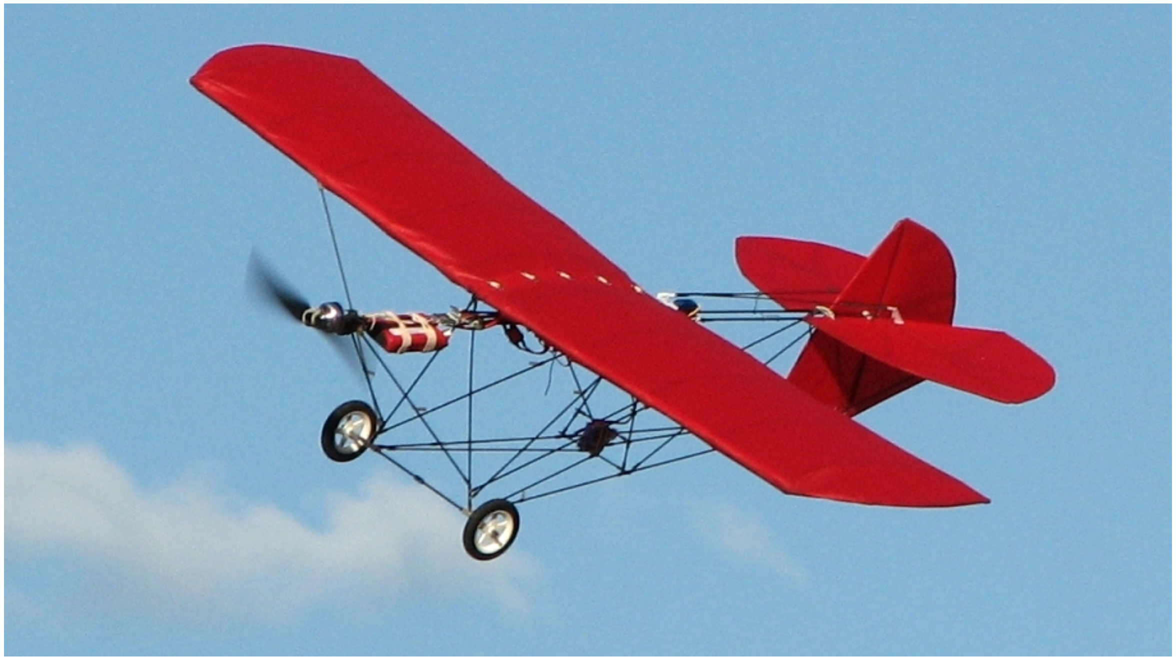
Ace Sim RC
ACESIM.COM/RC

The Carbon Prime Convertible ™

Proudly Presents

Portable Electric RC Aircraft

Quick-Build Kit Construction Manual



SPECS:

SPAN = 42" - AREA = 2.5 sq ft
AUW ~ 14-16 oz (4 channel - 100 watt)
Payload to 16 oz (30 oz total AUW tested)
3 or 4 channels - Rudder/Elevator or
Rudder/Aileron/Elevator plus throttle
Suitable for beginner to expert

FEATURES:

Fully portable and serviceable
Nearly indestructible
No balsa or foam
Fully adjustable
Unique wing warping roll control

Exclusive Soft-Lock tm shock absorbing plug-together construction system
Carbon fiber rod / tube with removable coated ripstop fabric covering
Excellent platform for aerial photography
Can use many different power systems
The most versatile indoor/outdoor flier available

Vintage Styling - State-of-the-art Engineering and Performance

Table Of Contents

Introduction

The Carbon Prime (CP) may not be your last plane but it should be your first and just may outlive all your others. It is truly a design where form follows function. We wanted a model stable enough to train on yet be able to advance with the pilot as an aileron trainer, sport flyer and just a fun all around plane. It has a large weight range and can use a number of different power systems.

We wanted it fully serviceable and strong enough to double as an aerial photography (AP) platform, handle stunts, winds and be fully portable for travel as well. And if you think it looks good besides, consider that a bonus, not a prerequisite as beautiful planes don't look that good once reduced to a pile of broken parts. "I crash, there-fore I learn".

The special poly fittings used exclusively in the construction not only hold the parts snugly together but also result in shock mounting the airframe components from crash damage. At worst they will release the parts under load and will just require your plugging them together again to get back in the air. If you should muff a landing and cartwheel it in, not to worry, as you could probably rip the wings off in a bad crash and most likely only have to plug things back together and replace some rubber bands to be flying again.

Of course no one plane will suit all needs but the Carbon Prime comes close. Rig as a lightweight rudder/elevator (R/E) floater for indoor or yard flying. Go 4 channel with added wing servo for aileron training and sport flying. Then beef it up with a big motor and duration pack and go tackle some wind, higher speeds, and STOL requirements.

For aerial photography, the roomy open fuselage framework allows you to get many unrestricted viewpoints for your shots. The large payload capacity can handle many different camera models making the CP one very versatile plane.

The Carbon Prime kit could almost be considered an ARF due to the high level of pre-fabrication but we'll call it a quick-build kit since there is assembly required. Minimal gluing is required however to retain the full portability benefits of the Soft-Lock™ plug-together construction system. Also, unlike other kit designs with similar construction, the CP requires no lashing to build.

If you've never built one of our planes before, then forget everything you already know about model building and jump right in for a new learning experience. Once the prefabricated fittings are positioned on the precut rods and tubes, everything just plugs together like "Tinkertoys ®".

Listed on the following pages are the tools and supplies required, parts list and construction diagrams. They are grouped together so you can easily print them out by selecting their page range in the print setup menu if needed.

Get to know the kit, plane and construction methods prior to starting. You will not only get building instructions in this manual, but some basic design concepts for understanding the field adjustable flight parameters available so you can "fly it your way!"

Do study the parts terminology so that later in the step-by-step text you'll know what is being talked about. Once you read through the instructions you should only need to print out a few sheets for reference and be ready to go.

NOTE: Since some parts from different sections of the plane have the same lengths but different diameter rods, keep the parts sorted until ready to use to avoid confusion.

Materials included in kit

CF Rods and Tubes:
All pre-cut to length

Fittings
Large and small diameter, pre-cut, punched and sorted

Bushing sleeves
Wheel, axle and linkage sleeve - precut to length

1 bag of 100	Small diameter rubber bands
16 inches	Ripstop clear reinforcing and repair tape
1 bag	Assorted motor mount parts

Hardware supplied

3	Clevises with threaded rods (1 rudder, 1 or 2 elevator)
2 packs of 2	Micro2 control horns - Du-bro #919 (3 horns needed)
1 packof 4	Micro2 E/Z Link - Du-bro #920 (3 links needed)
1 length	music wire for linkage
4 lengths	plastic strips for control horn plates
1	motor mount stick
1	pre-formed tail skid
2	wheels
8	wire ties
6	rubber hose mounts
2	Poly wing joiner sleeves

Items You'll Need

Thin CA glue
Velcro and/or large rubber bands to mount gear

Tools Needed
Needle nose pliers to bend music wire
(can add band around handle to hold parts)
Sharp pointed hobby knife
Sharp pointed scissors
Large, sharp needle or thin scribe for "hole poker" tool
(can add clamp or insert in wood dowel for handle)
Medium pencil
Yardstick and an accurate ruler
Wire cutters to cut music wire, NOT carbon fibre (CF) rods
Clothespins or other small clamps
Small screwdrivers for servo horn installation and adjustment

Other Handy items
Spring hook for pulling bands
(can make from piece of music wire)
Hemostats (forceps)
Wire strippers (used to trim CF rod if needed and gear wiring)
Medium sand paper to smooth raw CF rod ends
Heavy polyester thread for optional lashing of linkage
Rubbing alcohol to ease getting fittings or rods

Gear Required
3 or more channel radio with 2 micro servos (plus 1 mini servo for 4 channel wing warping option)
~100 watt or better motor system
(see gear and motor sections for more info)

NOTE: Specs and dimensions may change without notice to improve design and/or aid in construction.

Carbon Prime Parts List

Carbon Rods/ Tubes / Fiberglass (FG) Rods

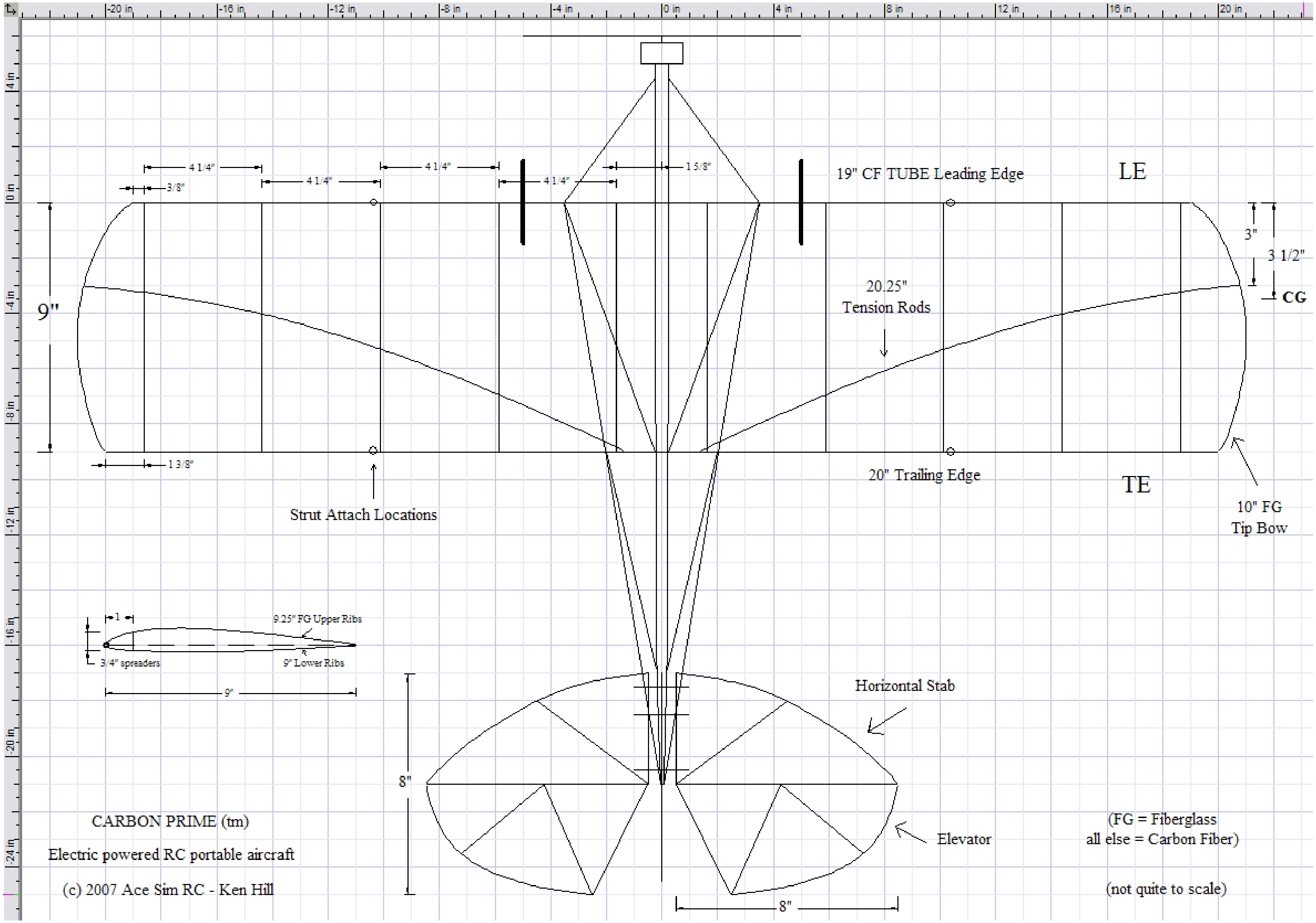
NOTE: duplicate length parts are listed with the thicker diameter ones marked with *

Quantity	Description	Length-in
	WINGS	
2	LE (Leading Edge) Tubes	19
2	TE (Trailing Edge) Rods	20
2	FG (fiberglass) Tip Bows	10
10	FG upper Ribs	9.25
10	Lower Ribs	9
2	Wing Tension Rod	20.25
2	Front Wing Support Struts	10.25 *
2	Rear Wing Support Struts	12.25
10	Airfoil spreaders	0.75
	TAIL	
1	Rudder Post	8.5
2	Elevator Post	8
3	Rudder/Elevator Short Diagonal	4
6	Rudder/Elevator Long Diagonal	4.5
3	FG Rudder/Elevator Bows	8.25
3	Vertical /Horizontal Stabilizer Post	8
3	Vert/Horiz Stabilizer Diagonal	5
2	Horizontal Stab Base	4
1	Vertical Stabilizer Base	4.125
2	Horizontal Stabilizer Bows	9.25
1	Vertical Stabilizer Bow	9.5
2	Tail Struts	6

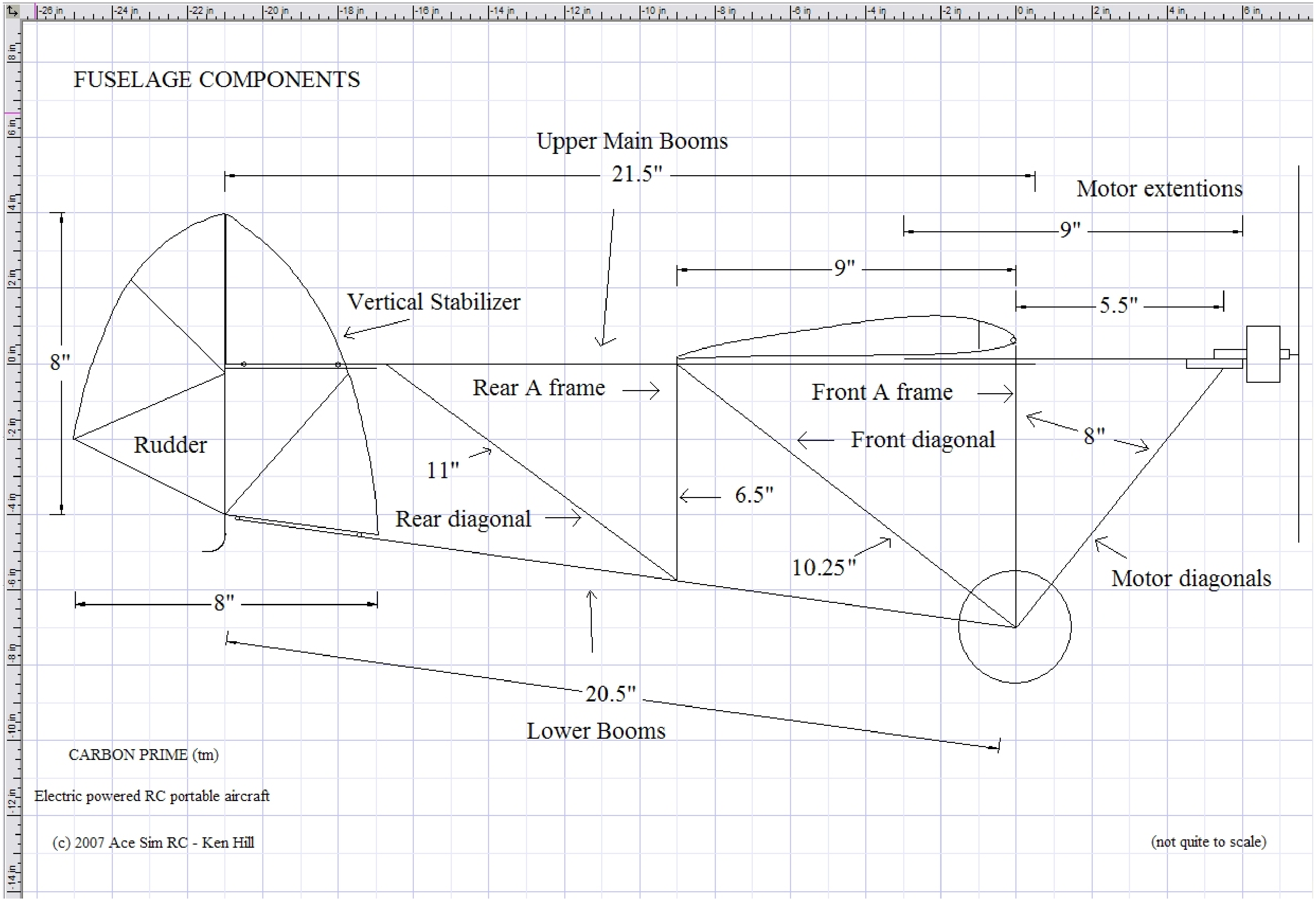
	FUSELAGE	**Length-in.**
2	Upper Main Booms	21.5
2	Lower Booms	20.5
2	Front Side Diagonals	10.25
2	Rear Side Diagonals	11
1	Landing Gear Axle	10 *
2	Front A Frame Sides	8 *
2	Rear A Frame Sides	6.5
1	Rear A Frame Base	4.5
1	Wing Servo Support	3.75
2	Axle to Rear A Frame Diagonals	8.125
2	Motor Mount Boom Extensions	9 *
2	Motor Mount Extension Diagonals	8 *
7	Upper Boom Connectors	1.75

