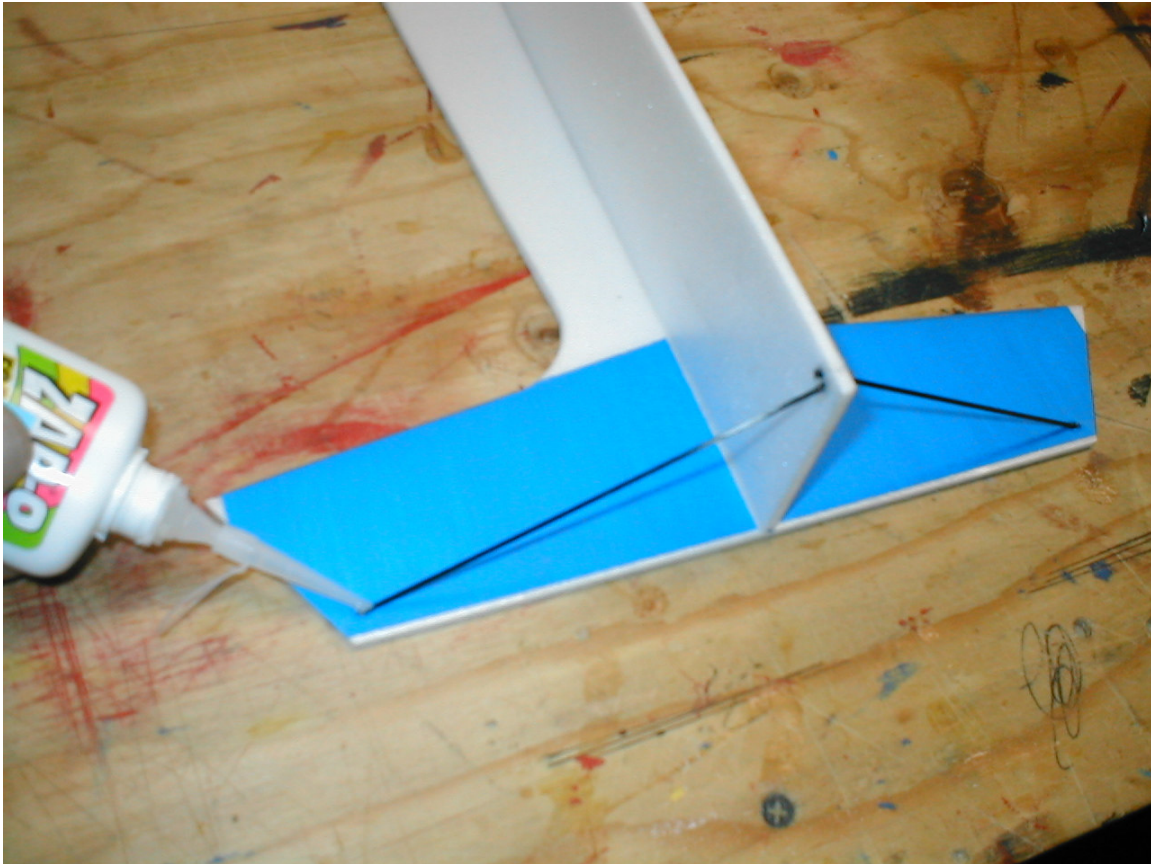
Next, I start to assemble the plane by placing the wing, fuselage and horizontal stab on a flat table with the bottom side facing up. I place the bottom former along the center line of the bottom wing and support it with a few steel blocks. Magnets help hold the foam formers to the steel blocks 90 degrees to the wing.



When I'm satisfied that the former is straight and in the correct spot, I glue it in place with foam safe CA. Foam safe CA requires a foam safe "kicker" to cure it. It will not harden without it. On some of my earlier planes, I didn't use kicker and found after a crash that some of the pieces came off without any damage. The glue was still wet. Some of those airplanes had been built weeks earlier.



Make sure your alignment is correct. Mistakes here cannot be fixed later. Be careful with the amount of glue that you use. It is easy to start adding too much glue here. You don't need to make a fillet. CA has the ability to wick itself under the two pieces of foam. Only add glue to one side. However, spray kicker on both sides to help cure it from two sides. Tip: Keep a paper towel near by to wipe up the excess kicker or glue. Don't let the kicker sit on the foam for more than a minute or two. It can destroy paint and leave stains if left for a long time. Also, leftover kicker can cause your next application of CA to kick off before you are ready for it. Note, even foam safe glue will melt the foam if it is in a sufficient amount when hit with kicker.

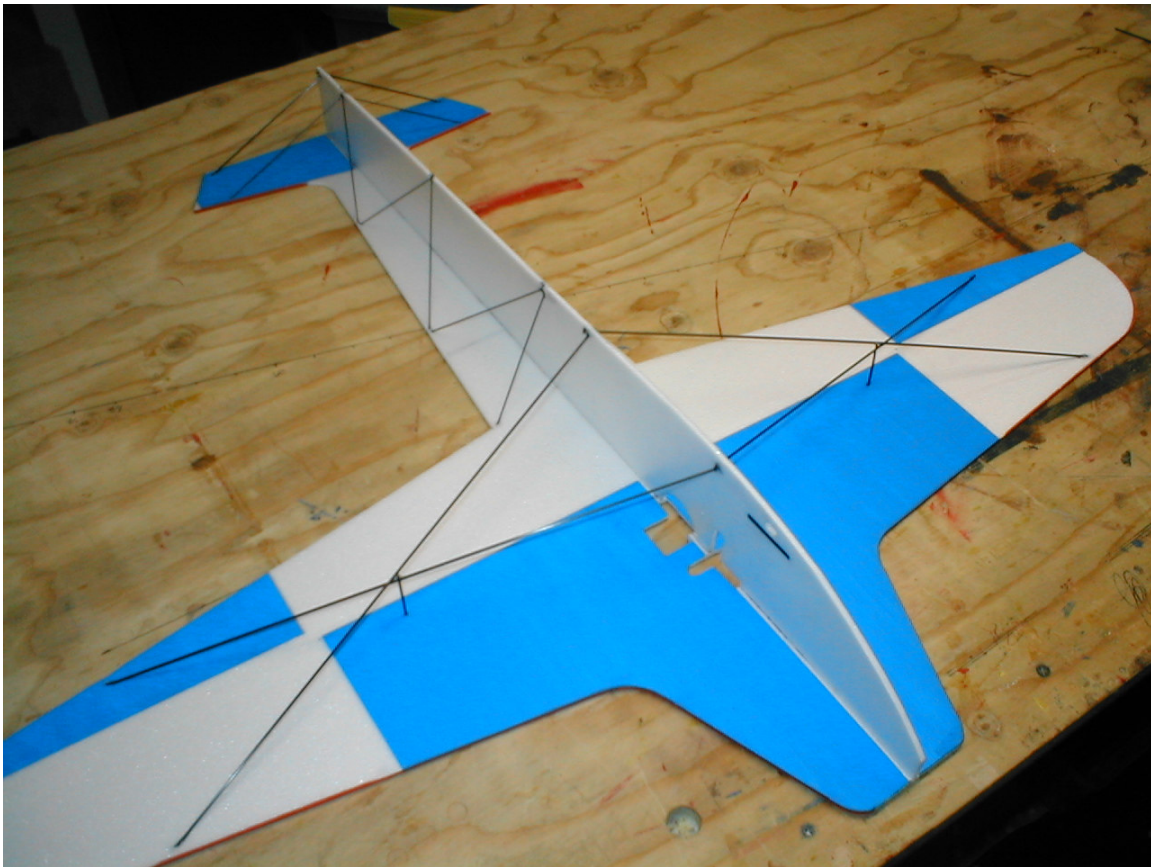


Next, I start adding the carbon fiber stiffeners. I like to use 1mm, 1.5mm, 2mm and 3mm carbon fiber rods in building my planes. Most decent hobby stores carry a good selection of carbon rods. I start at the horizontal stab and work forward using 1mm thick rods. You are effectively creating a truss work frame. I start by sharpening one end of a scrap piece of carbon fiber rod of the same diameter as the one I'm going to use. The sharpened end is used to poke holes in the foam where the trusses go. Add a small amount of CA to the carbon fiber rod and then insert it into the pre-punched hole. If you need to add more glue to create a very small fillet, do this sparingly. Use kicker when you are satisfied the rod is in the correct spot. Keep the vertical former in the vertical position. It is easy to force the former out of position without even trying. Keep moving forward about 4 inches at a time. Also, remember to keep the wing flat on the table. I have several lead shot filled bags that I place on the wings to hold them down.



It is surprising how stiff the structure becomes with just this much truss work completed. Tip: Use a cutting disk on your Dremel tool to cut the carbon rods. I started out by using a razor saw. After destroying several blades on the carbon rods, I quit doing that. Carbon is very tough stuff. The Dremel is faster anyways.

Next, I start to put on the wing struts. For this I use a 1.5mm rod. The rods should reach out to about $\frac{5}{6}$ th of the wing. I then put a dab of CA at the cross section to further stiffen the structure. Some times I will add a small vertical piece at this junction for added support. Just CA it in place when you CA the cross junction.



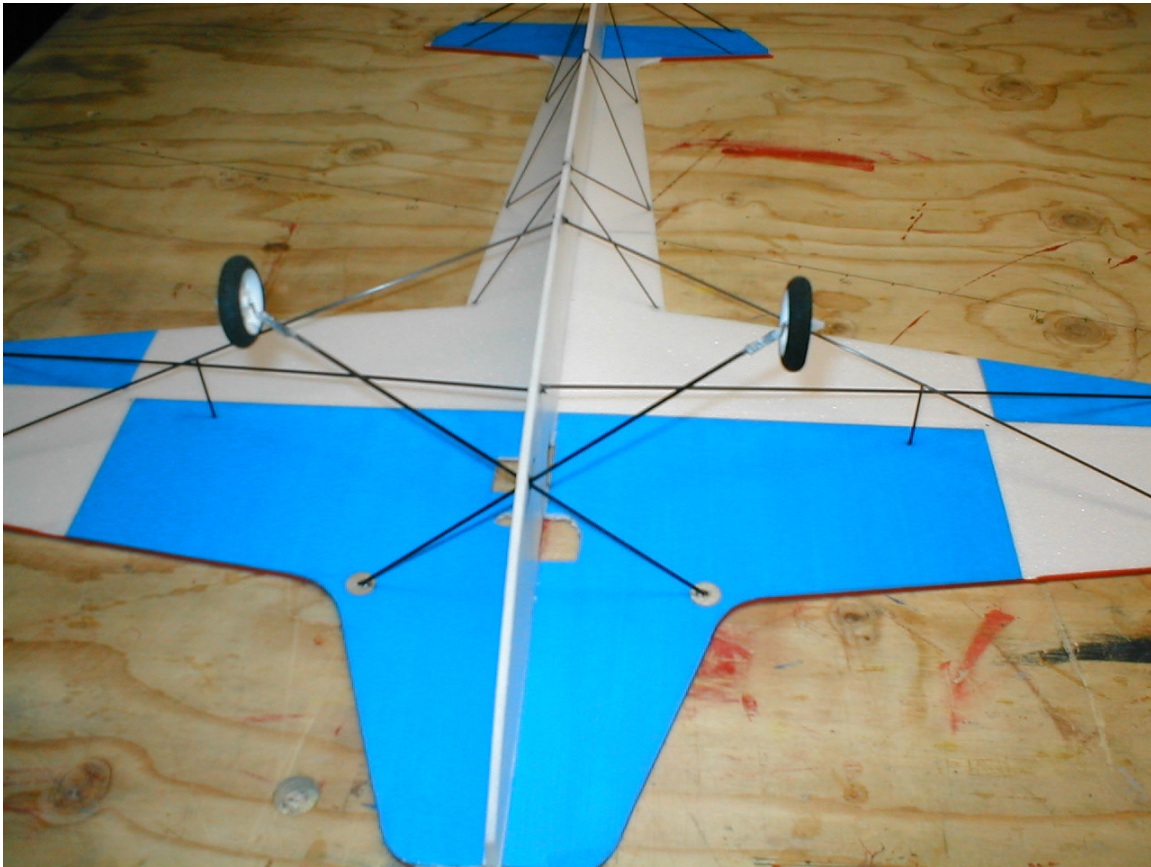
Note the 3mm thick 1-1/2" long hollow carbon fiber tube were the landing gear will go just above the servo cutouts. This tube is placed were the landing gear will rest against the former. It will provide lots of support for most hard landings. It also provides a good gluing surface. Carbon fiber glues well to itself with thin CA. Don't forget to use kicker. Remember to keep the glue joint to a minimum for weight.