	FITTINGS	**Length-in.**
small		
3	Elbows (wing joiners - servo horn)	1
16	Elbows	3/4
6	Elbows (1 hole - tail panels)	
2	Elbows (2 hole - booms to tail)	
80	"T"s (single hole)	5/8
90	Sleeves	1/4
large		
4	Elbows (LE tips - motor ext.)	3/4
34	"T"s (1 hole)	3/4
20	Elbows (2 hole for ribs)	3/4

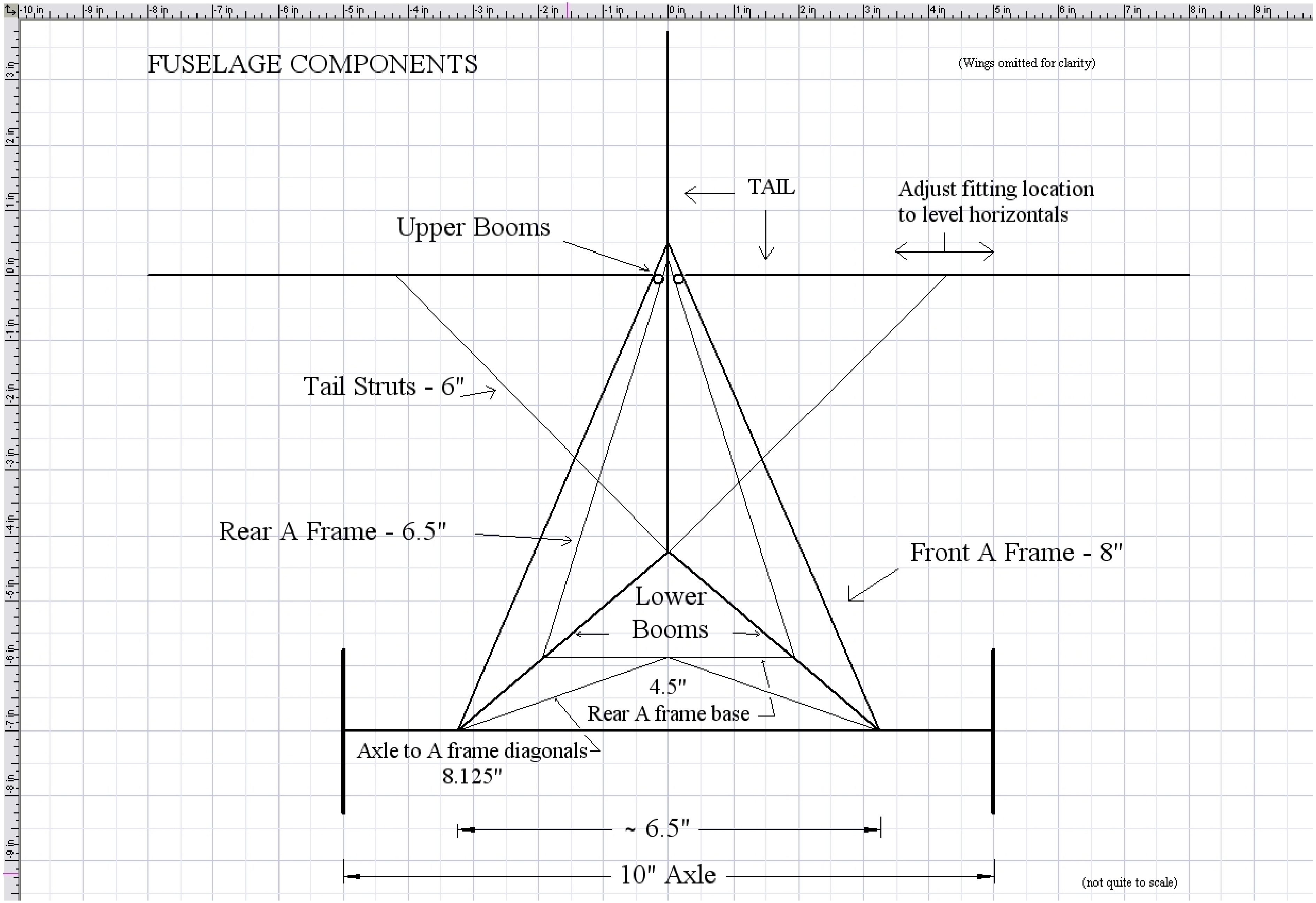
Top View Diagram



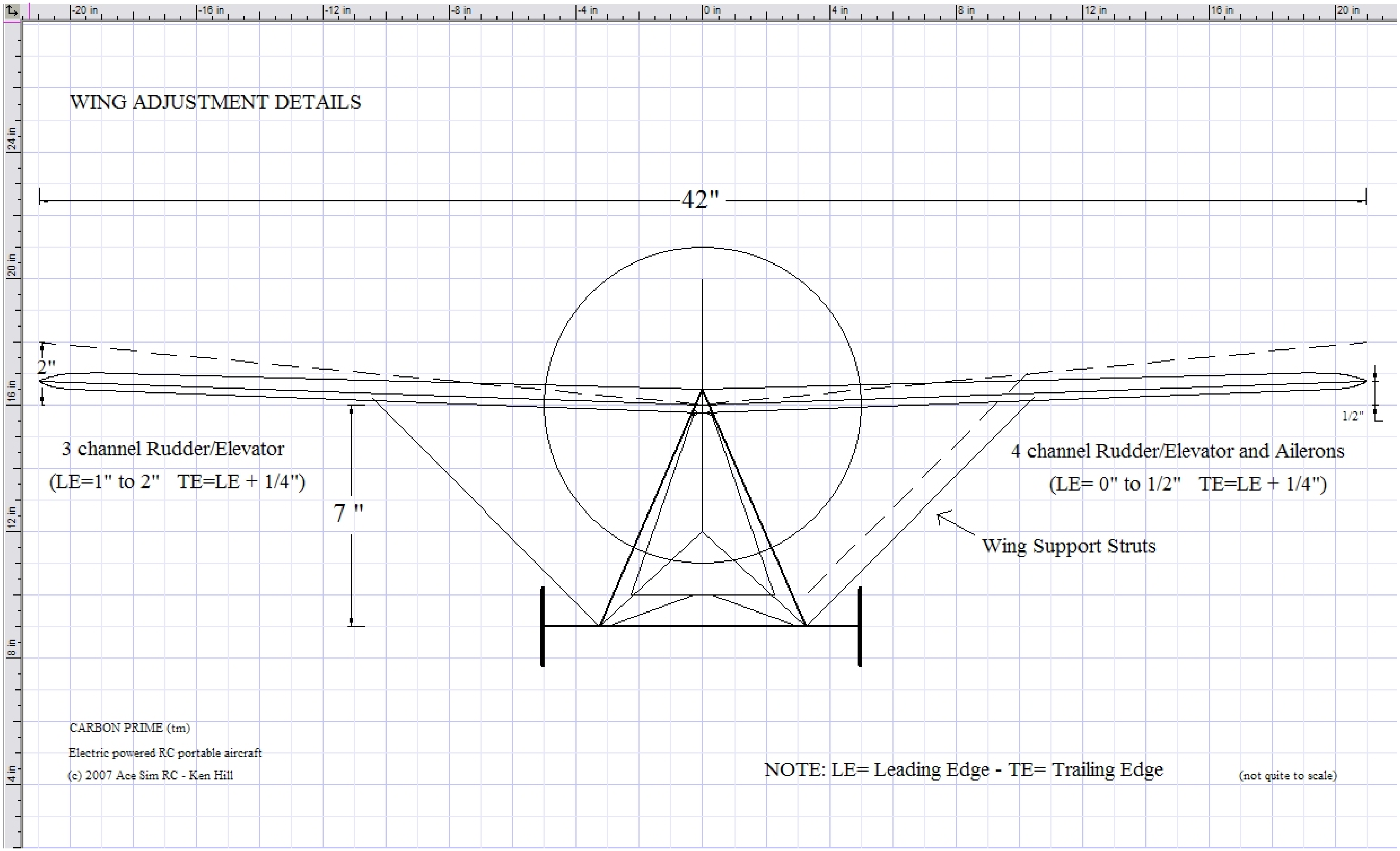
Side View Diagram



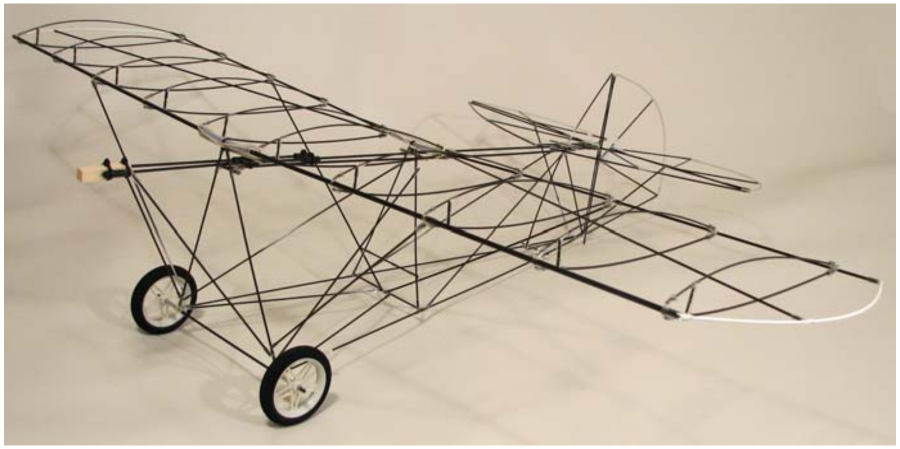
Fuselage Front Diagram



Fuselage Front Wing View

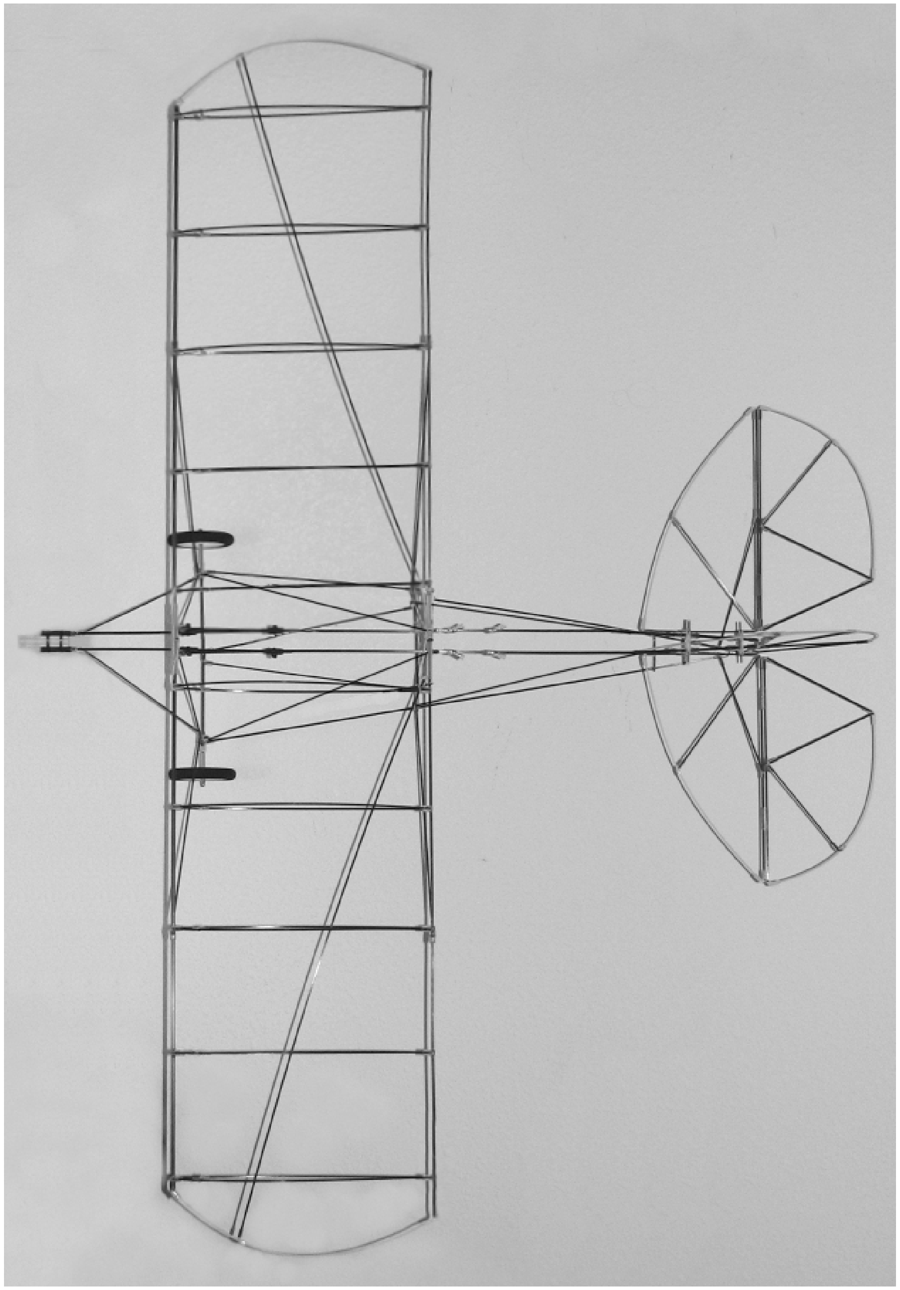


General Construction



The order of construction of the individual components isn't very important since everything is detachable. You will need to complete the entire framework (less gear) prior to fitting the fabric. This allows all fittings to be precisely located for proper frame alignment and then fixed into position where needed. Once disassembled and covering added, the fitting locations on the surfaces can be extended out through the fabric and will then be in their correct location. This prevents the mistake of making multiple holes and messing up your pre-made covers.

Exact measurements of the locations of all the fittings on the components aren't necessary or practical to document, as little variations can change things enough to miss-align the framework. At the end of the framework assembly, it is a simple matter to align the structure to specific required measurements to assure proper flight. Just shift the fittings needed to get the frame to match up with the measurements, build your frame straight and true and you're ready to tack the critical fittings in place.