Next, find the marks on the wing were the 1/64th plywood landing gear support disks will go. These disks are added to provide a strong gluing surface for the gear ends. Consult your plans for their location. If the plans don't show this style of landing gear and you would like to use it, place the disks about 3" out from the vertical bottom former. See next picture. The landing gear is done in a "X" fashion. This is one of the strongest ways of putting landing gear in a foamy plane. It not only helps support the bottom former, but, it allows the gear to support itself.



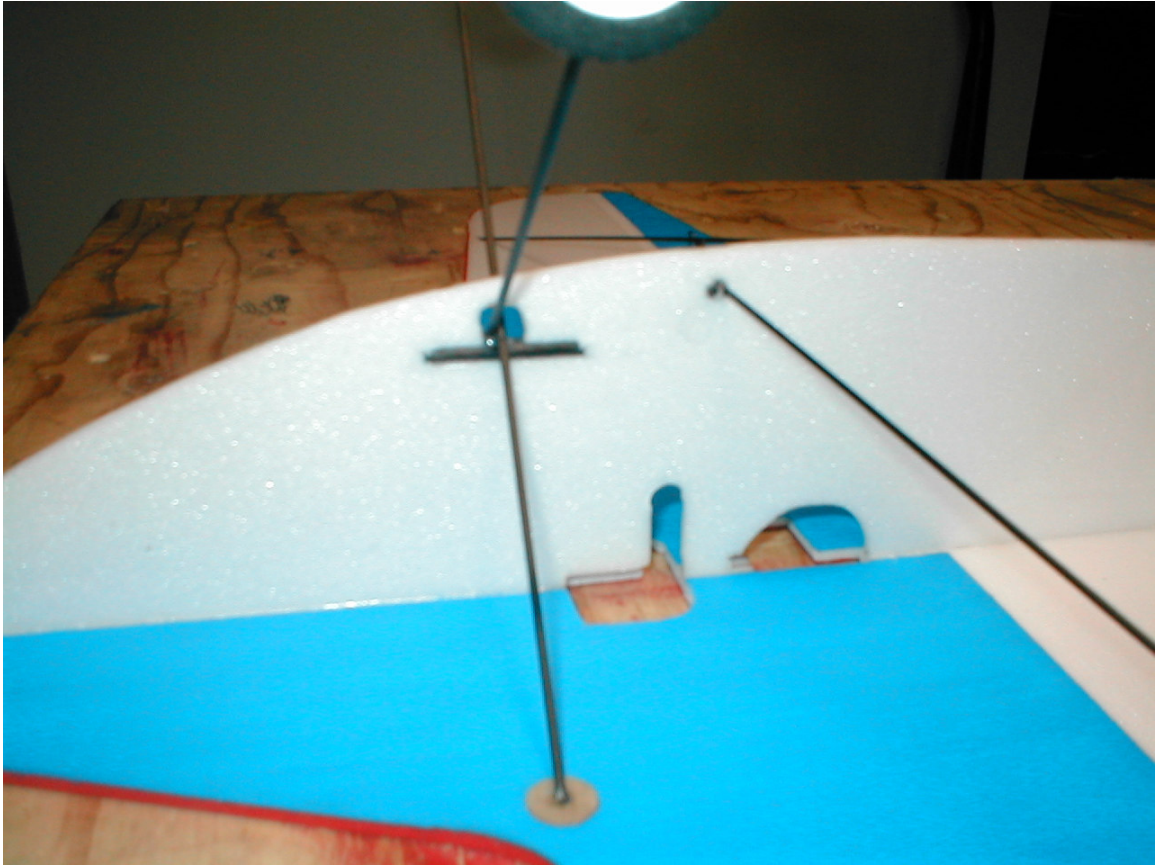
At this point, I start assembling the landing gear. I use 2mm carbon rod for the gear. The gear legs tend to run around 8 inches in length not including the wheels. This allows plenty of height for prop clearance and gives the plane a nice stance for easy takeoffs. I glue a small length of pre bent 1/32" thick wire to the end of the rod to mount the wheel onto. I do this by wrapping dental floss around the carbon rod and wire. Add some thin CA (Not foam safe CA) to the dental floss and you have a strong and light joint. Hit with kicker to cure it. Next, slide on the wheels and hold them in place with either a plastic cap or a piece of heat shrink tubing. Thin CA the heat shrink tubing in place as well. Be careful not to CA your wheel to the shaft.



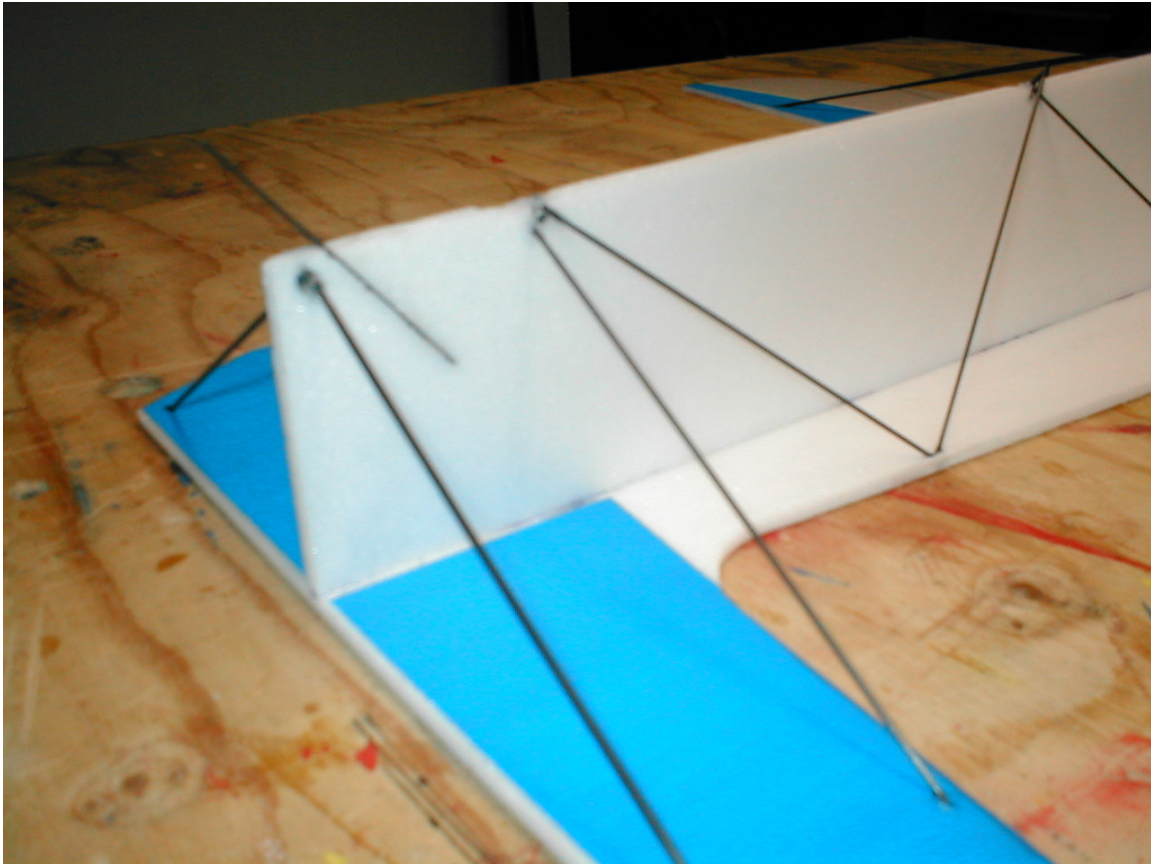


Insert the gear rods through the vertical former. Put a dab of CA on the end of the carbon rod for the landing gear and poke it into the 1/64th plywood stiffener. Make sure you align the wheel with the long axis of the plane for straight ground tracking. Hit this joint with kicker. Repeat with the other gear leg. Make sure that both gear legs meet exactly at the center of the vertical former while resting against the carbon tube in this former. When you are satisfied that the gear is aligned correctly, apply CA glue. Your plane now has landing gear.

Tip: Landing gear is another area that people tend to over build. Due to the light weight of the aircraft, a heavy robust gear is not needed. Do not use a steel rod here. Carbon fiber rod is the way to go. I am constantly amazed at how much abuse a thin carbon fiber landing gear rod can handle without snapping in two pieces. I have mushed my plane in from eight feet up and only dislodged the gear from the foam. No breakage of the rod. A few drops of CA and I was back in the air in less than two minutes. If you can't use carbon rod, maybe consider not using gear at all. This is fairly common for indoor flying.



Here is a side shot of the gear. You can see how the gear legs cross at the carbon stiffener in the fuselage. Also, note the 1/64th ply 1/2 inch diameter discs supporting the carbon rod in the wing. I have done this style of gear in all my planes for the last 3 years. It works great.



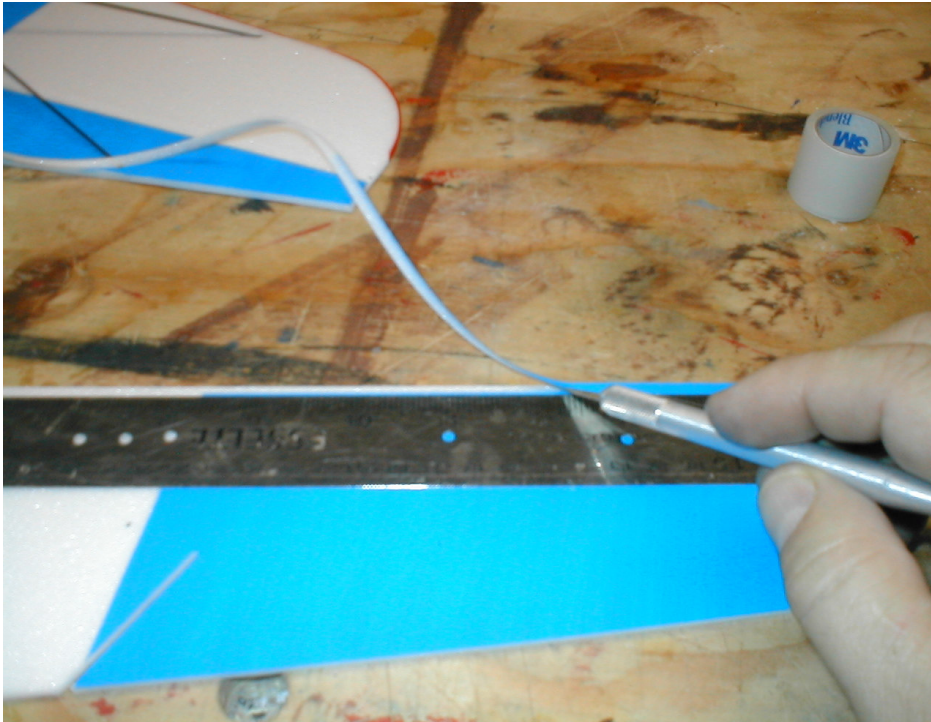
To support the tail of the plane, so the rudder doesn't drag on the ground, I insert a small piece of flat .5mm x 3mm x 7mm carbon rod at about a 30 degree angle near the rudder post.

The picture isn't the greatest; however, you can make it out above the horizontal stab supports. I slit the foam with a #11 X-Acto blade and insert the carbon rod. I glue it in with CA and hit it with some kicker. Even though there is no tail wheel, I have no problem steering the plane on the ground. It's cheap, simple, light and quick.