Gluing

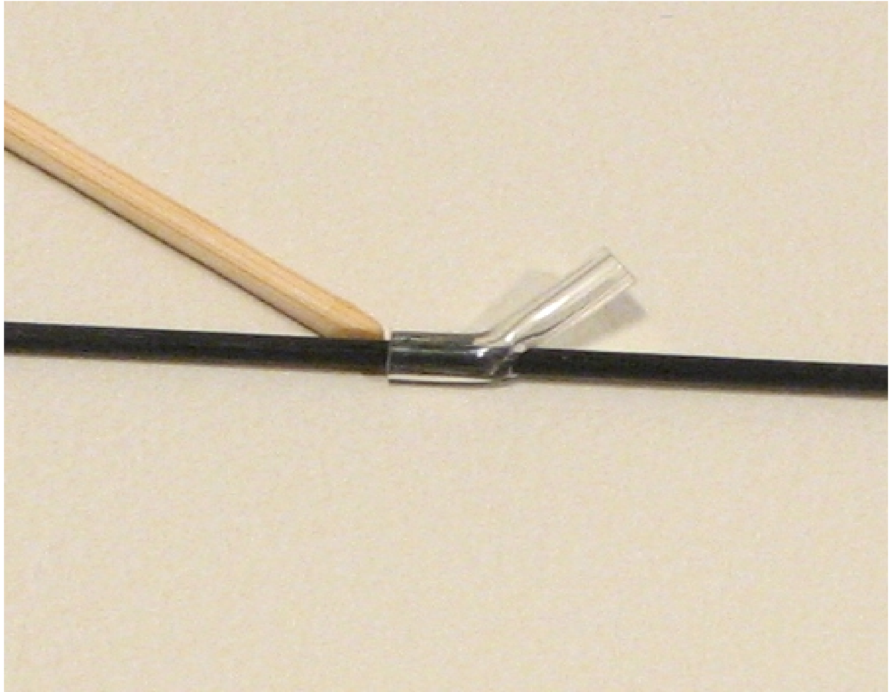
Some fittings can be glued and others need to stay removable. Since there are a number of ways to disassemble the plane for portability, use the rule that if it stays by itself don't glue it yet. You can always come back after everything is properly aligned and secure the fittings you won't need to remove if desired.

Only use thin or extra thin CA and be sure it's fresh and not starting to thicken from age. Set up a "glue pot" to prevent waste and only use the least amount needed to get the job done. If it starts to dry out, add fresh to a new clean location in the pot so as not to contaminate it.

DO NOT use plastic wrap, only a plastic bag or a blister package type plastic as plastic wrap will melt through. Only a few drops are added to the pot at a time and use a toothpick, skewer or other thin stick to apply only the smallest amount to the fitting. It's best to slice the stick off into a wedge end and dip it a few times into the pot to pre-soak up CA prior to applying it the first time to the fittings.

All that is needed is to have the stick end wet and press it slightly under the edge of a fitting for the glue to leech from the stick into the fitting and it's done. You'll know this is happening as it will change appearance and look wet where the glue goes. Don't over-glue as it only needs enough to keep the fitting from shifting.

If glued correctly, the fitting can still be removed later if repositioning is ever needed. All that is required is to use a thin, sharp scribe or awl, (or heavy needle seated in a wood dowel for example) and pry under the glued edge of the fitting to get it started. Then slide the point around the rod or tube to loosen the fitting completely.



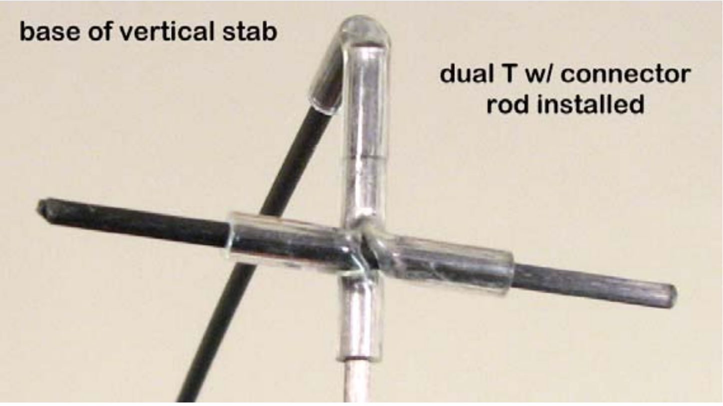
Fittings

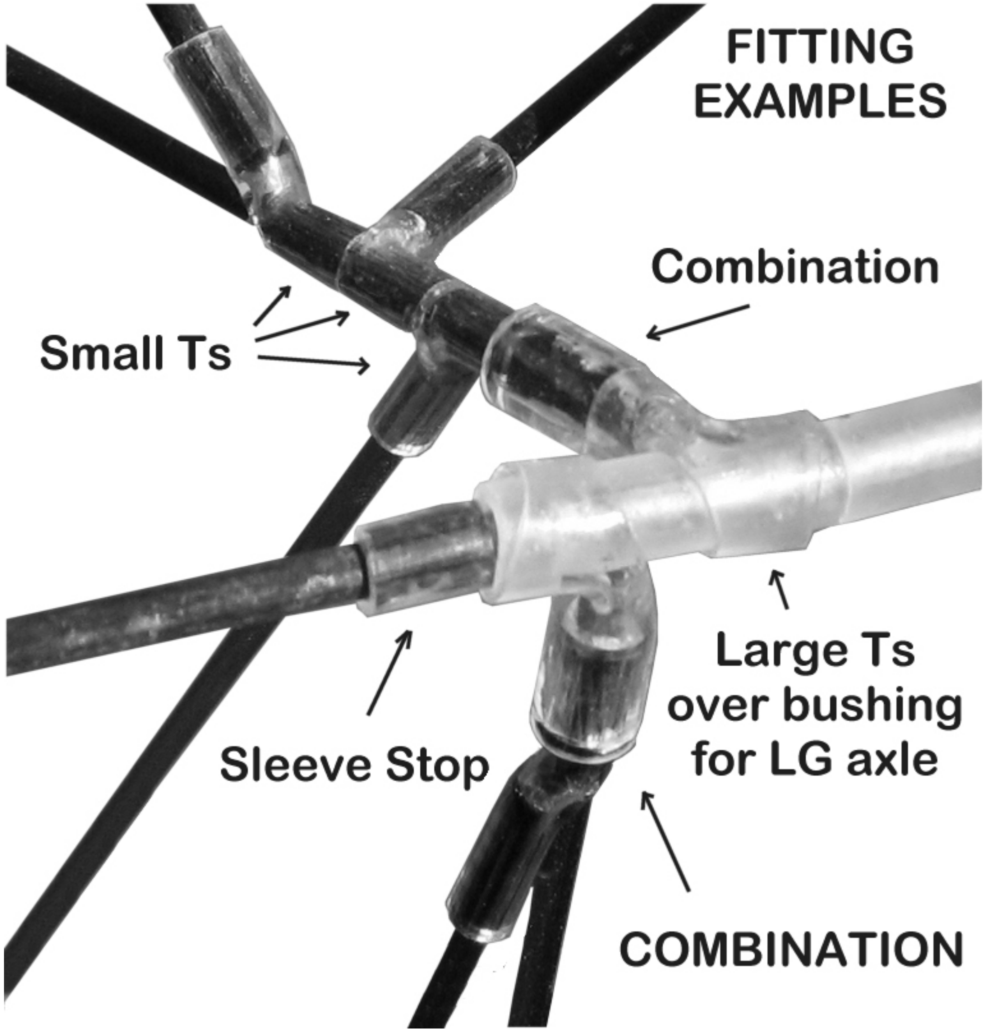
There are a number of different fitting uses but only three types and two diameter sizes to work with. The small diameter is used for "T"s and elbows plus variations for most size rods. The exception is the 1/4" long sleeves that are used to shim the larger diameter .125 ID "T" fittings when installed on smaller rods. These are also used as end stops for the wheels and such.

The beauty of these fittings is that they act like Chinese finger lock toys you may remember as a kid. They are easy to plug into but hard to remove without releasing the compression.

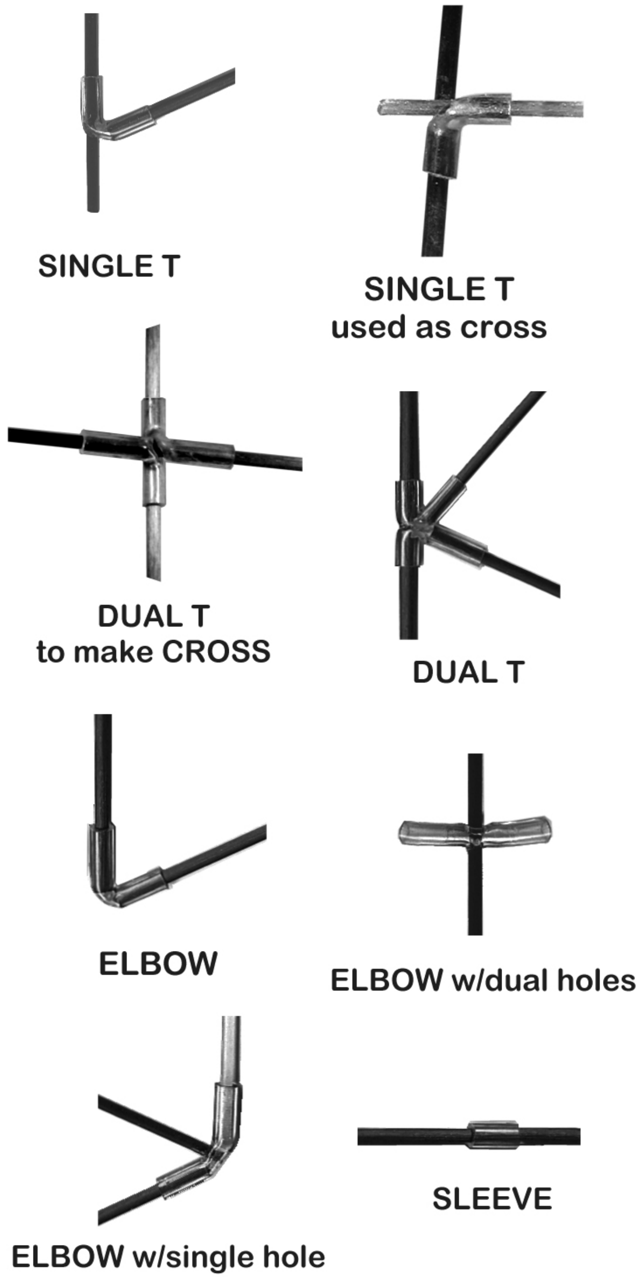
The example at right is the most complex junction on the plane and is simply made up of many individual single fittings nested close together. Each step to construct this axle junction will be covered as we go.

The dual T cross below is typical of the tail connections. This is the lower front of the vertical stab viewed from the bottom and will connect to the lower fuselage booms.





FITTINGS - SMALL DIAMETER



Small fitting notes

T fittings have one hole poked in them that is off-set from center slightly. Use the short "half" as the "top" of the T. This makes it easier to move it on thicker rods to position where needed.

When installing a rod in a T fitting, start in the end of the smaller "half" and once at the hole, twist the rod to help work it through. Some Ts require you to start the rod through the hole first and exit out the shorter end depending on the required location of the T on its rod.

The single and dual T crosses get short connector rods inserted through the fittings. This requires the connector rod to exit the hole in one T and for the dual, reenter the hole in the other T.

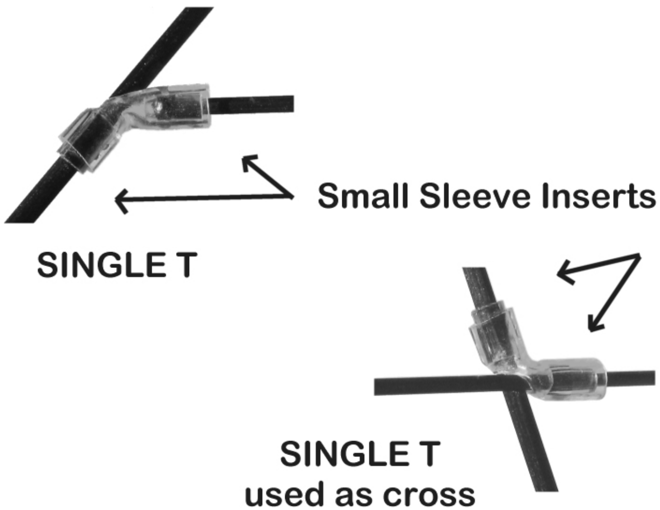
Here a thin pointed awl or "poker" tool is needed to get the rod started in and out of the holes in the fittings since they need to be stretched to fit both rods at the same time.

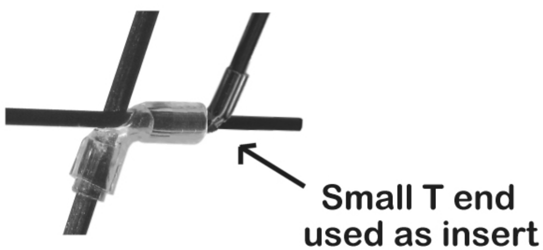
Elbows are just that. The Elbow with dual holes is used to connect the boom ends at the fin so it can just be slid over the center rod directly right through its middle.

The Elbow with single hole requires the middle inserted rod end to be glued. After testing the fit (twist rod as you insert in hole), just dip the end of the rod in CA, tap off any excess and insert it fully in the hole and allow it to dry before assembly. This is the best way to glue T base rods if required as well.

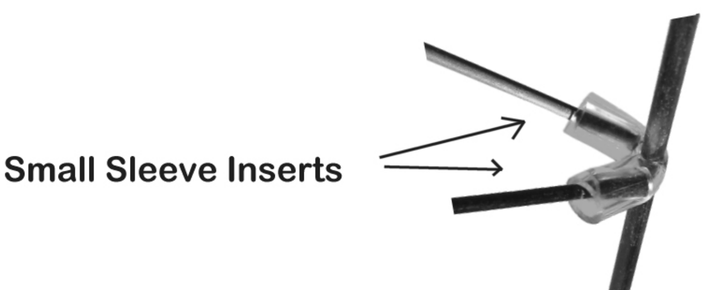
NOTE: Locations shown for all fittings are based on the center of the connected rod position or intersection, not the end of the fitting.

FITTINGS - LARGE DIAMETER





COMBINATION LARGE & SMALL Ts



WING RIB ELBOW

Large fitting notes

Use these examples as reference when a specific type fitting is called for in the step-by-step instructions. Note that the small sleeve inserts are not used in the ends of the large T combination type where the end of the small T takes its place.

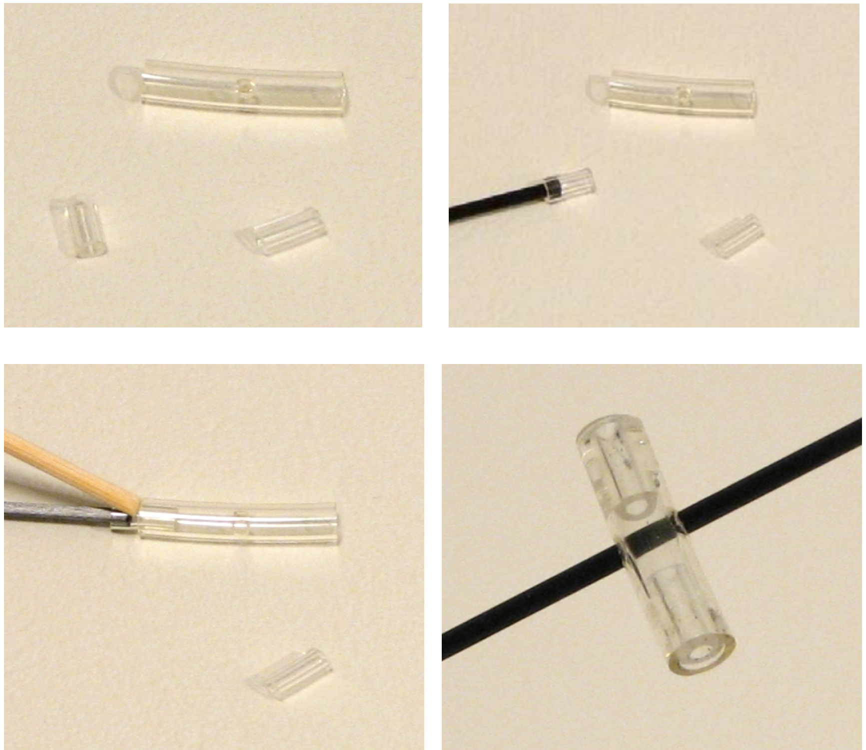
Wherever a smaller rod you want to stay removable is fitted into a large fitting sleeve insert, it's best to pre-glue its insert into the large fitting end first. This prevents the rod from getting glued in the process or having the sleeve slip out when removing the rod if not glued. Just partially insert the small sleeve in the large fitting, touch a little CA to the exposed insert and push it in flush quickly before it dries.

T fittings start with the same large fitting but the T top rod exits out one of the two holes provided. If being used on a large diameter tube like the LE spar fitting does for example, you can trim the Ts top length slightly shorter to ease installation.

For bigger rods needing a large T fitting with insert, you should first install and locate the sleeve inserts on the rod then slide the large T fitting in position over it instead of inserting the sleeve in the large fitting first.

If you find it difficult to get the small sleeve started on the larger rods, it can be stretched slightly first by inserting an awl, thin needle nose pliers, etc. Once on the rod it can then be slid into position easier by pushing it along with needle nose pliers. Fittings like these only need the large T glued to the sleeve once positioned to allow adjustments so be careful where the glue goes.

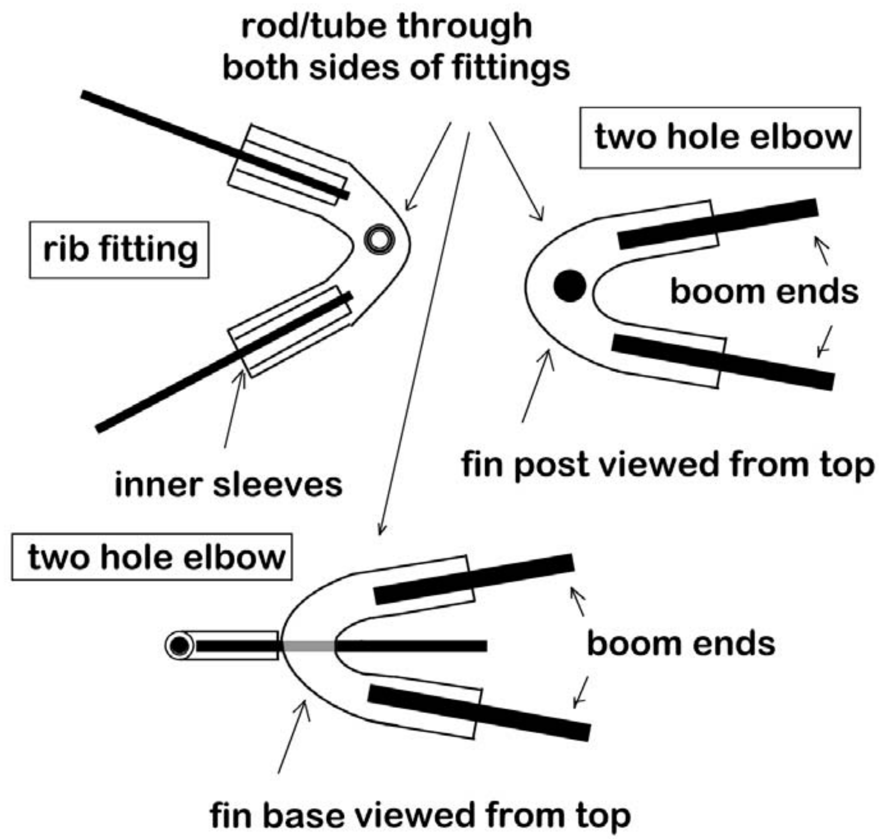
Following are the assembly steps for the rib fittings you'll make later. This procedure is also typical of large T fittings needing a shim to attach firmly to a smaller rod on either the top or base of the T or both. For Large Ts however, do not glue in the insert shim until directed in the step-by-step instructions.



TIP: For very high stress, high load connections (like the wing struts) you can "treat" the ends of the struts for better friction grip if you feel it's needed.

Simply dip the end of the rod in CA, hold or clamp so the excess drips off and dries thick at the end. Don't test the fit until it is completely dry of course. This can be repeated again if needed to enlarge the end for the amount of tension it can hold.

The following diagram shows a typical rib fitting with inserts and the use of the small two hole elbows for the boom ends on the vertical fin (stab).



Tail Surface Construction

The following tail diagrams are actual scans of the components so if you print them out full scale to match the 1 inch grid, you can build right on them. It's not really necessary however since if you assemble as shown using the correct length parts, you are guaranteed accuracy.

Since the pre-sewn fabric covers are based on these dimensions, be careful that all parts are fully seated in the fittings and you should end with a good fit.

The hinge posts of the control surfaces may be bowed slightly outward when completed but once covered they compress in some and will straighten up.

The fabric tail covers are sewn to act as very efficient and gap-free hinges and work great as long as the hinge posts end up parallel and the fabric is pulled tight enough.

Control Surfaces

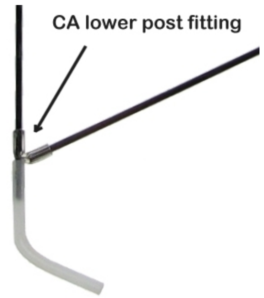
Start with the control surfaces since all three are the same. The only difference is that the hinge post of the rudder is 1/2" longer than those of the elevators. It uses a T instead of an elbow at the bottom of the post to allow it to extend out so you have something to attach a skid or wheel to later.

You can glue the bow ends if they want to pull out of their elbows from the bending loads but leave the diagonal support rods un-glued on the bow T fittings for fine-tuning of the covering fit later.

The rudder post lower T fitting should be glued to the post to prevent it from twisting during landing loads as well. Since it is a T and moveable, instead of trying to measure this fittings location on the post, you can simply match it up with the lower elbows on the elevators.

Tail Skid

The preformed poly tail skid allows ground steering and simply gets glued to the rudder post with CA. If you want to make up a tail wheel instead, just use the post to secure a wire wheel fork or use it to mount a pre-made assembly.



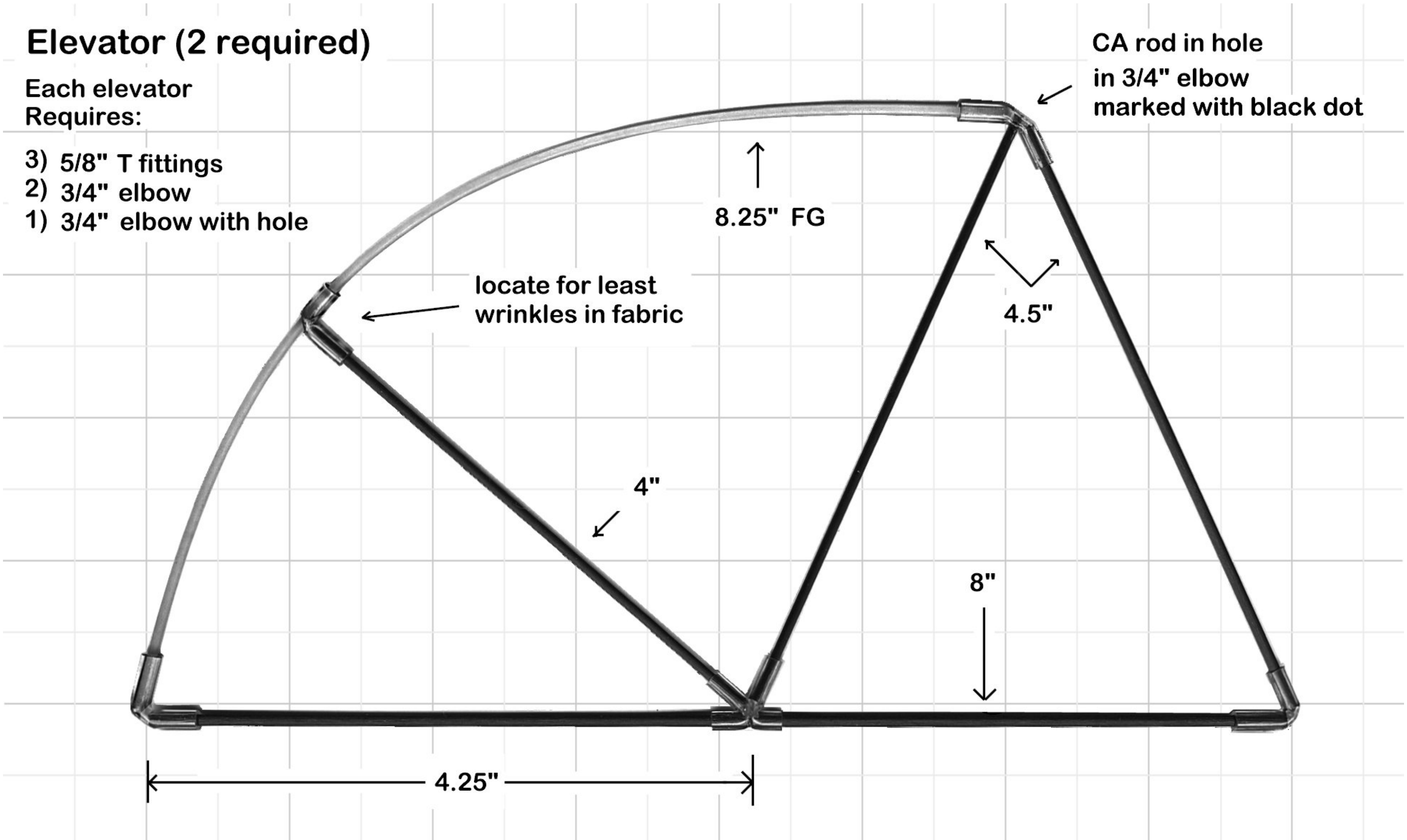
Horizontal and Vertical Stabs

None of the Ts added to the stab surfaces for connecting to the fuselage frame should be glued but just positioned generally in the locations indicated for now. If you need to glue anything it might be the bow ends again but be sure all needed fittings are added in the correct locations first.

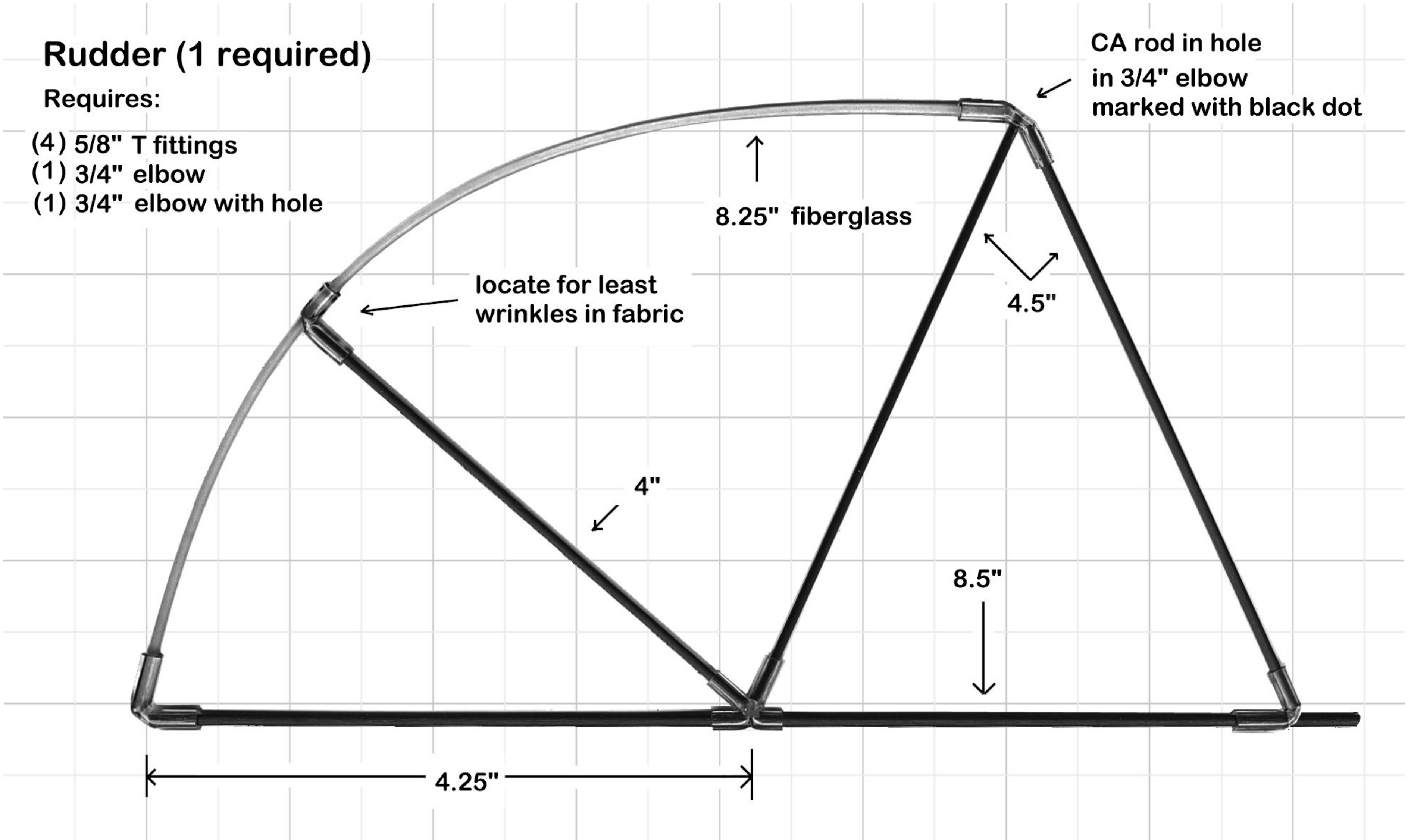
Except for the connection fitting locations, the horizontal and vertical stabs are the same except that the bow is longer on the vertical stab to create its base angle to match the fuselage frame. The same coverings are used on all three since they are open at the bottom and will be individually fitted around their bases anyway.

Don't worry about shortening any of the attachment fittings on the stabs as noted on the following scans yet. That is done when fitting the surfaces to the fuselage later.