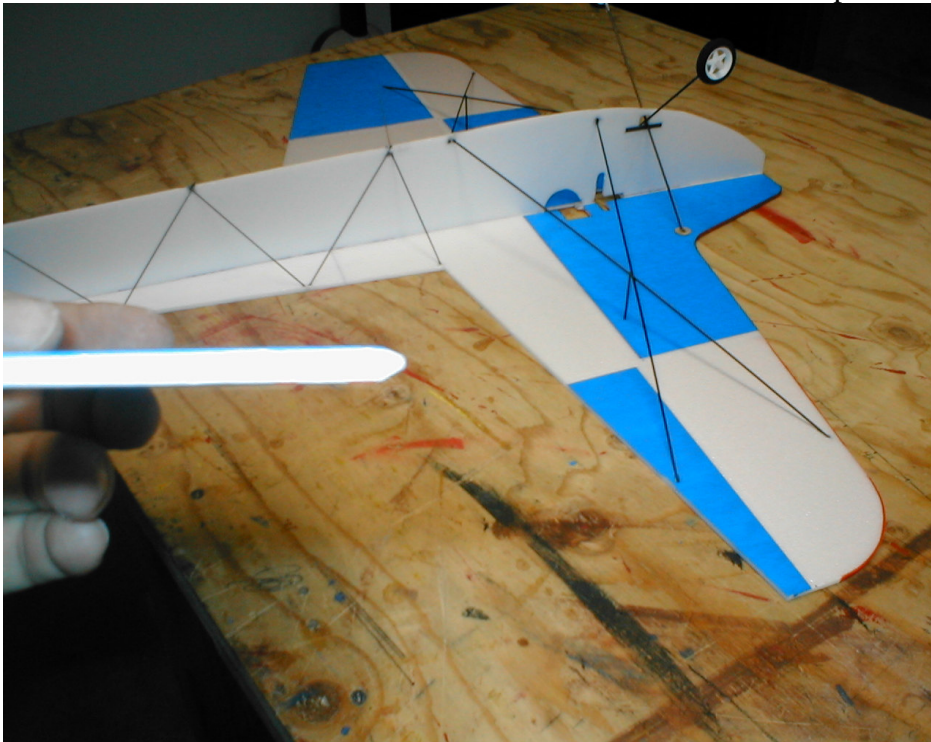
At this point the plane is ready for some ailerons and an elevator. The rudder will be added later. The top former has to be in place before the rudder can go on.

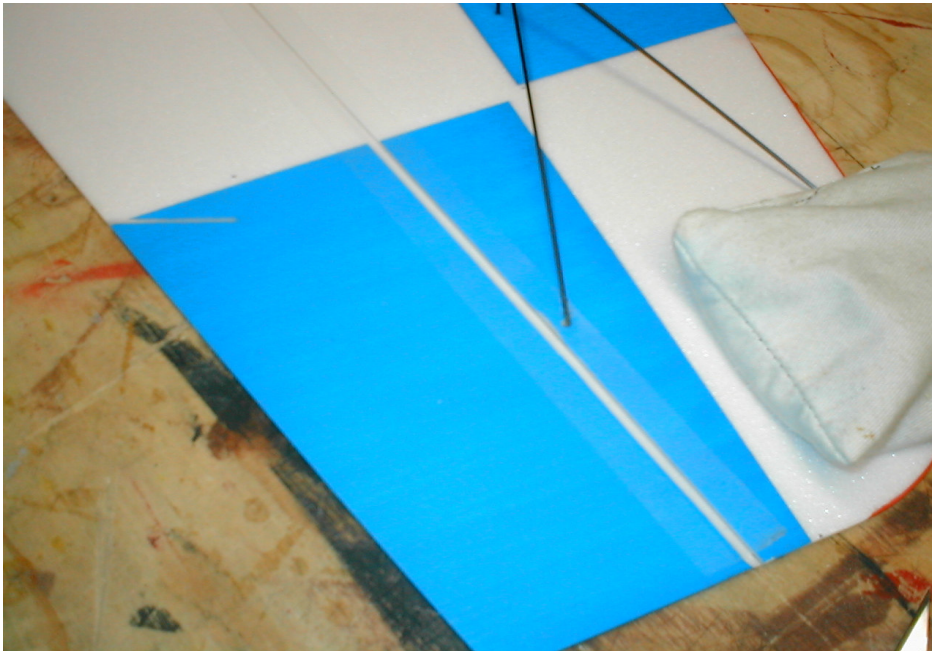
I still use tape hinges. My local drug store will order me a small case of Blenderm medical tape for about \$2.00 a roll. There are 12 rolls in a case. That keeps me in tape for a least one season. Make sure it is the non-perforated stuff. The perforated stuff may be good for allowing yours cuts to get some air, but, the holes make the tape easy to tear. I have not had a tape hinge failure to date. I put tape on both the top and bottom of the control surface. Just try to make the joints free enough to get at least 55 degrees of throw without binding. If you have to remove a piece of tape to reset the control surface, go

ahead. This is better than having a stiff or binding control surface. Note: Removing the tape will often remove your nice paint job. Don't be afraid to pull out your paint and touch it up.



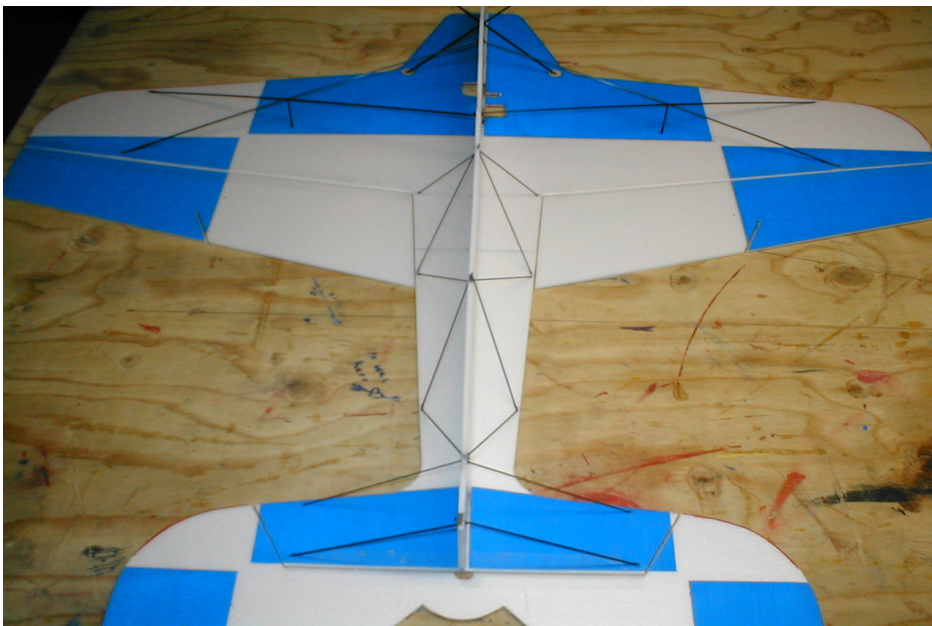
Start the hinging by cutting a 55 degree angle in the leading edge of the control surface. Do this to both sides. Make sure the bevel is even between the top and bottom surfaces.





This is what the hinge line should look like when you are finished. Note that there is no gap between the wing and the aileron. The tape is pressed down in the gap between the wing and the aileron. If done correctly from both sides, you will create a very free moving hinge that is plenty strong. For all you competitive flyers, taping your hinge gaps on your ailerons and elevators is just a normal thing to do.

Tip: With all the hinging and building done on a flat surface while the plane is upside down, one is assured a straight plane. This is a good thing. Here is a picture of the fully stiffened and hinged plane.

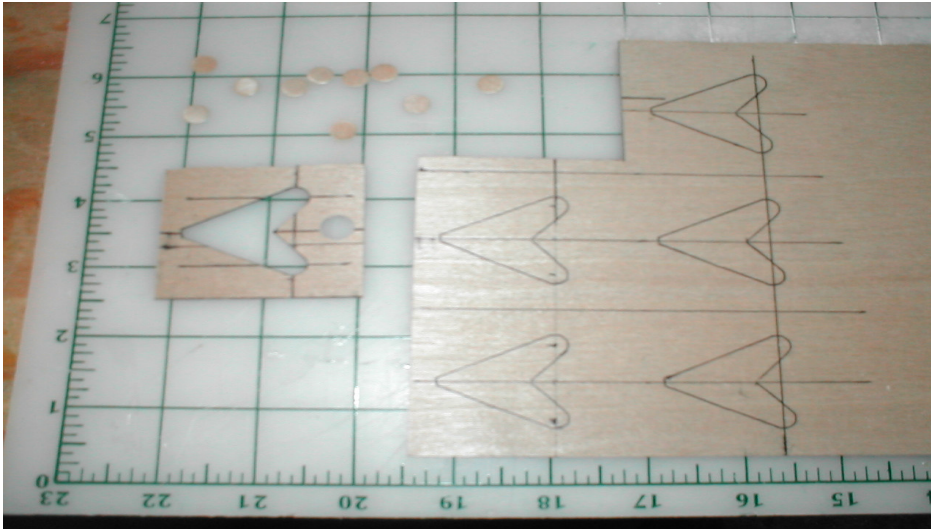


Now is the time to turn your plane over so you can stand back and enjoy it for a while.

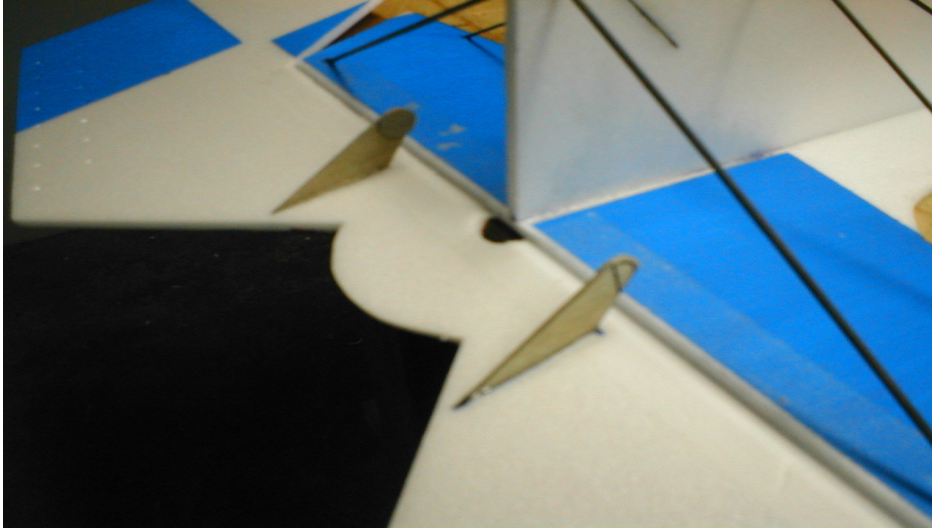


At this point it is time to start thinking about making the control horns for the different control surfaces. A good friend of mine (Mike Fritz, a long time well known modeler) provided me with some used hole punches from his work. Thanks Mike. I have several different sizes. From left to right: 1/2 inch, 7/8inch, 3/8inch and 1/4inch. They are very effective in cutting holes in foam and thin plywood. If you don't have a friend like Mike, sharpening one end of a brass tube will give you similar results.