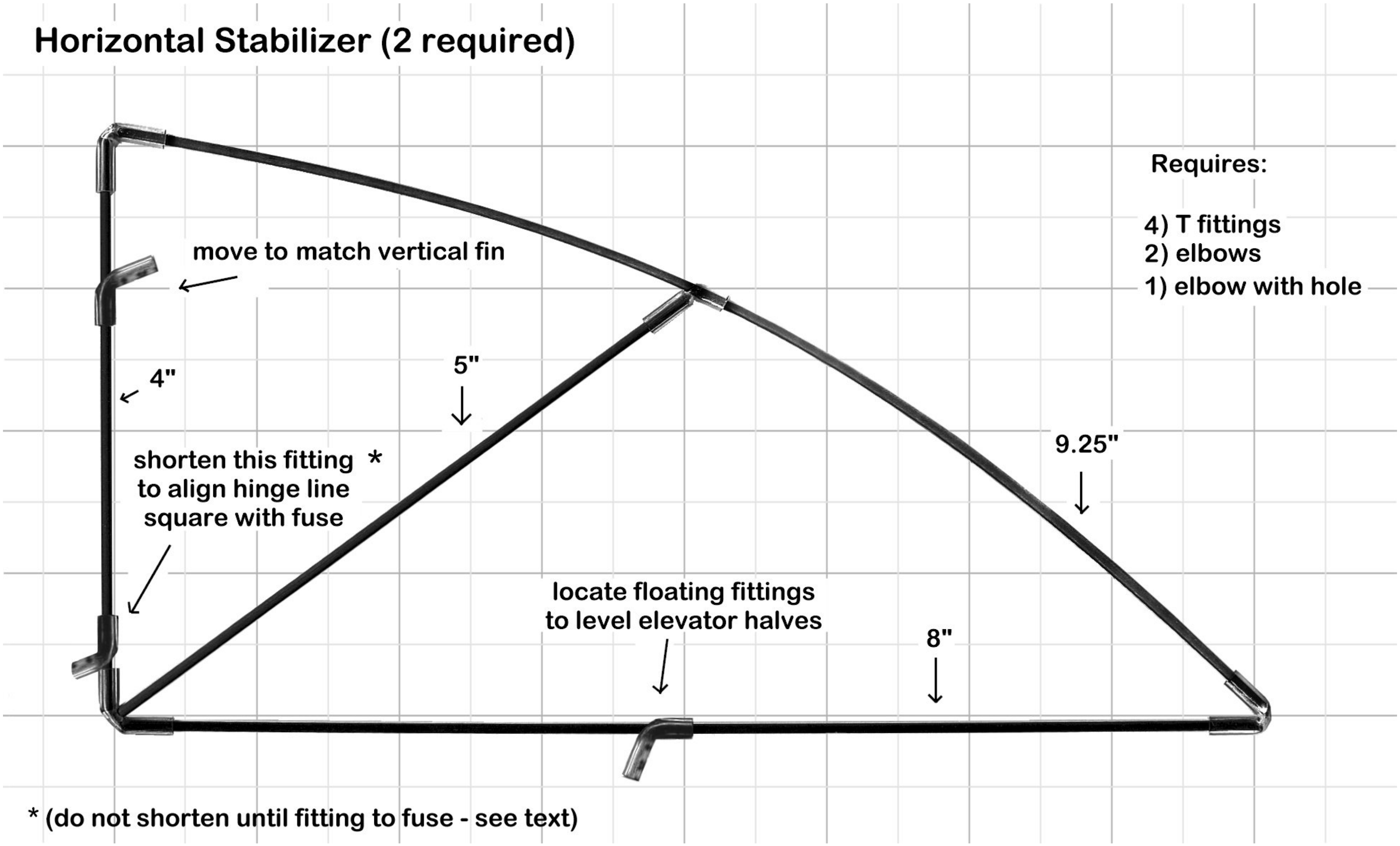
Elevator Diagram



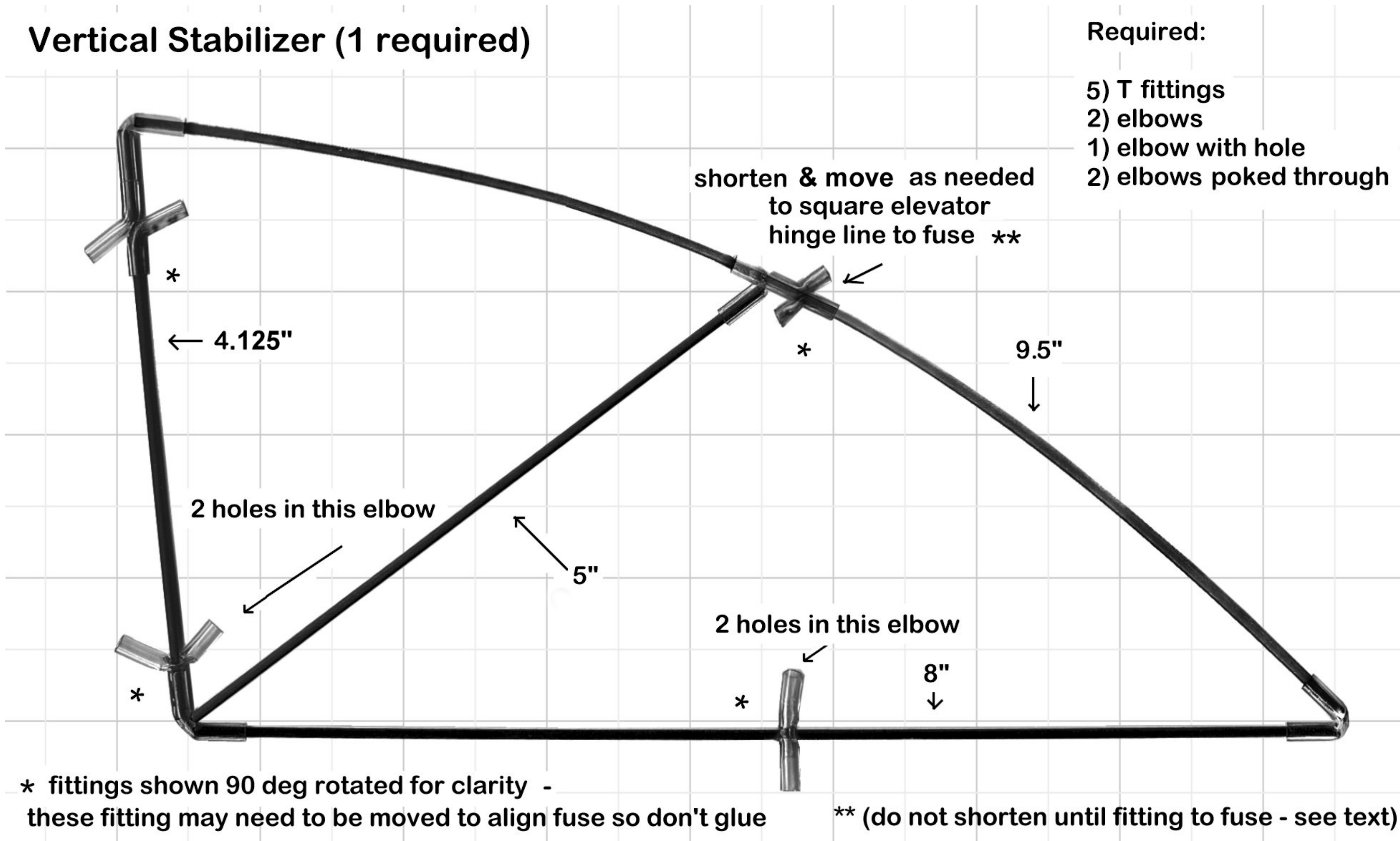
Rudder Diagram



Horizontal Stabilizer Diagram



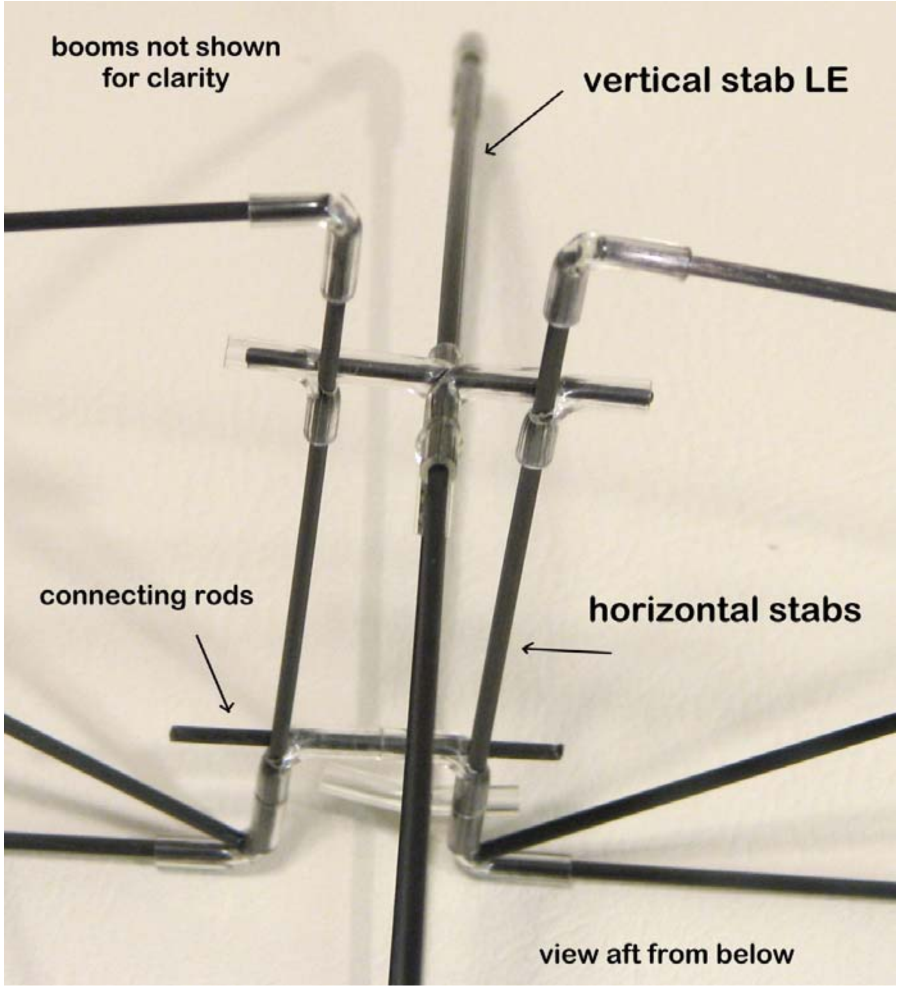
Vertical Stabilizer Diagram

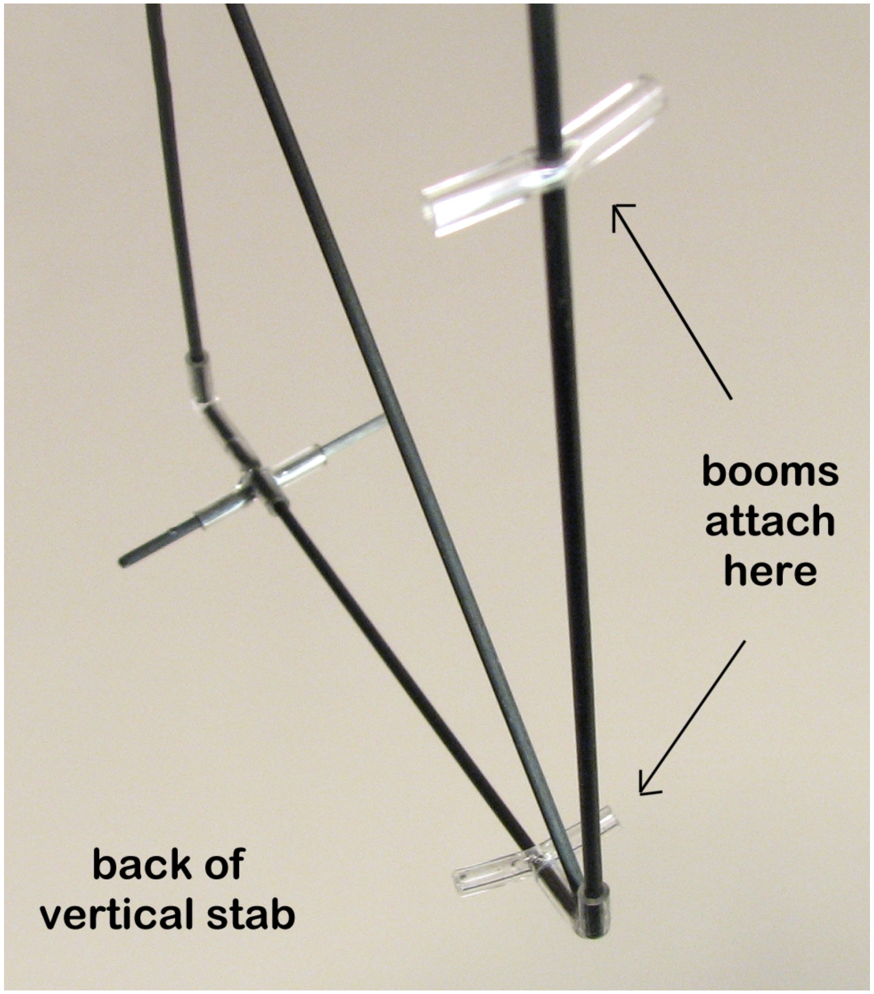


Tail Fitting Samples

Here are examples of how the attachment fittings are used on the tail for reference. The upper and lower booms are not shown yet to make it easier to see what is going on. The first picture shows the correct positioning of the fittings between the vertical stab and horizontal stabs. Note that the connecting rods are above the stabs. Once covered, this will allow them to fold down or with the rear pin removed, fold down and pivot forward to reduce overall packed height. More about this operation is covered in the Portability section.

The second picture shows the dual hole elbows used to connect the rear ends of the upper and lower fuselage booms.





Control Horns

We originally wanted to have a method of control horn attachment that could be done after the covering was installed and allow removal for service. DuBro 1/2A horns were tried on a larger prototype but proved awkward, heavy and over-kill.

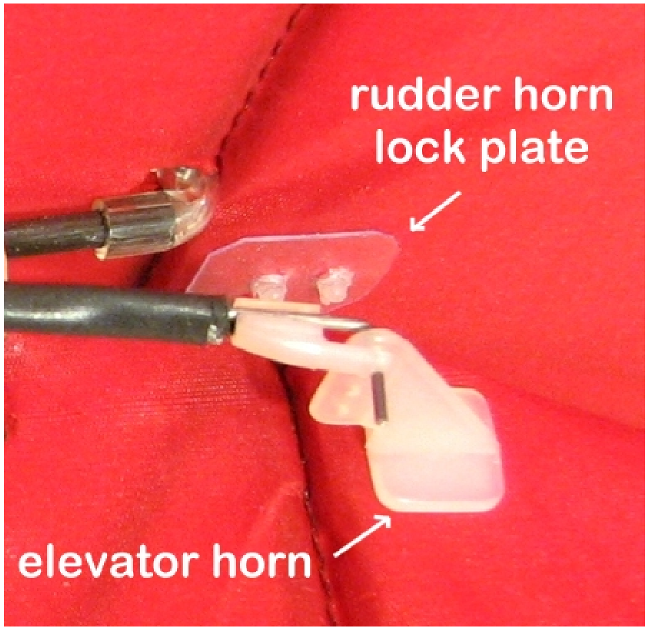
Finally we came up with a method to use the DuBro Micro2 style horns that are big enough as well as being strong and light. Normally these horns are made to punch into foam and be glued but by creating a box-like structure with blister pack plastic we found an easy, light and very strong method that is still removable if ever required for service.

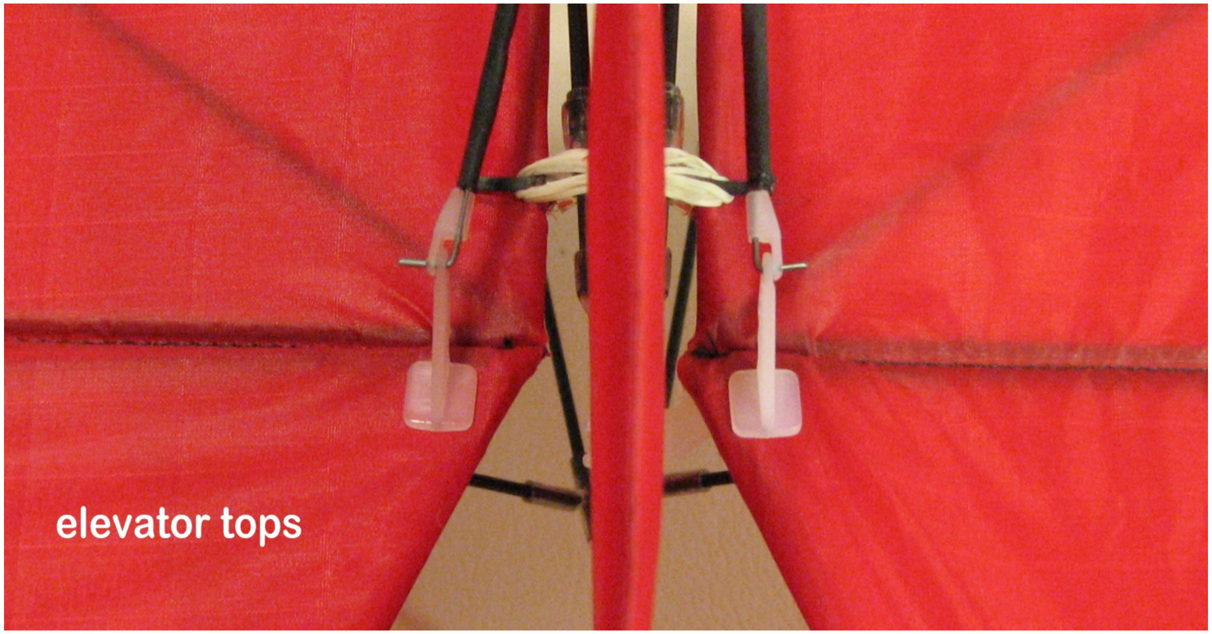
The included stripes of plastic need to be rolled around a rod to create a U shape that fits into the saddle where the horn needs to go.

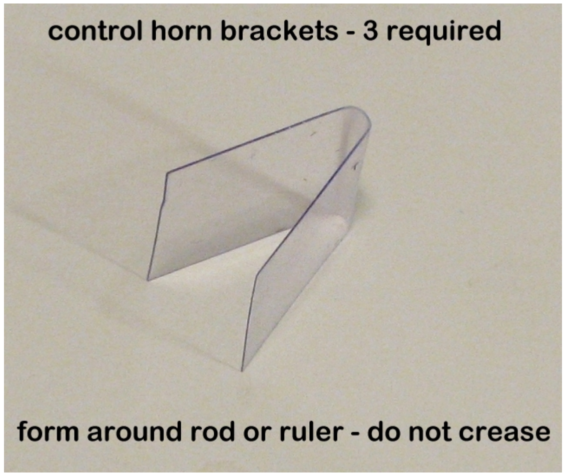
This U gets glued to the fittings around it then trimmed to follow the edges of the post and elevator baseline. Finally, the horns are lined up so the holes are exactly over the hinge gap about a 1/32 inch forward of the hinge post.

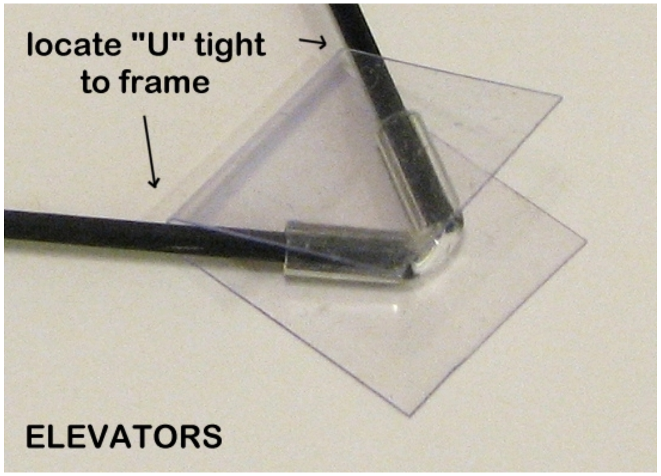
Small holes are either drilled or carved out with a hobby knife through both layers of the support. Once the covering is on, holes get punched in the fabric to match the ones in the U support and the horns are inserted.

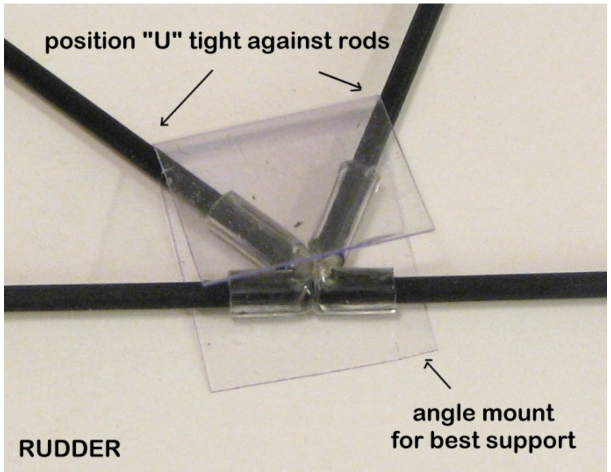
To secure, a plastic lock plate is cut and holes punched with the "poker tool" just large enough to insert the barbed pins through but small enough that they grip tightly. This provides a locking, snug sandwich. If the horn ever does get pulled loose, it's a simple matter to make another locking plate to fix it.





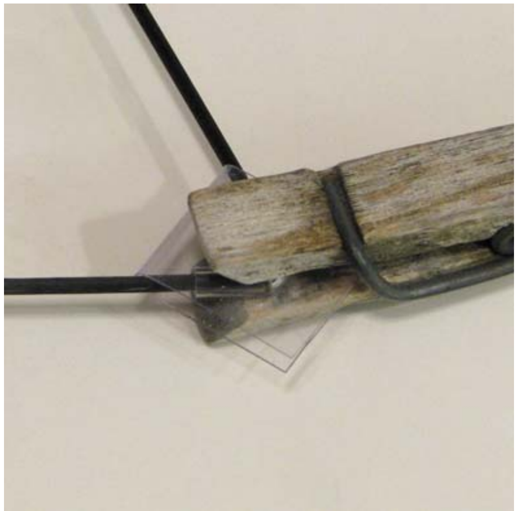


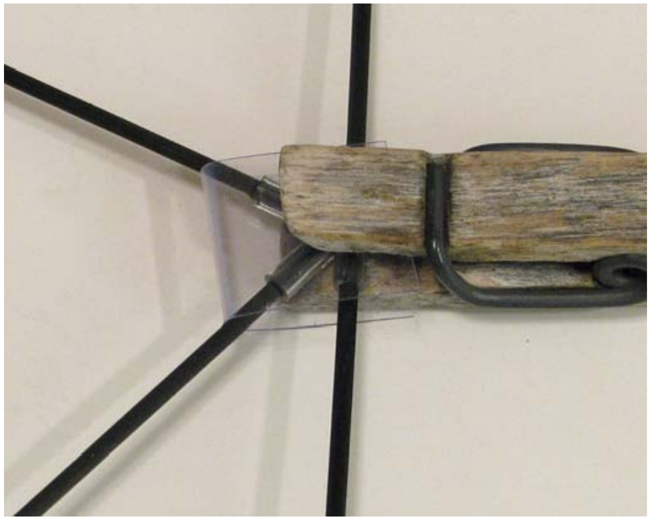


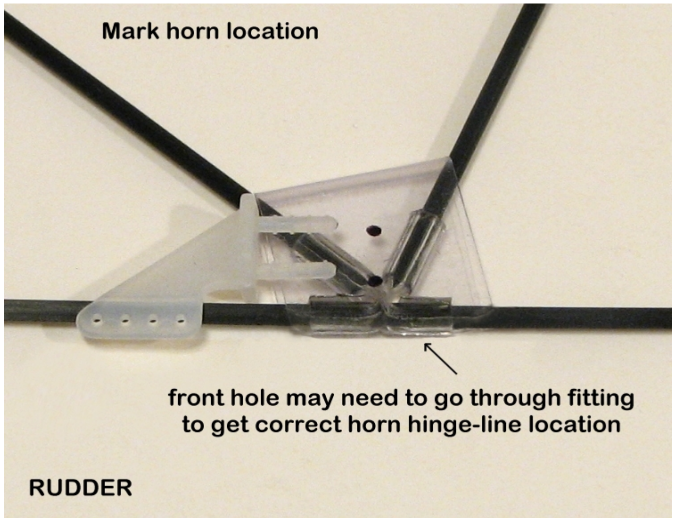


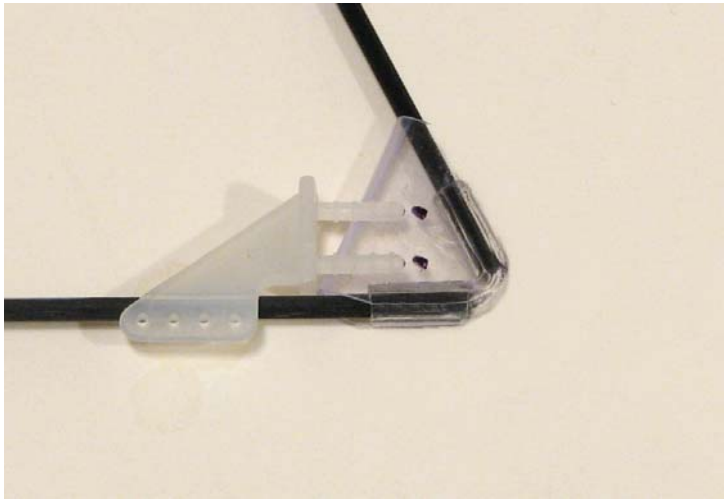
After the supports are glued, trimmed and ready, lay the horn on its side in position and get the holes lined up over the hinge line. Make a small mark with a Sharpie or scribe (poker tool) at the end of the posts where the holes need to be.

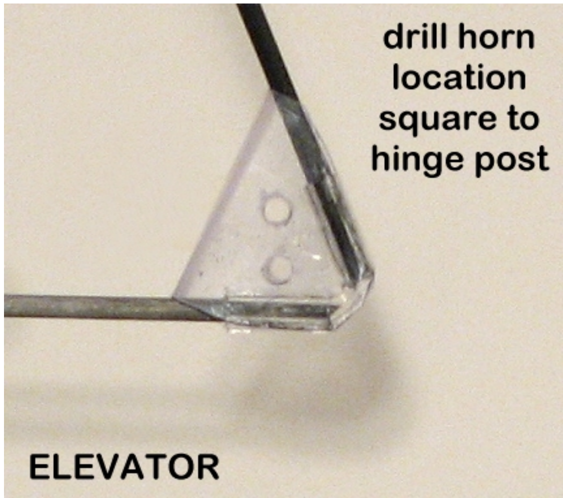
Once the top holes are made just large enough for the posts to be free to enter and exit unrestricted, mark their locations for the other side of the support. If you find them off the mark, elongate the holes to correct the error now.

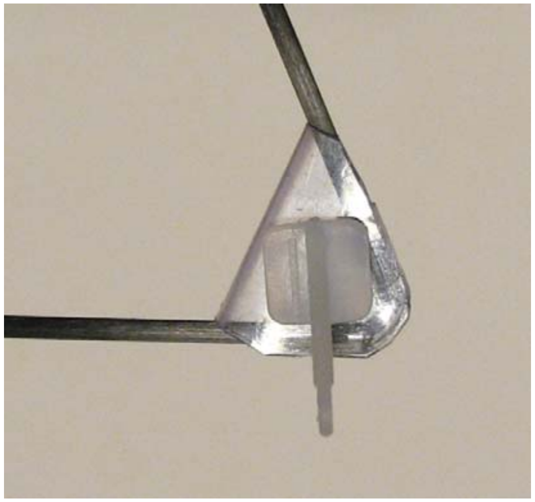




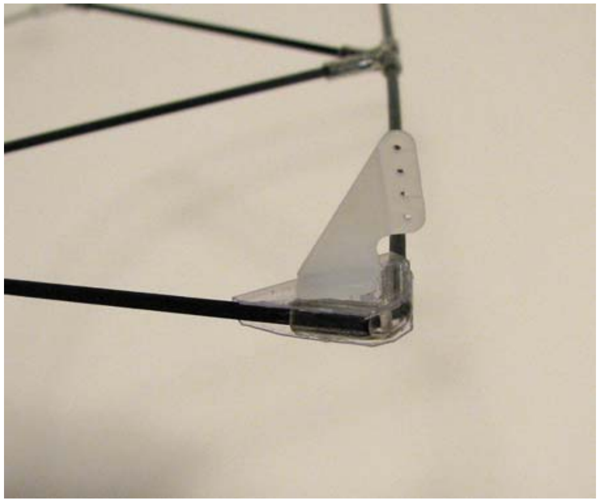


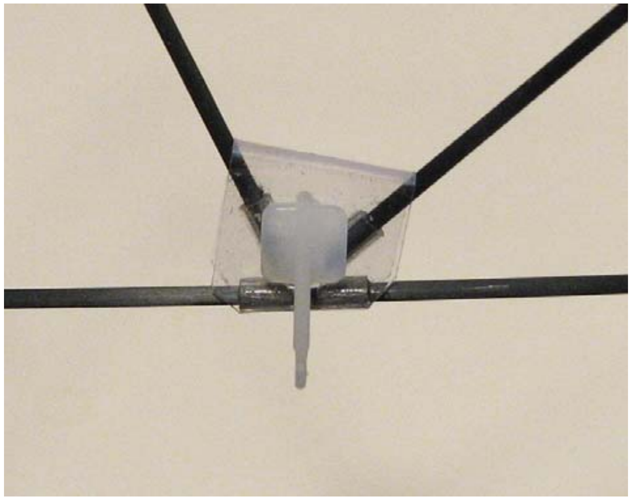


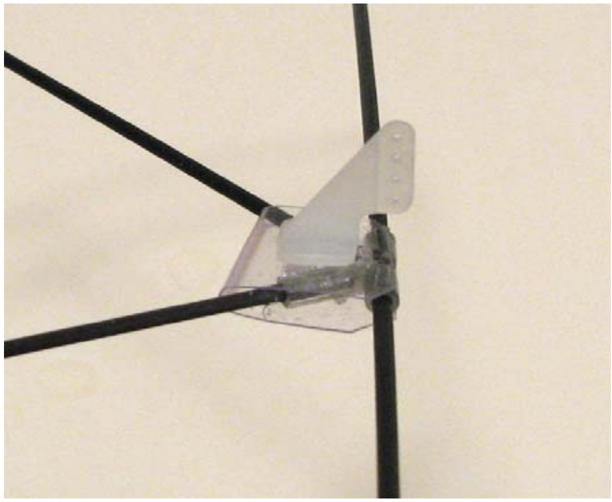




Using the poker or scribe tool centered through the holes, pierce them just enough so you can get them started from the other side.