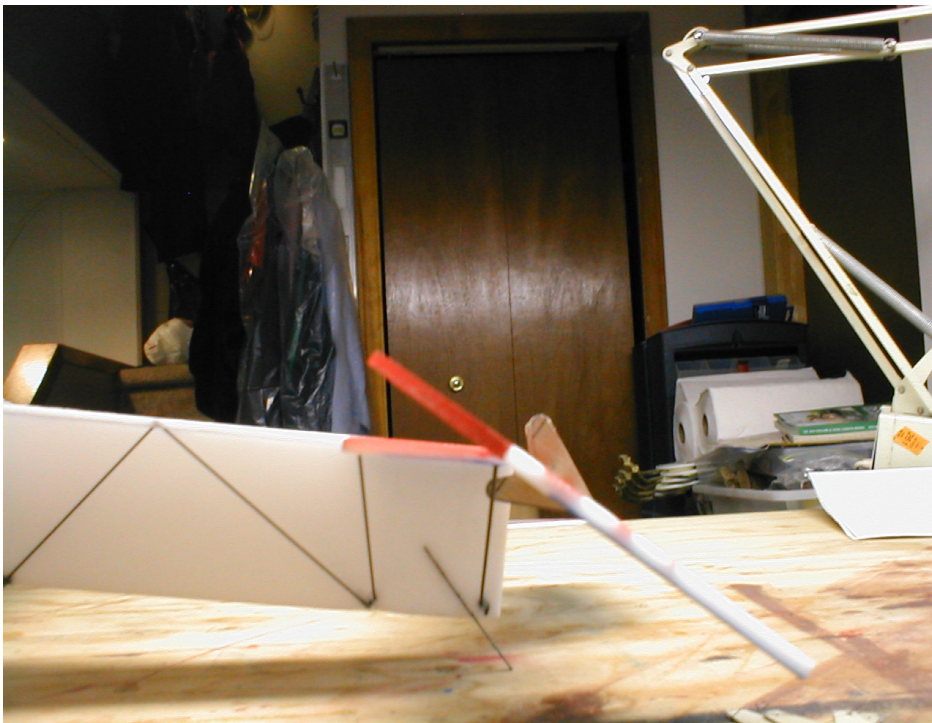
I trace a control horn via a template on a 1/64" thick piece of plywood. I then mark where the holes will go with a sharp point. Using my X-Acto knife I cut out the control horns and drill a very small (1/32) hole in the punch marks. I make sure that the distance between the holes is exactly the same as in my servo control arms. I use 1". This will ensure that your control throws will be identical on both ailerons and elevators.



1/4 inch diameter doublers of 1/64th ply adds a little strength to the holes. Remember to drill the holes through both the control horn and doubler. If you want to get fancy, you can paint these to match your color scheme. Don't paint where the foam will make contact with the control horn. We don't want to affect the gluing surface.



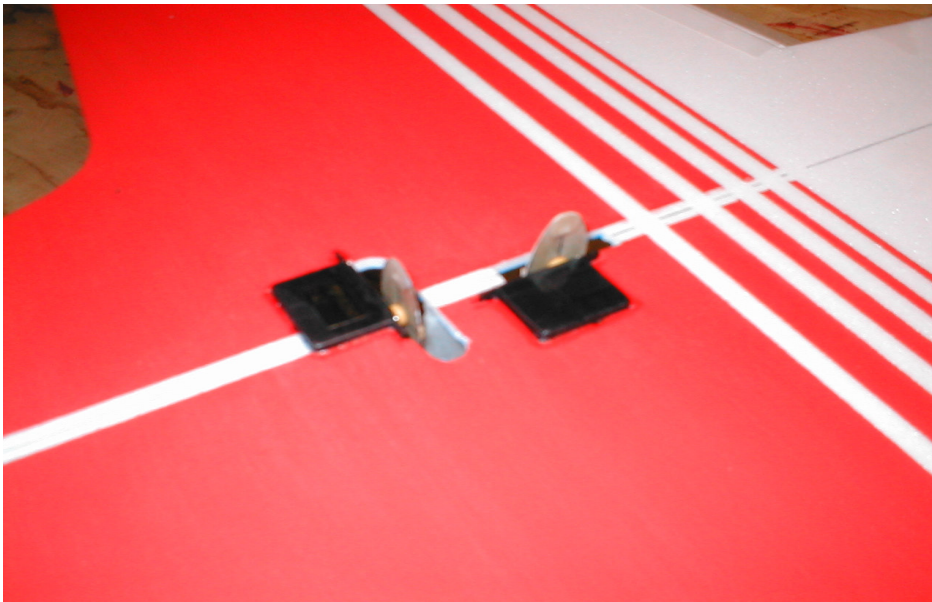
Next, I insert the control horn into the pre-cut slots in the foam. These slots will be identified on your plans. If not, make sure they are aligned with the servo output arms. Use a long ruler or straight edge to do this. If you are using a dual pull/pull elevator system like I do, make sure they are symmetrical.



Make sure when you glue them in that there is an equal amount of control horn protruding from either side of the control surface. If you don't, you will have an unequal Throw. This will make the plane fly wonky.



Glue in the control horns using the CA sparingly again. After kicking the glue joints, clean up the kicker and you are ready to start adding some servos to your plane.

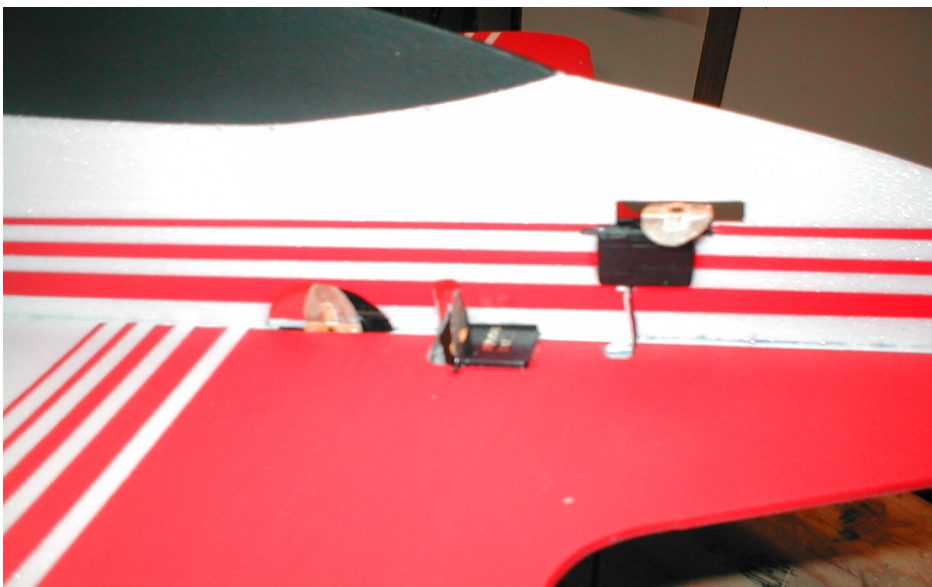


While the servo cutouts are exposed, I like to add the servos at this time. Note: I have added 1/64th ply extensions to the servo arms to have them match my control horns. I glue the servos in place with CA. Some modelers may not want to do this. If you don't like to do this, a neat trick is to wrap the servo with helicopter blade heat shrink material. This material is very thin and will add an immeasurable amount of weight to your servo. When you want to reuse the servo, you just cut it out of the wing and peel off the heat shrink covering. Shrink on another piece and you are ready to go again. Me, I just scrape off the glue with a hobby knife and start over again. Some of my servos have been

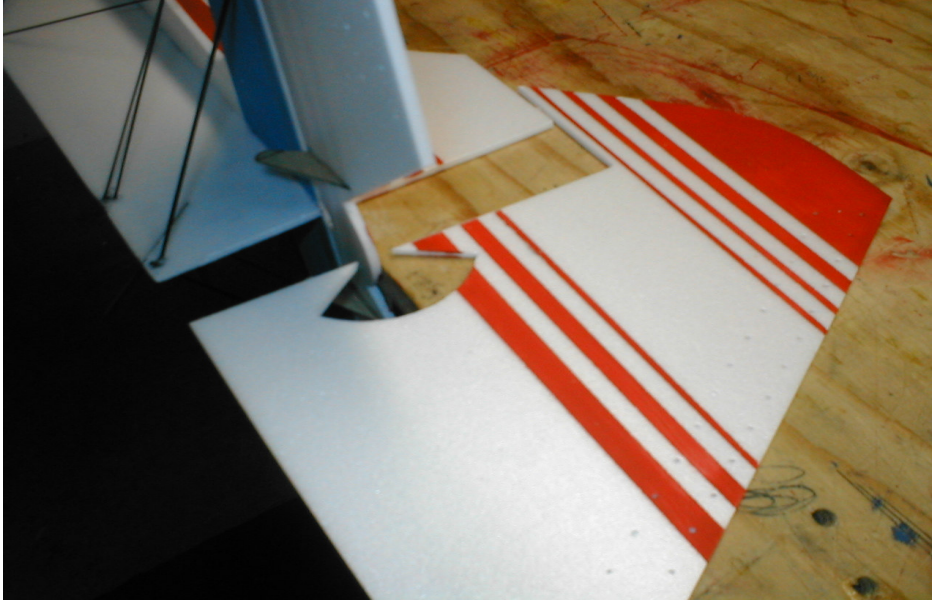
through six or seven planes and I haven't noticed any difference from when they were new. Whatever way you end up doing it, be careful to mount the servo as securely as possible.



Next, I add the top vertical former. Using a square to keep the former at 90 degrees, place the former exactly where it needs to go. The tail post is the important end to line up. If your rudder line is not straight, you won't be able to mount your rudder to it correctly. The front can be sanded square later. Sight down the former to make sure it is straight and glue in place with CA. Again, only put CA on one side and let it wick under the former. Hit it with kicker on both sides.



I then add the rudder servo. Note the $\frac{1}{4}$ inch hole passing through the wing. This is to allow the servo wire to pass to where the receiver will be.



Now is the time to add the rudder. If you were careful aligning the rudder post when you added the top former, mounting the rudder should be easy. Do it the same way as you did the ailerons or elevator. Don't forget to bevel the leading edge of the rudder.



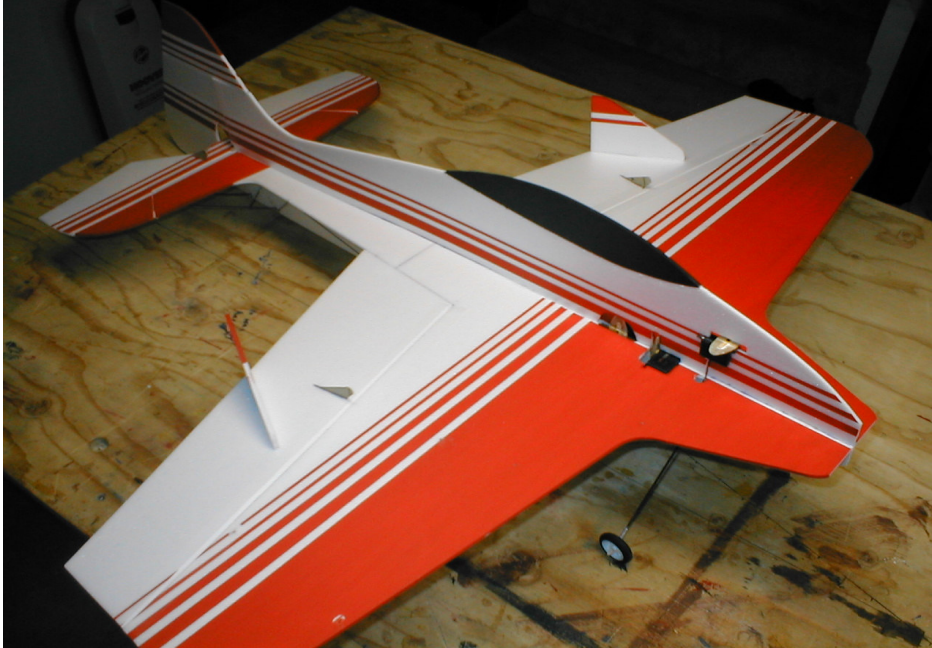
Next, add the rudder control horn.



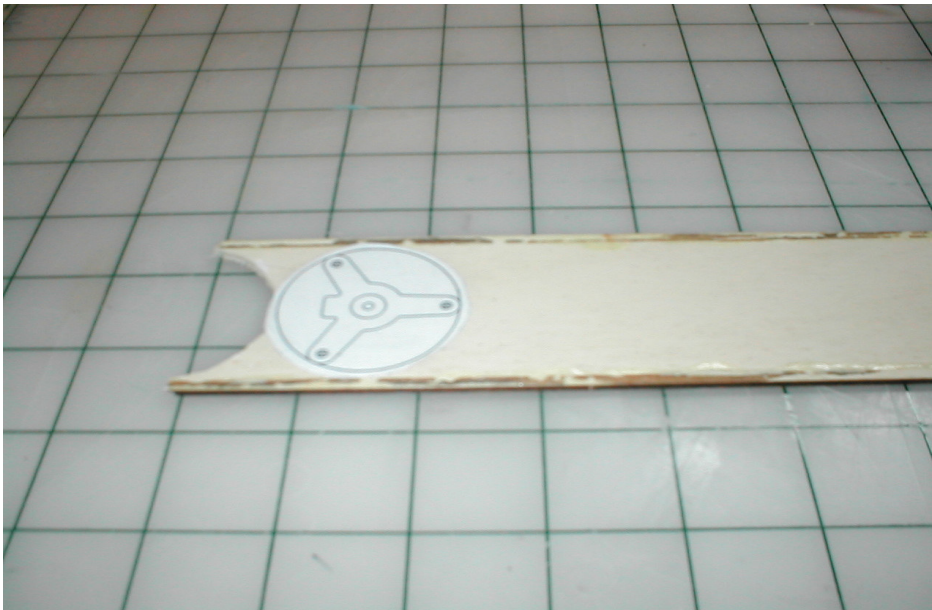
It's starting to look like an airplane. A few more steps and it is time to start adding the motor and the rest of the radio.



Add the vortex generators now. Glue in place with CA. Make sure they are perpendicular to the ailerons before committing to the glue. The generators should be self aligning.



Next I cut out the motor block. This piece is made out of 1/8 inch light ply. In order to make a motor block, you must first have purchased a motor. You will need to know where the mounting holes are. I like to make a drawing of the motor mount and place it on the plywood. I then draw a circle around it and cut it out.



This is a scrap piece of 1/8 inch ply that I had lying around the shop. This will be the third motor mount from this piece of stock. I like to punch and drill the holes before I cut out the piece. After cutting it out on the scroll saw, I sand the edges smooth.

Then for appearance, I like to use a black magic marker or black paint to color the wood. It is not necessary, but it looks good. I'm not going back on what I said about keeping it simple and not making it too pretty. It is a small thing and it doesn't take any time at all.

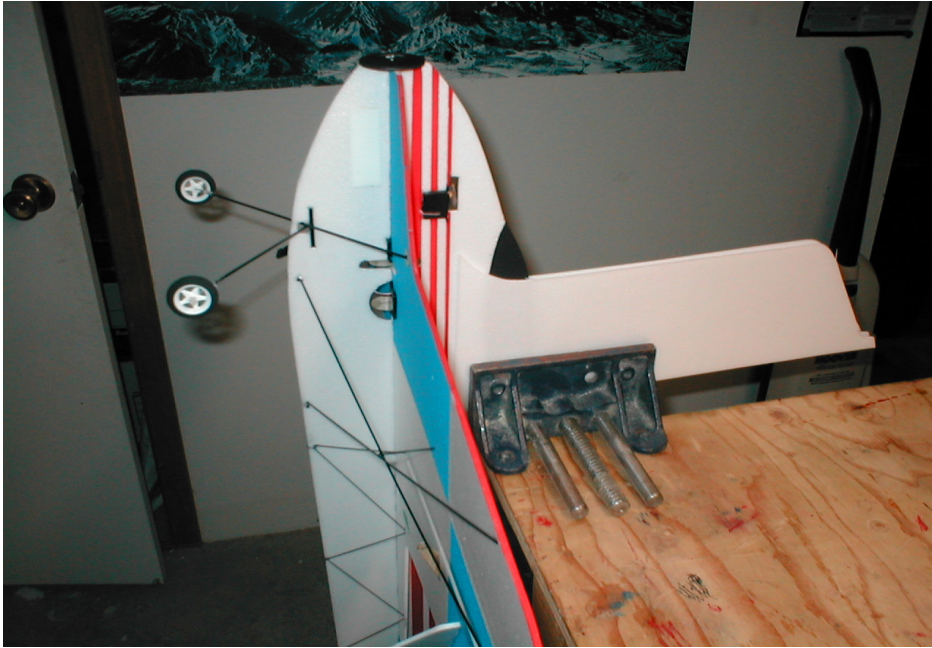


Note: The oval shaped hole is for the motor wires to pass through.

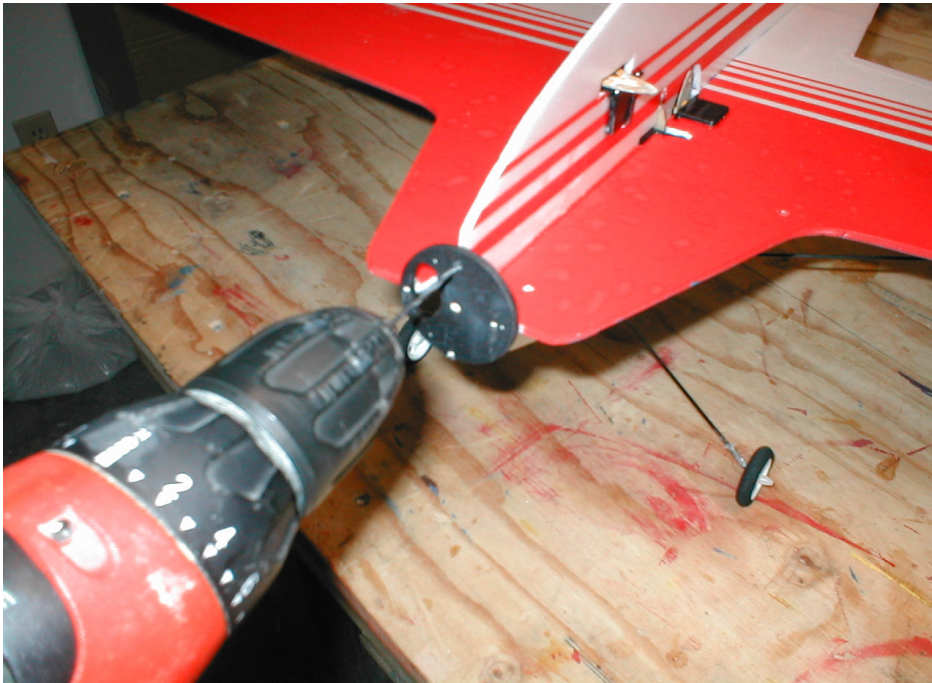


Sand the front flat to accept the motor block. Next, I prepare some epoxy mixed with micro balloons to glue the motor block onto the foam. CA will **not** work here. It is too week and brittle and the motor will come off on your first or second flight. Take time at this point to align the motor block carefully. If there is right thrust in the front of your plane, (most do have this) I like to sand it right into the foam. Make sure the vertical

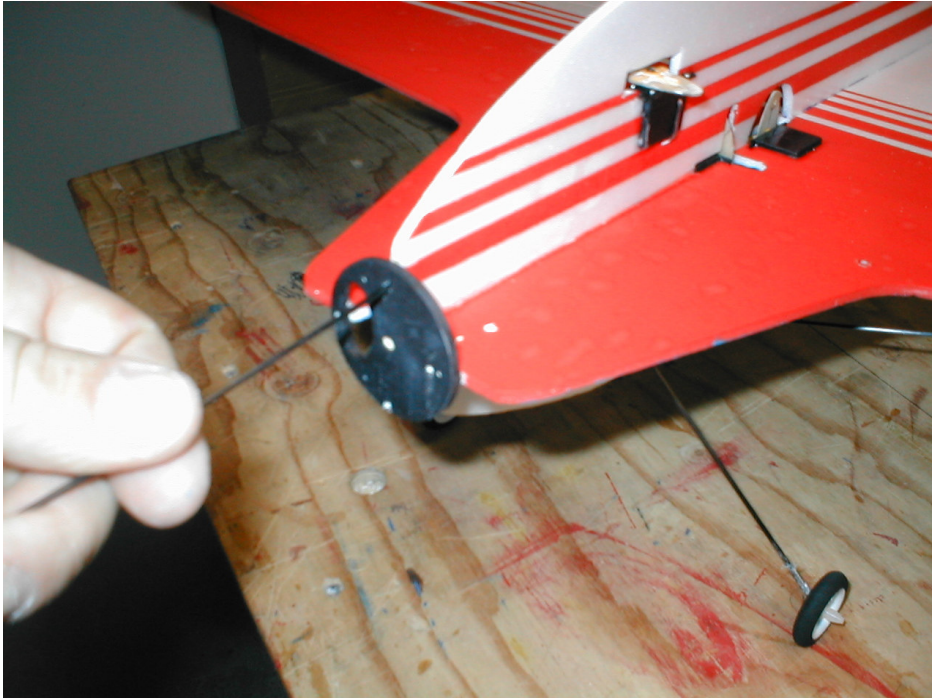
positioning is square to the frame. I haven't seen any 3D foamies with up or down thrust yet. With the plane mounted vertically in my vice, I add a liberal amount of thickened epoxy to both the foam and the motor block. After ensuring that you have the motor block mounted in the correct spot, clean up the over spill and leave it to setup. I use 30 minute epoxy.



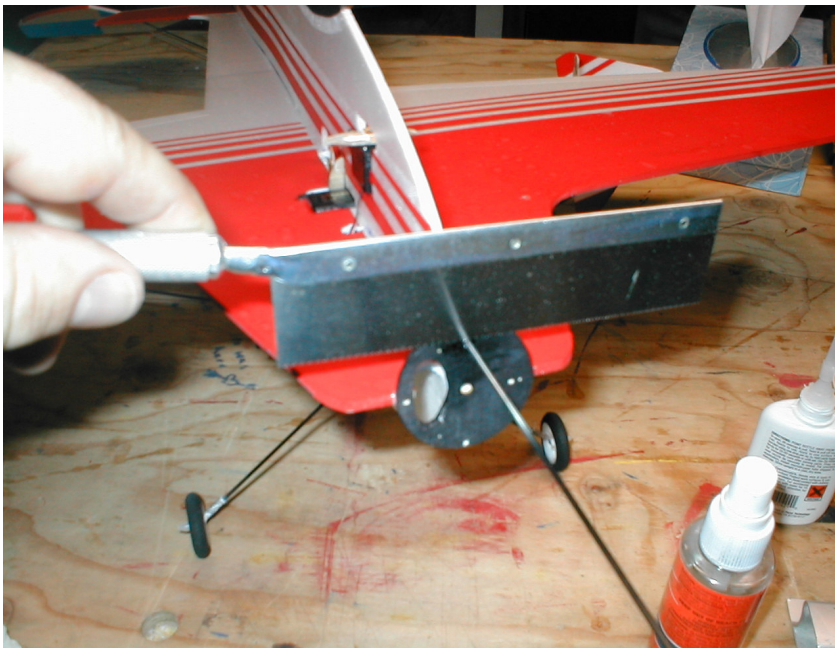
31 minutes later, I start to add carbon rods to the mount to help support the block.



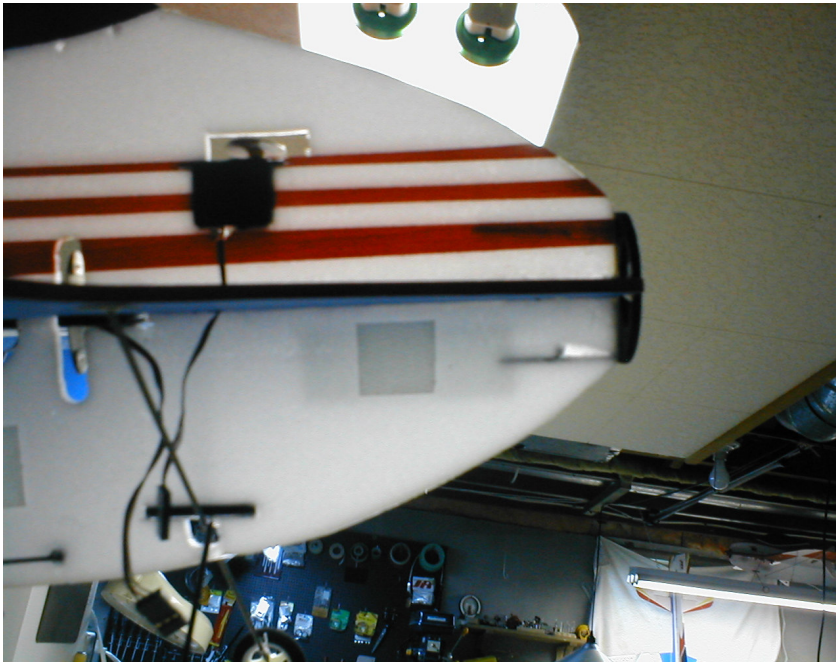
Start by drilling four holes just big enough to insert a 3" long piece of 1mm carbon fiber rod.