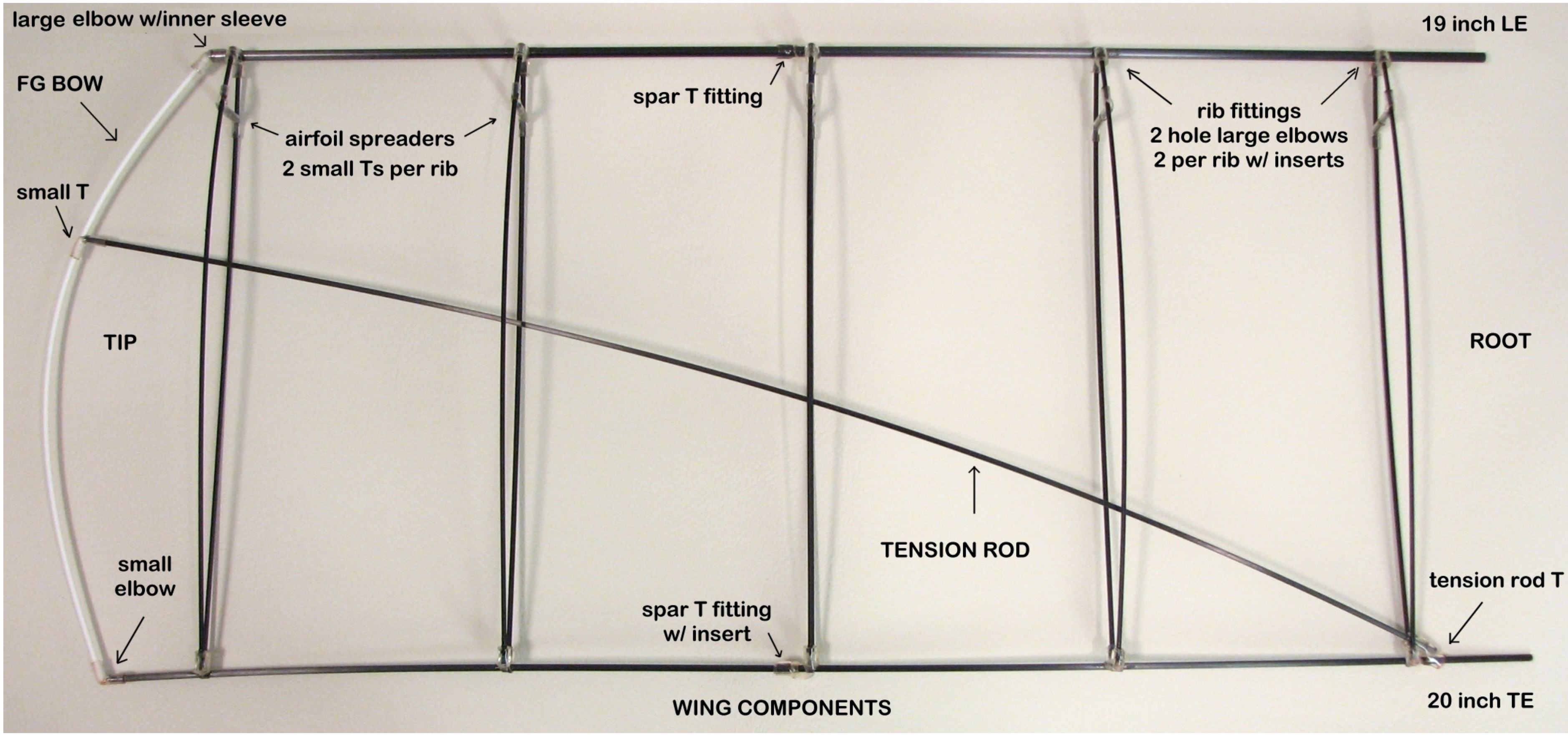






Assure that the elevator horns match each other and all have just a little overhang when compressed to align the linkage holes over the hinge line. (Note elevator horn on left is not down tight and square yet like the rudder horn is on the right) Also try to keep the horns square to their hinge posts.

Wing Construction



NOTE: FG = fiberglass - LE = leading edge - TE = trailing edge

Airfoil

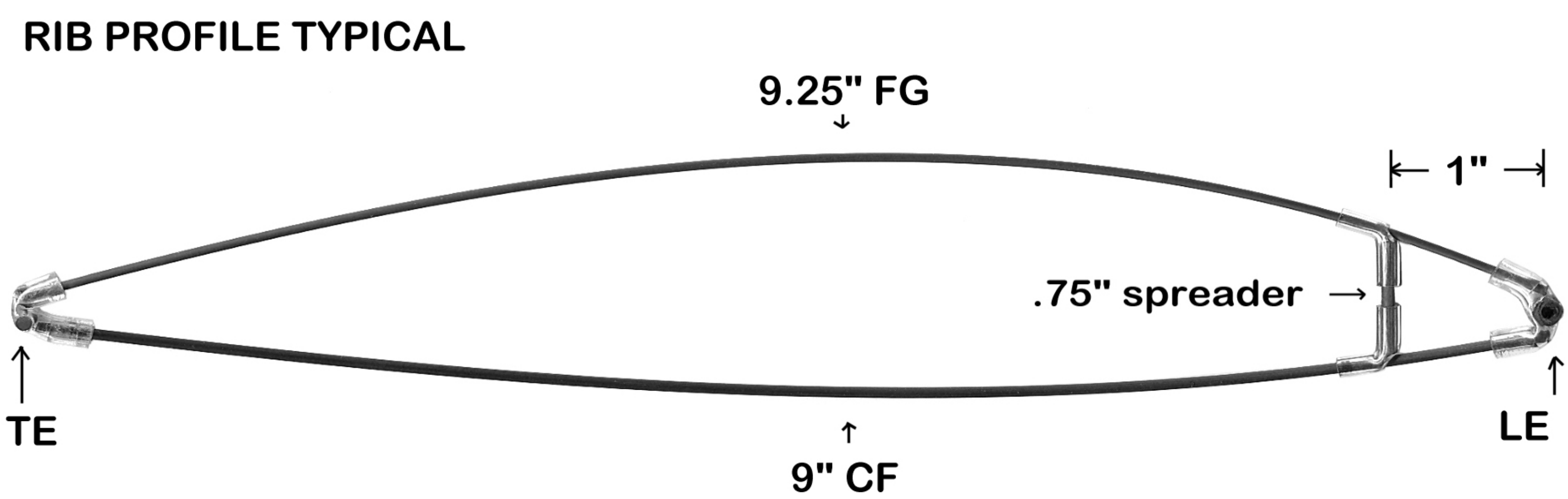
The airfoil shape is created with the different flexibility and lengths of the upper and lower ribs. The upper ribs are fiberglass and 1/4" longer than the lower carbon fiber ribs. This gives a nice semi-symmetrical section that has proven good all around performance.

Of course if inclined, you can always leave the rib spreader T fittings unglued and experiment with different airfoils just by changing their position and/or spreader rod angle or length. You can even vary the airfoil out the wings if you want.

This is one of the benefits of the Carbon Primes' flexible structural design and can be like having your own aerodynamics experimentation lab. ☺

It's advised to build and fly the plane "stock" however until familiar with it before experimenting so you have a basis to work from.

Note that it is much easier to assemble the ribs when the rib fittings are already on the LE and TE so follow the step-by-step instructions coming next.



Ribs

There are 5 ribs per side and they are all the same size. Make up 20 large fittings with inserts glued in flush in both ends. (Refer to page 15)

TIP: if the LE tube and TE rod has one end smoother than the other, use it as the root end where it will be slip fit into their connectors on the fuselage .

Work 2 of the rib fittings over the leading edge (LE) tubes through both holes in the sides of the fitting and 2 over the trailing edge (TE) rods the same way. These will be the OUTER 2 ribs counting from the wing tips in.

For the spar fittings, start a large fitting over the LE from the root end and exit it out through the hole so it ends up a T fitting, angled toward the root.

For the thinner TE rod, do the same but first add a small sleeve on the rod near the correct location prior to installing the large spar fitting over it. They will end up just outboard of the 3rd rib.

Add the remaining 3 inboard rib fittings to the LE and TE. Lay out the fittings roughly into position.

You'll need to install small Ts to each upper and lower rib rod for their spreaders and locate them 1 inch from an end. Do not glue them to the ribs yet however.

Be careful with installing the rib parts that you end up with a left and right wing and not two of the same side. (voice of experience) ☹

Position the LE and TE flat on your table and insert the lower ribs fully into the fittings with their spreader Ts towards the LE. Glue the lower ribs fully into the LE and TE fittings now but be careful not to glue the rib fittings to the LEs or TEs yet.

Add the upper ribs the same way and install the 3/4" spreaders to the small Ts as you go to complete the airfoil assemblies.

Hold the LE and TE together at each station when gluing the upper ribs to keep them inserted fully into the fittings until they dry. Adding heavy bands around the LE and TE can help this task but don't make it so tight that the rib rods want to poke through the fittings.

Since you glued the lower ribs first, note the shape the TE fitting takes in the rib scan above. This makes for a flatter wing bottom.

You want the **center** of the LEs and TEs at each station to be as close to 9 inches wide as possible. The fabric wing cover is sized for this so if the wing chord ends up too wide then fit could suffer when installing it later. Sight along the wing to assure you are getting it straight and even.

Again, don't glue the rib fittings to the LE or TE yet.

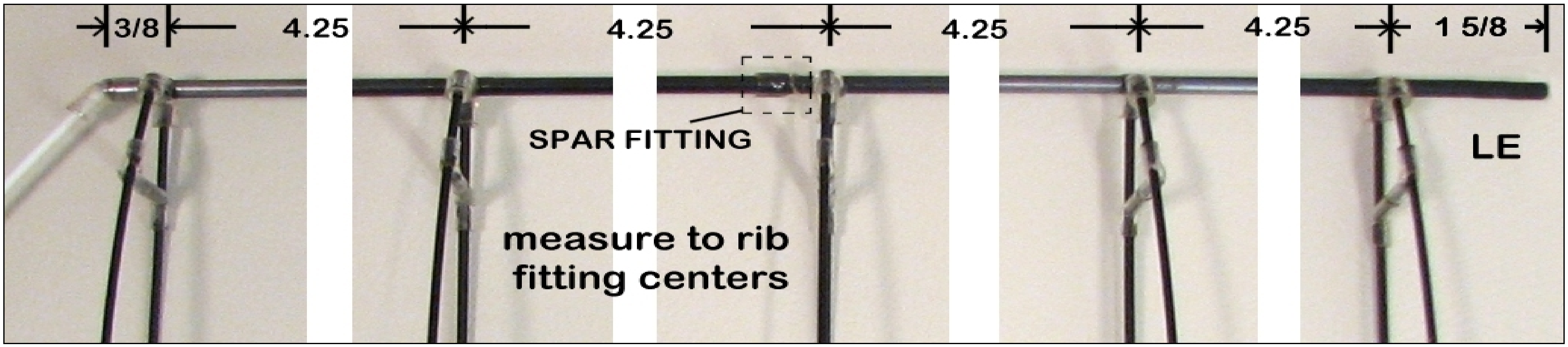
Rib Layout

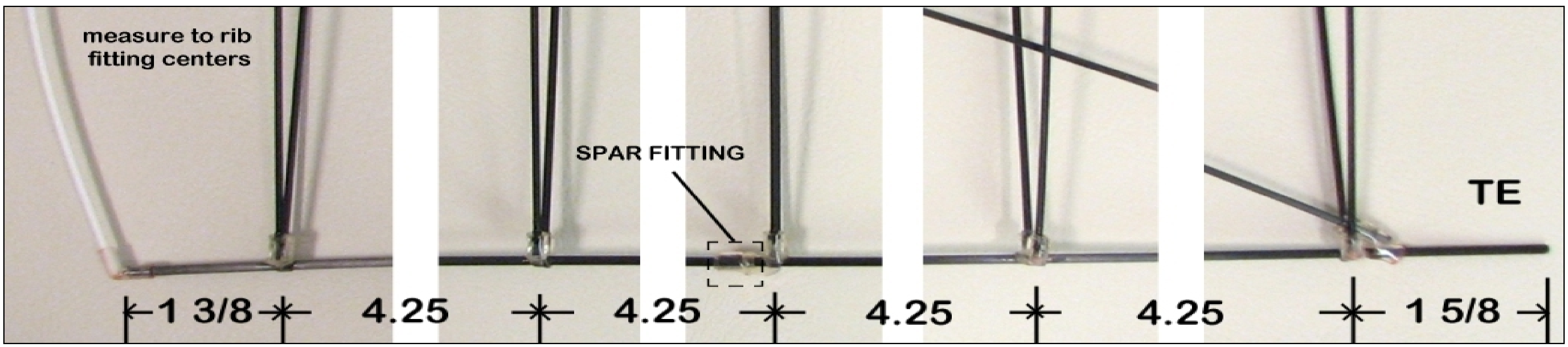
You want to layout the rib positions carefully centered on each rib fitting. Start from the tips and work inboard and equally space as shown on the top view diagram. Pay special attention to the different distances from the tips between the LEs and TEs of the outboard ribs. If correctly done the root ribs should end up equal distance from the root ends of the LEs and TEs.

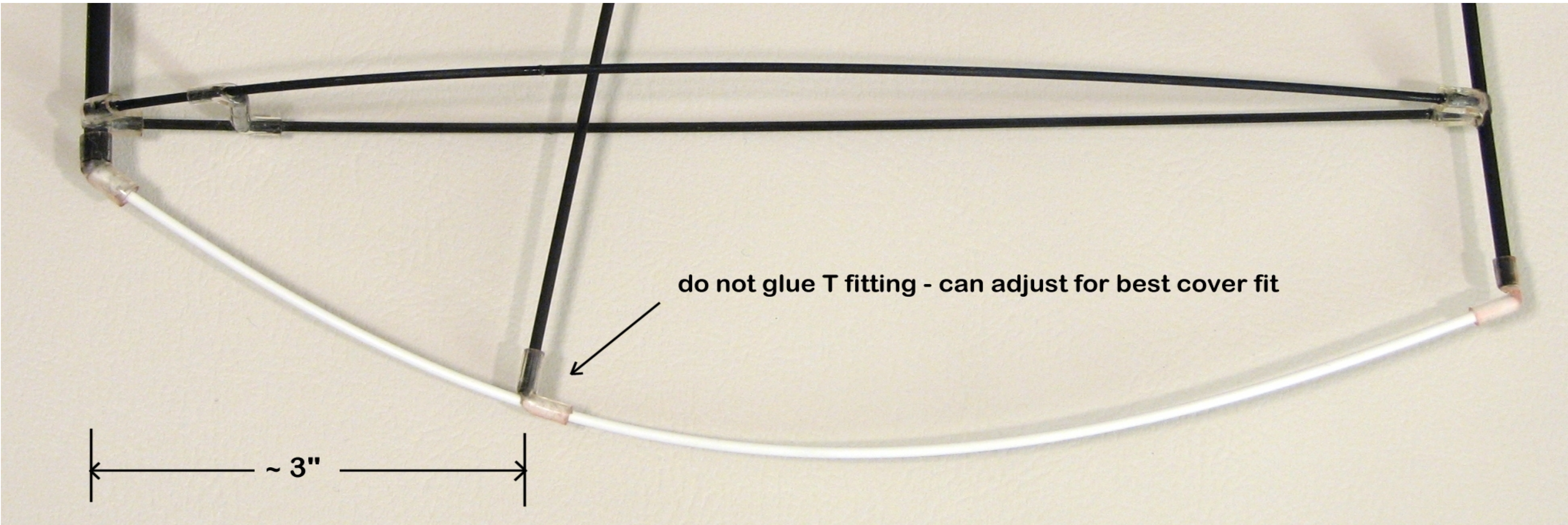
You want the left and right LE fittings to match and the left and right TE fittings to align as well. Butt the two wing halves together at the LEs and check and do again with their TEs together. This rib spacing is critical for the flat fold-up ability shown at the end of the Tension Rod section.