Glue them in place with either epoxy or UHU glue. CA won't work here because you can't get the kicker all the way into the holes. Trim off any excess carbon rod that sticks out. The motor mount should be flat and smooth.



The motor block is almost ready for the motor.



Here is how the motor block and support rods look like from the side.

That completes the construction of the airplane.

Section 3: **Radio, power train mounting, setup and Mixing**

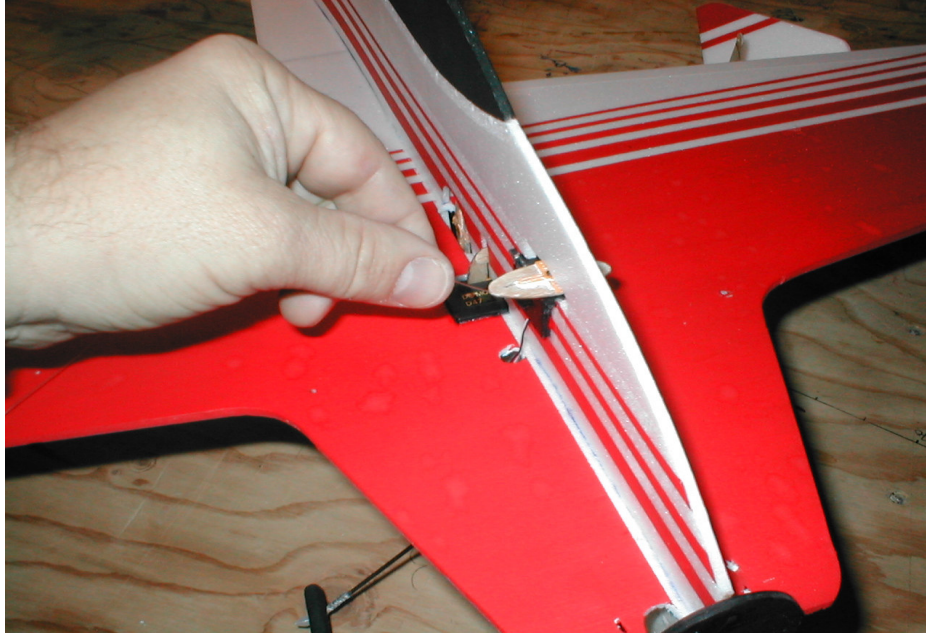
There are a few things that you need for this next step: Fishing line or some other suitable cable, a computer radio, a flight pack and about two hours of free time. It is also time for you to get out your favorite receiver, motor and speed control. You will also need your battery. This next step can be daunting for some, so I will take it slow and we will get through it together. Don't be discouraged if you don't understand what I am getting at the first time you read through this section. As you follow through with your own plane, you will understand. When you get to the radio mixing part, please don't just throw up your arms and say, "I don't need to do that stinking mixing stuff." And "I like to keep it simple." With a few minutes of your time and a little understanding of your computer radio, you can set up a plane that will not only fly great, but it will make you look good as well. And it's not that hard. Trust me.

For the pull/pull setup you can use any light line you can find around your house. It can be thread, fishing line, string, or a light weight braided cable. Just make sure it is light and non-stretchy. Note: The line you use must take CA well. You can use anything that has a 4 pound test or higher.



It doesn't matter what control surface you start with. Tie a knot in one end of your fishing line and thread it through one eye of the control horn. Hit it with thin CA and kicker to hold it in place.

Feed the line up to one of the holes in the servo arm from the bottom and pass it through. Run the line across the top of the servo arm and down through the opposite hole.

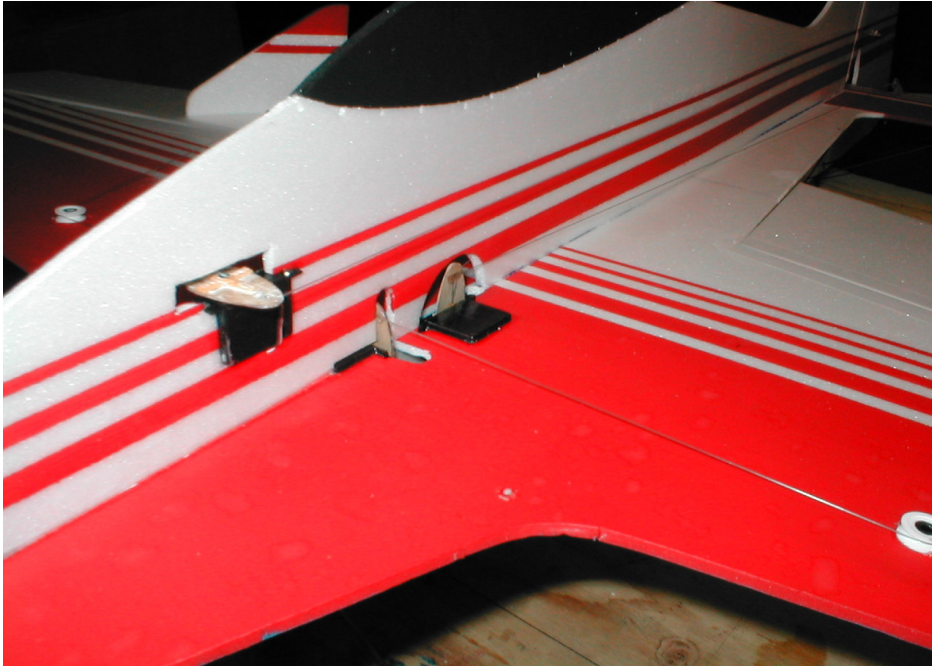


The line is then run back to the opposite side of the control horn. I just pass the line through the hole and bend it back on itself. After taking out all the slack (don't pull to tight, you will bend the plane) I put a small dab of thin CA on the folded over line and hit it with kicker. This holds the line in place while you tie a knot in the line to permanently secure the whole setup together. Again, I hit it with CA and kicker so the knot will not unravel.



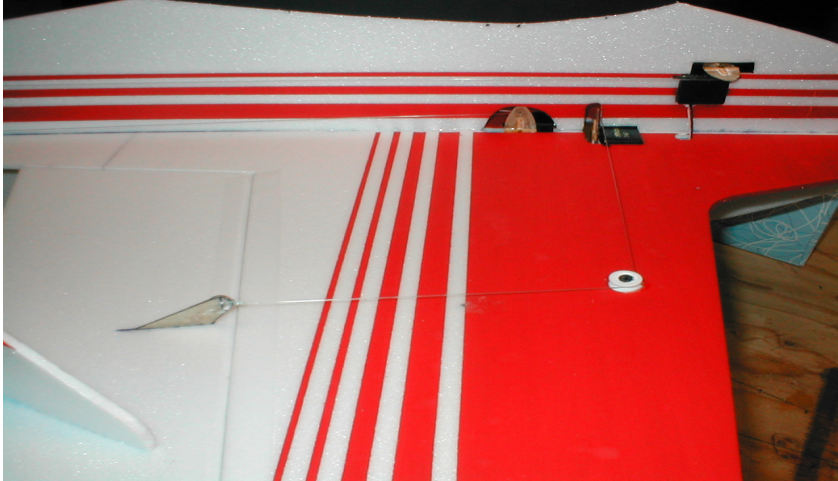
Notice that I have not added glue to the servo arm at this time. Plug in your radio system to center the servo before performing the next step. With the servo arm centered and the power turned on to the system, center the control surface. When you are satisfied that the

servo is centered and the control surface is centered, CA the line to the servo arm. This makes it permanent as in the picture below.



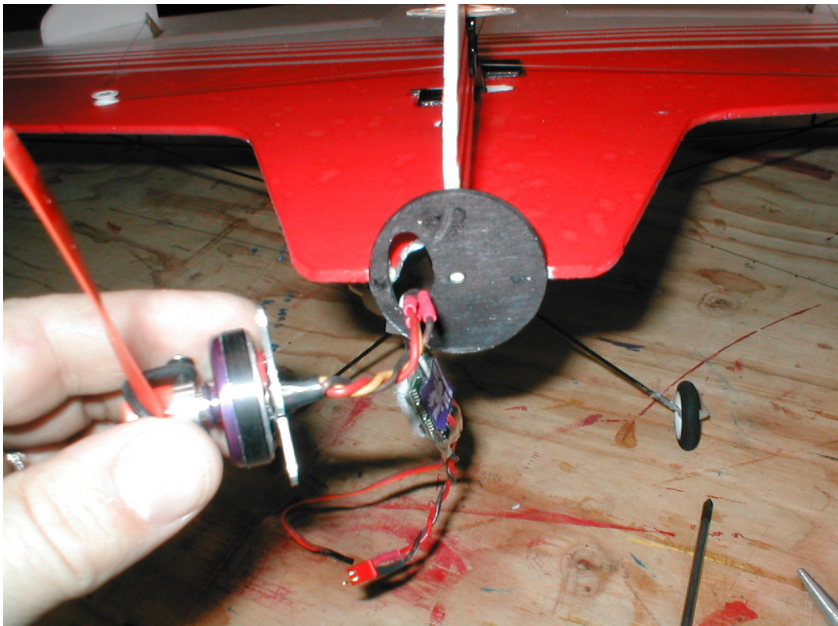
Also note, if you are using a pulley system as in the picture above and below, you need to make sure the line is taught enough to stop the line from coming off the pulleys.

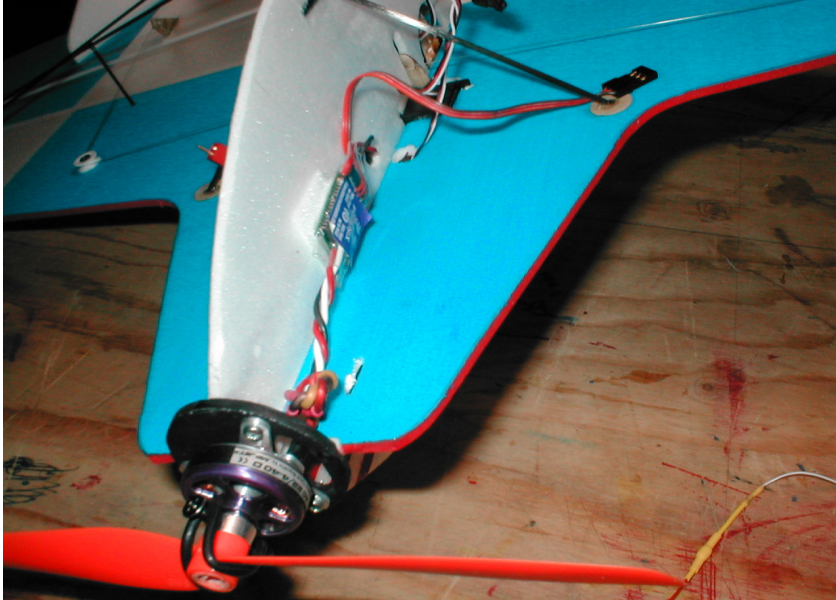




With all the control surfaces connected and moving in the correct direction, it is time to setup the control throws and dual rates. If you are lucky enough to have a condition switch, you can set those up at this time as well. At the end of the article, I will produce a table for control throws and expo setups. I will also give a list of standard mixes. Time to mount the motor, speed control, receiver and battery.

If you pre-drilled for your motor, all you need to do is screw it onto the firewall (Motor block). Note that the speed control is soldered and heat shrunk right onto the motor leads. Some people prefer to use removable connectors between their motors and speed controls. I find that I don't change motors and speed controls often enough to worry about a quick disconnect system. Most motors these days are made of high quality parts and will last a long time. Besides, quick connectors weigh too much.





This is a picture of the motor fully installed on the firewall. Small pieces of sticky back Velcro between the speed control and vertical former holds the speed controller nicely in place. The Velcro not only allows you to remove the radio gear easily, but it provides a small amount of shock absorption in a crash.



I have mounted the receiver in the same manor as the speed controller. It is time to start plugging in all the servos and speed controller to the receiver. Make sure you get the correct servos in the correct channels. Run your antenna back away from the speed control and motor so you will not get interference from them. If you have a full size antenna, try weaving it in and out of the vertical former on its way to the back of the

plane. Make sure the antenna cannot get wrapped around a control surface and cause a jam.



Find the balance point of your plane from the plans and balance the plane by adjusting where you place the battery. When you have balanced the plane, put about a two square inch piece of self adhesive Velcro between the battery and former. You need just enough Velcro to hold the battery however, not too much that you rip off the former when removing the battery for charging. If you are not sure where the battery will balance the plane exactly, put a long stripe of Velcro on the fuselage so the battery can move either forwards or backwards to find the sweet spot.

Tip: Indoor foamy airplanes that are being setup for 3d flying need to have a neutral C of G. To do this, fly the plane upright and trim it for level flight with hands off the elevator. Next, roll the plane upside down and let go of the elevator. Do this at a safe height so your pride and joy doesn't auger in if the balance is not correct. Note what the plane does. If the plane climbs inverted, you are too tail heavy. Move the battery forward. If the plane descends inverted, you need to move the battery aft. Make your adjustments in $\frac{1}{2}$ inch increments until you are close. Then fine tune it with little battery movements. Once the plane flies upright and upside down without the application of elevator, you have done it. Land and make a mark where your battery was with a pen or marker. Always put the battery back in this same spot for every flight. Contrary to popular belief, a neutral balance airplane is not unstable in the air. Yes, the controls will be more sensitive however, that's why radios have expo. More on that during the setup faze.



Here is a picture of the finished product. The radio is setup as far as it can be before the first flights. It is now time to take it into the air.

During your first few test flights make sure that the plane is trimmed in the pitch, roll and yaw attitudes. Take your time on this. Some people like to just start yanking the plane around before any trimming is done. This may be fun now, but later when you start to get serious about your flying, you will find your plane will do strange things during simple maneuvers. It may not even do basic maneuvers without some difficulties. In any case, you may have your hands full. Not fun for your first few flights on your new toy.

Radio Setup:

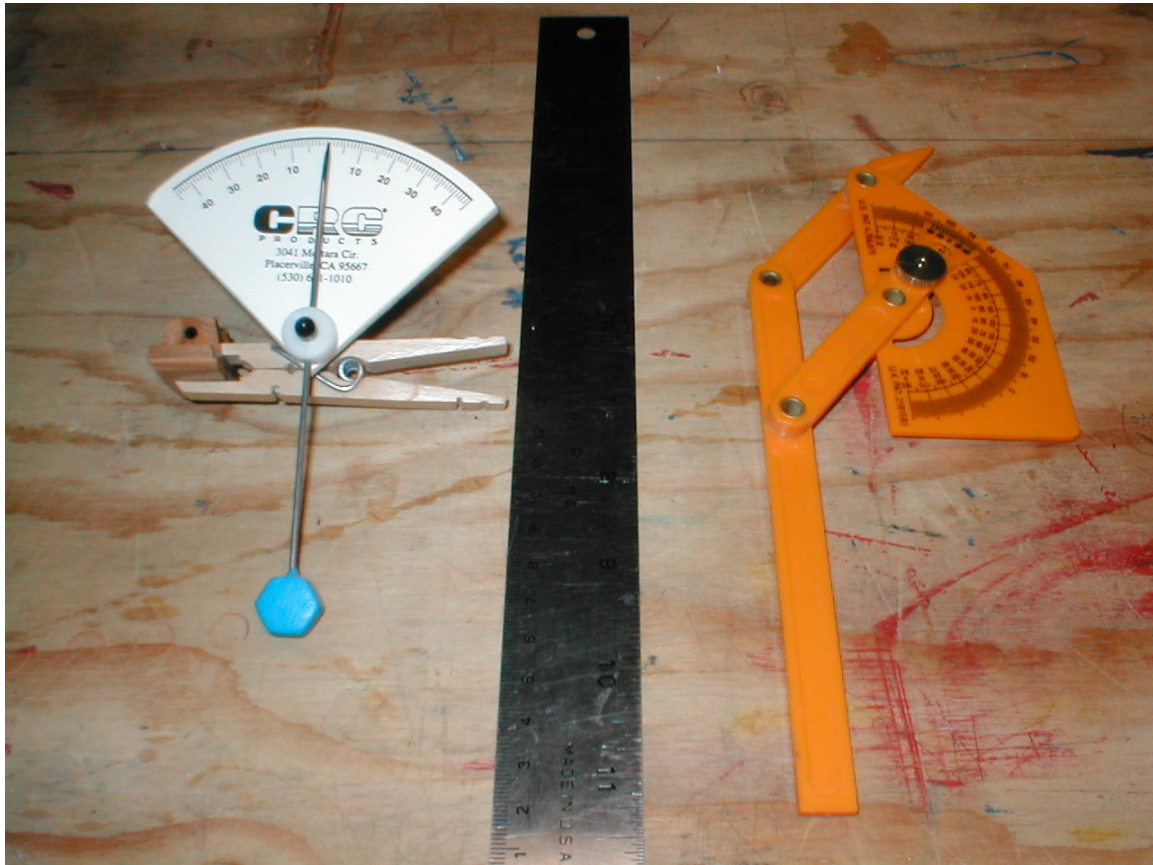
The radio I will be using to demonstrate the setup procedure is a JR XP9303. The functions that we will be using are by no means only found on JR radios. The function may be named differently on your brand; however, they accomplish the same thing. If you need to pull out your transmitter's manual, feel free to do so. As a matter of fact, it is preferable. Let's get started.

With all the servos mounted in the plane and hooked up to their respective control surfaces, it is time to set up your throws. Check to make sure the surfaces are going in the correct direction. This step may sound elementary; however, many planes have been destroyed on take off when the ailerons were hooked up backwards.

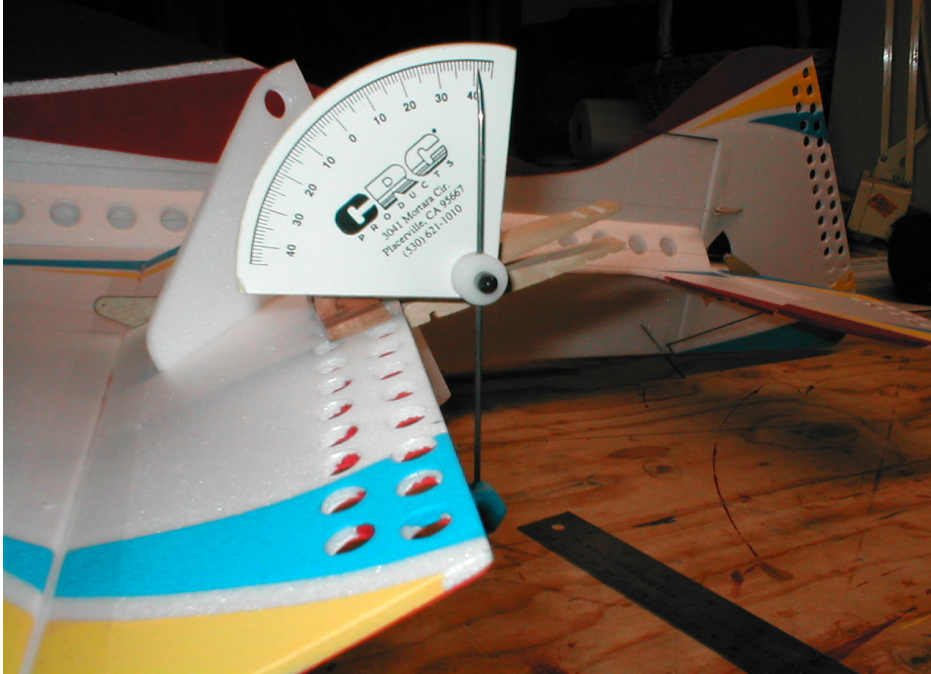
I like to start with getting the throws to at least 42 degrees of travel. This will allow you to do all the 3D maneuvers. You can do this by either moving the control rod on the control surface closer to the control surface, or, you can increase the servo travel in your radio. On this model, we have no choice but to increase the throws with the radio. With a JR radio, you will use the travel adjust function to accomplish this. If you want a truly

superb flying model, it is also imperative to make sure your ailerons travel equal amounts in both directions, up and down. You must also make sure that the ailerons travel in equal amounts in relation to each other. If you don't, the plane will not do an axial roll. With a two aileron setup, this is fairly easy to accomplish using travel adjust, and Dual rates. If you are using one aileron servo like our subject model, you will have to take care in your initial setup. The holes in both the servo control arm and control horn must be of equal distance between them. Also, the control horn must be centered equally in the control surface. If the distance between the hinge line and the hole in the control horn is not equal top and bottom, the throws will not be symmetrical. If you have a split elevator, it is also imperative that the throws are equal in both the up and down direction. If one elevator is pulling more than the other, you will create a roll when all you want is pitch. This is one reason why loops can become corkscrew shaped.

Below are a few devices that will help you manage your control throws.

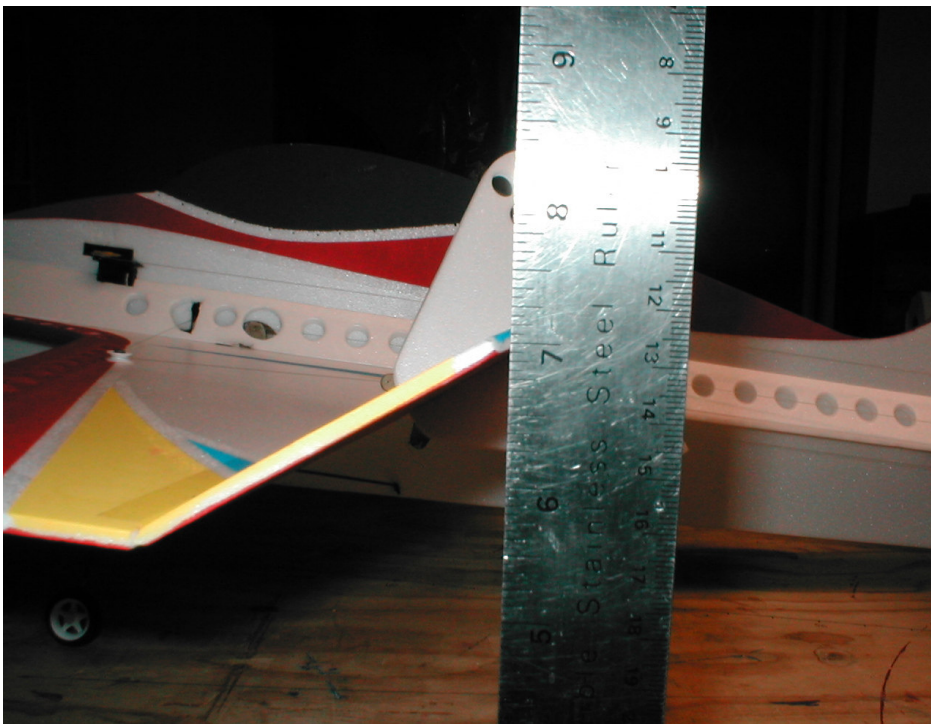


The first method is using the CRC Products angle gage. It is probably not the best tool to use on foamies due to its weight. It will bend the 3mm foam and give you an inaccurate reading. However, see the picture on next page for its use.



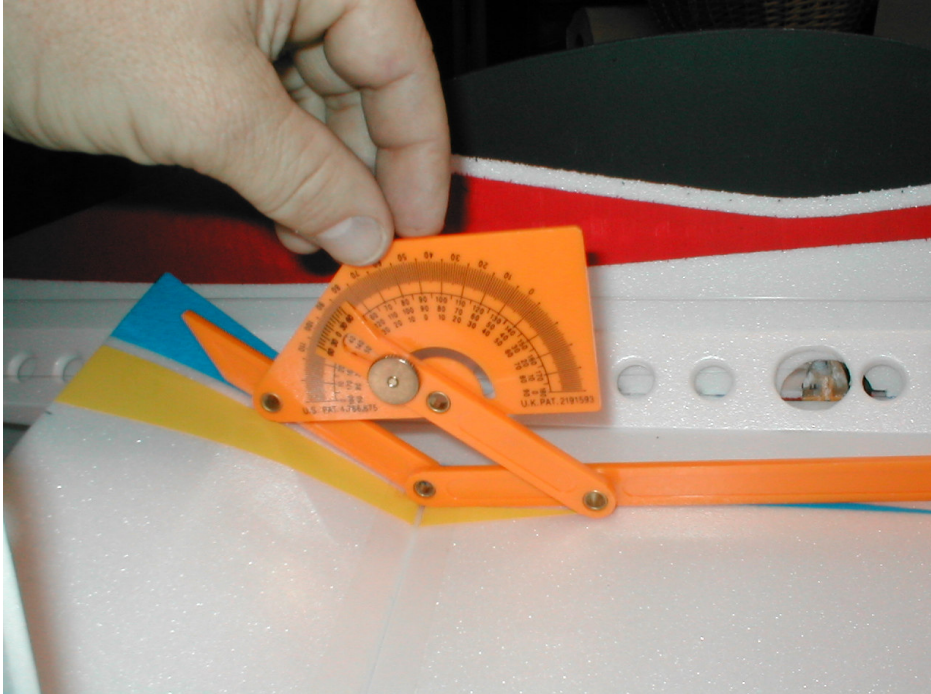
Just clip the CRC gage on the back of the neutral control surface, center the needle to “0”, and deflect control surface to the desired amount.

The ruler method is probably the most common to use as most people already have one at home.



You have to make sure the long axis of the plane is horizontal to the table before measuring. I like to use the center of the foam trailing edge as the measuring point.

Another favorite method is to use an angle gage such as the one in the picture below. It is easy and accurate. Just set the gage to what ever angle you desire and adjust the control throw to match it.



Now that the throws are in the correct direction, equal in deflection, and to the desired amount, it is time to set up your dual rate or flight mode switch('s). Below is a table to help you with the approximate numbers.

<u>Surface</u>	<u>Flight Mode</u>	<u>Dual Rate %</u>	<u>Expo %</u>
Rudder	0 (Snap Rolls)	25	25
	1 (Knife Edge/normal)	80	30
	2 (3D Flying)	125	50
Aileron	0 (Snap Rolls)	100	60
	1 (Knife Edge/normal)	100	60
	2 (3D Flying)	100	60
Elevator	0 (Snap Rolls)	60	50
	1 (Knife Edge/normal)	80	60
	2 (3D Flying)	100	70

If you only have a dual rate switch, just use the “normal” and “3D” setup as your low rate and high rate respectively.

I would like to take a minute here and talk about “Expo”. Expo is one part of radio setup that will improve the way a plane flies by ten fold. It is an easy thing to set up and the desired results are incredible. Everyone should use Expo. Expo is essentially a way of softening the feel of a control surface down around the center of the sticks. It is almost impossible to move a control stick without introducing some movement from the other control surface attached to that stick. For an example, when moving the aileron stick, some elevator can be accidentally introduced causing the airplane to pitch during your roll maneuver. By using expo, movements around the center of the stick are deadened. This will take out unwanted movements of your plane and help you become a smoother flyer. All proportional radios are set up from the factory to give you a linear throw on all channels. If you are using a neutral balance on your plane, expo will allow you to have big throws without over controlling, or possibly snapping your plane into the ground. I have test flown many airplanes that have not had expo set up on them and just about augured them in. The planes felt like they wanted to snap out on me with just a touch of elevator. Five minutes of programming for expo and the plane tamed right down. When I gave the plane back to the owner, they were amazed at how well the plane flew. Some people have even complained that there new plane was tail heavy because the elevator felt so sensitive. Again, five minutes with there radio and I had it flying very smoothly without changing the C of G. With the throws that we use for the foamies and especially when operating with 3D rates, it imperative that expo is used. Don’t ignore this step.

At this point the radio and airplane are setup for the approximate rates to allow you to safely fly the plane so you can start to dial it in. Now is the time to take the plane into the air. Start by trimming for normal flight. Take out any roll, pitch or yaw by using your trim levers. You should be able to fly the plane in straight and level flight at a comfortable speed with hands off the sticks.

Next, check the pitch and roll rates. For elevator, perform a normal loop. You should be able to pull full stick on normal rates without having the plane snap out on you. It will definitely snap out on you on 3D rates. On the snap roll rate, because of the small elevator deflection, you may not be able to pull out of a loop before the ground comes up to you’re plane. Ouch! So try this in a big gym only. For roll rates, this is more personal. Again on normal rates, the roll rate should be a comfortable rate for you. On 3D rates, it will be a blur. On the snap roll rate, it will remain the same as the 3D rate.

Next, we work on the balance of the plane. As described earlier in this article, you adjust the battery positioning to achieve level flight when the plane is upright or up-side-down. As a recap, assuming you have trimmed for upright flight, roll inverted, if the plane climbs, move the battery forward. If the plane descends inverted, move the battery aft. You will notice that the plane will fly very nicely at this point. However, you are only part of the way there. The next part is crucial to a great flying 3D plane.

We are now going to mix for knife edge flying. Now I know some of you will want to skip this next step. Some will say that they will never do knife edge flight, so why bother.

If you are planning on doing a simple rudder turn, you will want to do this mix. If you want to do an axial or slow roll, you will want to do this mix. And lastly, if you want to do any maneuver that requires the use of rudder, including take offs, you will want to do this mix. If you are not capable of doing knife edge flight, I recommend that you find someone that is. Get him or her to fly your plane in this next faze of trimming. No plane out there can be flown in knife edge flight without some sort of mixing of both the rudder to elevator and rudder to ailerons. Most planes either pull to gear or canopy while in knife edge flight. They also will have a perverse or adverse roll tendency while in knife edge flight. Perverse roll is the condition where the plane will want to roll in the direction that the rudder is applied. (i.e.) Applying right rudder while in knife edge flight will cause the plane to roll to the right. Were Adverse roll is where the plane will roll opposite to the rudder applied in knife edge flight. (i.e.) Applying right rudder while in knife edge flight will cause the plane to roll to the left. All the foamies that I have flown pull to the gear and have had proverse roll. In other words, the plane tucks under and wants to roll out of the knife edge flight. I must note here that when putting the plane in knife edge flight, you should not use the elevator or ailerons to right it. We want to see what the plane is doing on its own. I first mix the rudder to elevator. Since my planes pull to gear while in knife edge flight, I set them up with about 5% up elevator mixed to the rudder. I then go airborne again, roll it into knife edge flight and see what it does. If it flies straight in pitch, without pulling to gear or canopy, I move on to the Rudder to aileron mix. If it doesn't fly straight in pitch, I add more mixing or take some away until it does fly straight. You should fly the plane in knife edge flight for quite a few passes to make sure you have the mixing done correctly. Don't forget to do this in both directions. My planes tend to have proverse roll while in knife edge flight. They want to roll themselves out or back to level flight. I start again with about 5% opposite aileron to rudder mix. This means that if I am using right rudder, the ailerons should roll the plane to the left. The right aileron should go down about 5% and the left aileron will go up about 5%. Work this over and over again, fine tuning your mixing. You may even have to go back to your rudder to elevator mixing and re-adjust as you get closer to pure knife edge flight. When you finally get the plane dialed in, you should be able to fly knife edge flight from one end of the gym to the other just by using rudder only. A note here: most radios now have mixing with a point curve. This means that small rudder applications require small mixing values. Larger rudder applications require a larger amount of mixing. This is not always a linear relationship. Therefore, radios can be set up with a non-linear curve. Much like a throttle curve.

At this point you will probably notice that flat rudder turns are now a breeze to do. No aileron or elevator application should be required. Not only does this look cool, it is a necessary maneuver for indoor flying. See, I told you it wasn't that difficult. Try some knife edge outside 360's and some 4 point rolls. You will find that it is relatively easy to do these maneuvers.

As an added bonus, you should notice that stall turns have become easier to do as well. The plane won't roll off at the top and the down lines should be straight without tucking under or pulling out prematurely. This is the minimum amount of mixing that should be done on all your airplanes. All the previous mixes are required and some would consider them mandatory. After this, the other mixes are optional. They will improve certain parts of your flying but, not all. If you want to, you can stop reading here. Although; the other

mixes make for interesting reading and may help you remove an unwanted flight characteristic from your favorite plane.

Up to this point, all mixing will be “turned on” at all times. In other words, there is no on-off switch or lever for activating them. Some mixes may only be needed during certain aspects of flight such as stall turns, down lines, snap rolls etc. Therefore, they need to be set up with an on-off switch. They can be activated by your flight mode switch or even a control stick.

One example that uses this technique is the snap roll setup. A friend of mine likes to mix elevator to ailerons and rudder simultaneously. He does this by using his condition switch to activate his elevator stick as the on-off switch. Sound a little confusing? Fear not, here is how it works. A condition is set up for snap rolls on his flight mode lever. When selected, the flight mode switch uses the elevator stick as the on, off switch. Without this condition, you would enter a spin normally by moving the elevator, rudder and ailerons sticks to their full travel at near the same time. We call this “burying the sticks in the corners” However, this does not always produce a pure snap roll. When doing a correct snap roll, especially when competing, the judges want to see the nose of the airplane break the plane of flight slightly before the aircraft actually snaps. If they don’t see the break, most judges will think the plane just did a fast barrel or aileron roll, not a snap roll. This will score you a big fat “0”. To do the maneuver correctly, the elevator must come to the stop slightly before the rudder and aileron sticks do. This will cause the plane to stall first, allowing the nose of the plane to break the plane of flight before snapping. Timing this can be very tricky and hard to do. If your timing is not perfect, the snap roll will not be perfect either. My friend beats the odds by building in a delay in the rudder and aileron deflection by setting up his radio to *not* put in the rudder and aileron until the elevator has reached 95% of its travel. Even though the sticks are fully moved on the rudder, ailerons and elevator at the same time, the rudder and ailerons won’t move until the elevator reaches its stop. You simply move all the sticks at the same time and the elevator stick provides the timing. Don’t forget to turn it off when normal flying.

The next mix is one that will need to be turned on and off as well. Although I don’t use it myself, I do know of a few guys that use it with great results. Try mixing throttle to rudder. When full throttle is used, especially with high angles of attacks, right rudder is required to control the yaw due to slip stream. This is assuming you have not put right thrust in your motor or there is not enough right thrust. Some people feel that 3D flying is easier with no right thrust at all. The Slipstream yaw will be removed by the use of mixing throttle to rudder. As an example, assume you have just pulled up into a vertical up-line. In this attitude, after a short time, the nose of the airplane will have a tendency to yaw to the left. Right rudder will have to be manually applied to counteract this tendency. With the mix of throttle to rudder, you should not have to touch the rudder in the climb. This will limit or eliminate any tendency of your plane to wiggle its bum in up-lines as you search for the perfect amount of right rudder. However, in straight and level flight, if you pinned the throttle, you won’t need to control slip stream yaw. Therefore, it can be turned off.

Another throttle mix that is useful is the mixing of throttle to elevator. Again when doing vertical maneuvers, such as long down lines, the plane will have a tendency to pull out of

the dive. By mixing down elevator to low or idle throttle, you can make the plane travel in a perfectly straight down line. Again, use this mix with an on-off switch.

In all cases of mixing channels together, start with small percentages and work in increasing increments from there.

Of course, with computer radios becoming more sophisticated and easier to program, you can do any mixing your mind can dream up. So don't be afraid to get into this part of your radio. The results will be worth the learning curve. Now go out and show the world how it's done.