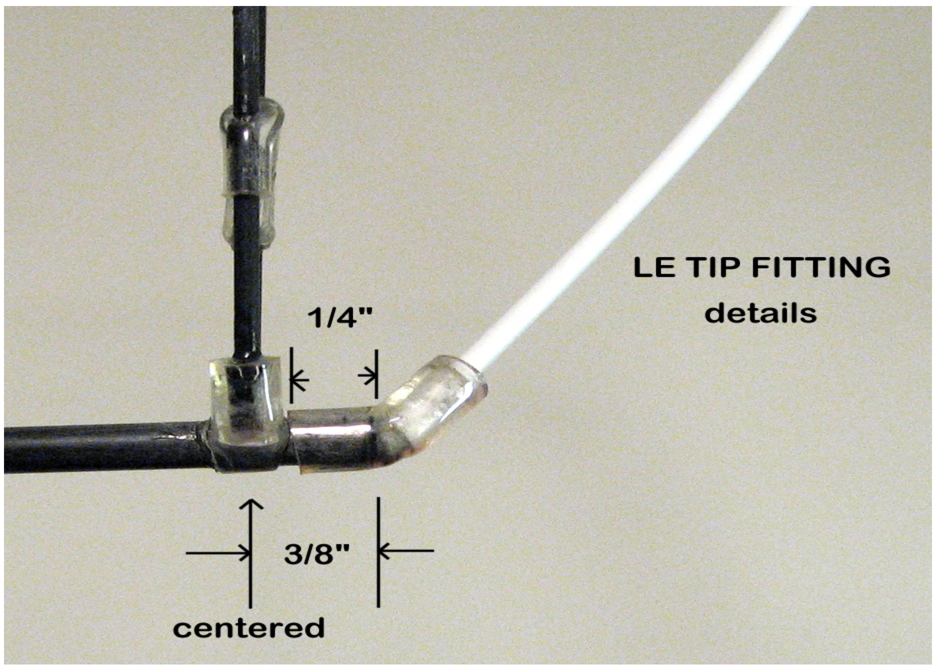
Once satisfied with their positions and straight orientation to each other, carefully glue all rib fittings in place at the fronts of the LEs and rear of the TEs only keeping the wing panel as flat as possible so no twist gets introduced.

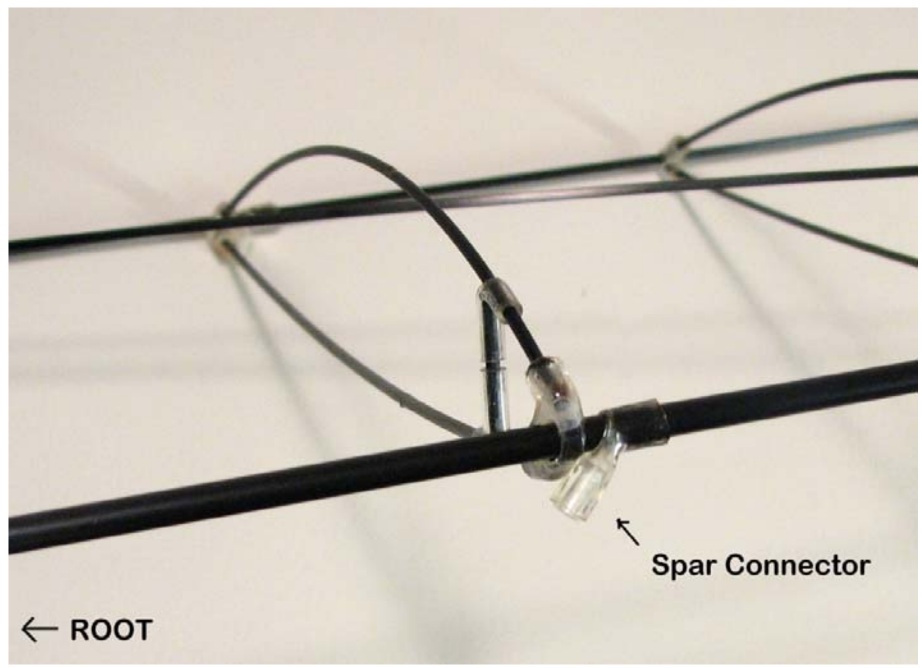
Finally, align all rib spreaders by sighting down the wings. It's much easier to measure the root and tip ones and eyeballing the rest than to measure each separately.






do not glue T fitting - can adjust for best cover fit
~ 3"


LE TIP FITTING
details
1/4"
3/8"
centered

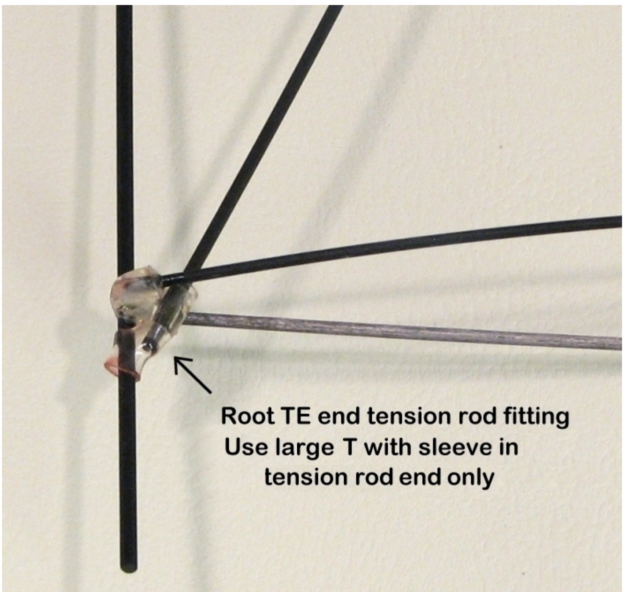

Spar Connector
← ROOT

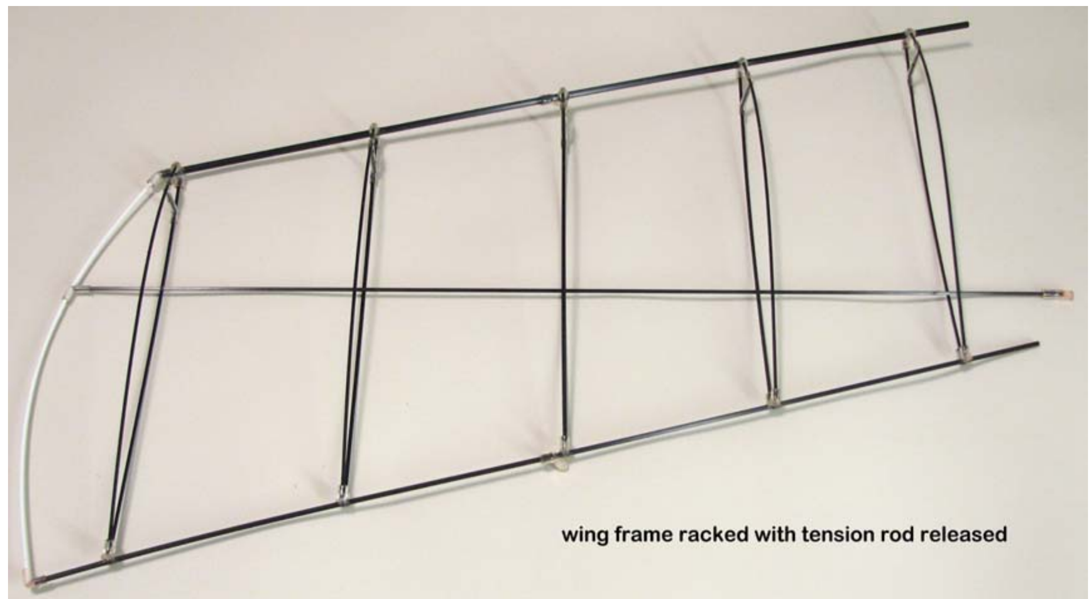
Tip Bow

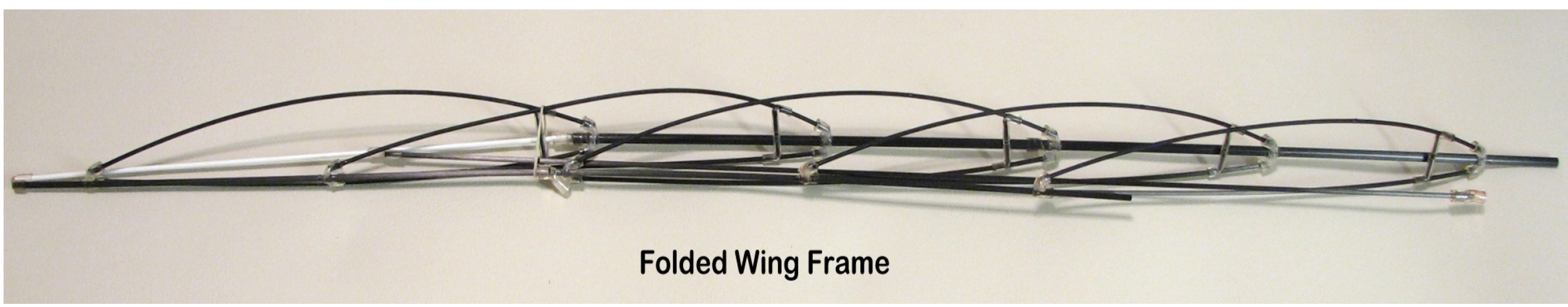
Add a small T to the tip bow rod. This bow gets attached with a large fitting elbow over the LE tube tip. Only insert it 1/4" over the LE so that with the outermost rib against it matches the measurements as shown. Add a small sleeve in the exposed end where the tip bow seats. The tip bow TE fitting is just a standard small elbow. Be sure the tip bow is fully seated in both fittings. (Note: small TE elbow can be trimmed shorter if needed to get tip bow fully seated.)

Tension Rod

The diagonal rod through the center of the wing allows easy removal of the wing cover once released. When racked and cover removed, the frame folds flat when collapsed for storage or transport. These rods are put under slight compression when the wing TEs are inserted into the rear wing joiners and hold the rods root fitting up against the root rib. Use a large T for the root end positioned so the fittings long “half” receives the tension rod. Add a sleeve insert in the tension rod end half only, not in the TE side to allow easy removable.







Wing joiners

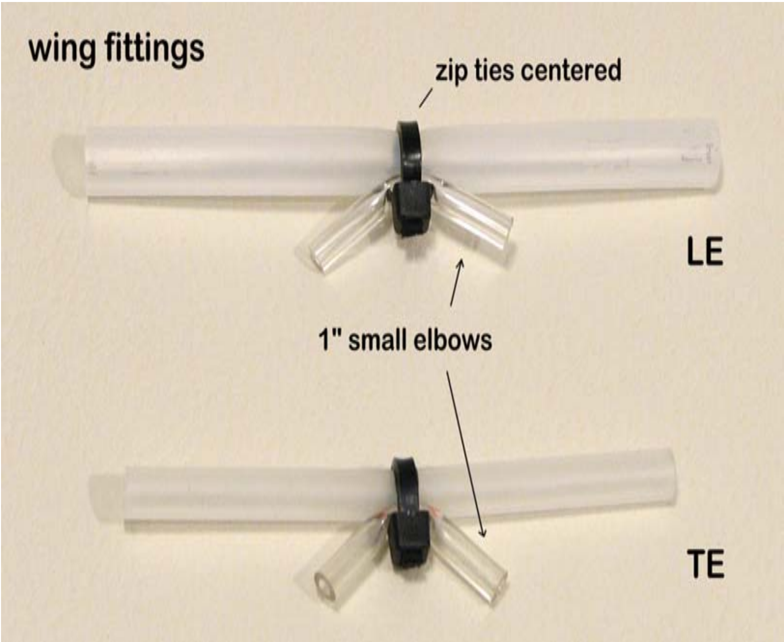
Assemble the wing joiners by measuring the fitting centers and cinching a zip tie around them tightly as shown. You want them tight enough that the poly tube actually compresses in the center and acts as a stop to keep the wing LEs centered. To get it tight enough, start snug by hand, double check centers and while holding the tie end with pliers or vise-grips, push the lock hub on the tie away from you with needle nose pliers resting on the lock hubs sides.

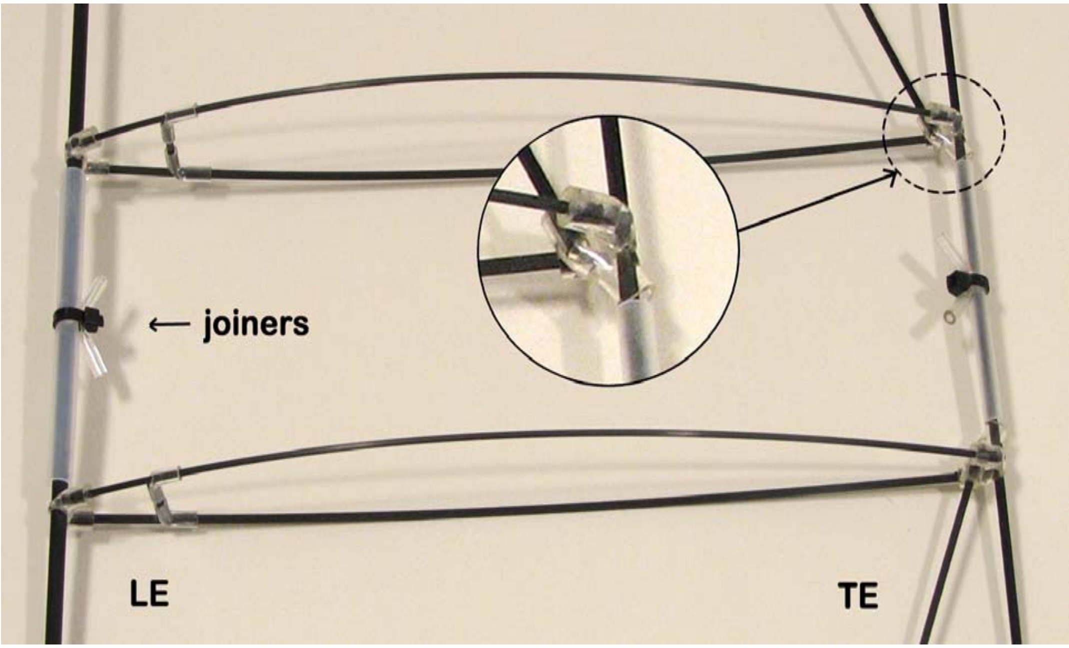
The wing halves just slip fit into the joiners and are held tightly inserted with the wing bags connected in tension with bands at the root.

Test fit the wing halves without covers now with the TE joiner pushed and held fully against the tension rod end fittings holding the rods slightly bowed. Check that the LE tubes are straight in line with each other. If they are swept forward, you can trim some from the TE joiner ends. If sweep back you can either reverse the tension rod fittings using the long "half" on the TE or just add fitting material shims to the TE rods up against the tension rod fittings to fill the gap. NOTE: these mods can effect wing cover tension so unless the sweep is severe it's best to wait until fitting the covers to adjust.

The elbow fittings on the joiners connect to the tops of the A frames and need to be tight on the A frame ends. If you want to be able to remove the wing in one piece without removing all the rubber bands that connect the two halves, you may later want to do the rod end treatment mentioned in the fitting section if they do not seem tight enough once installed. Otherwise, you can always glue them in place on the A frame tops and remove each wing half separately from the joiners.

NOTE: Again, wait on any gluing until you are sure you need it to allow for maximum portability options.





Portability

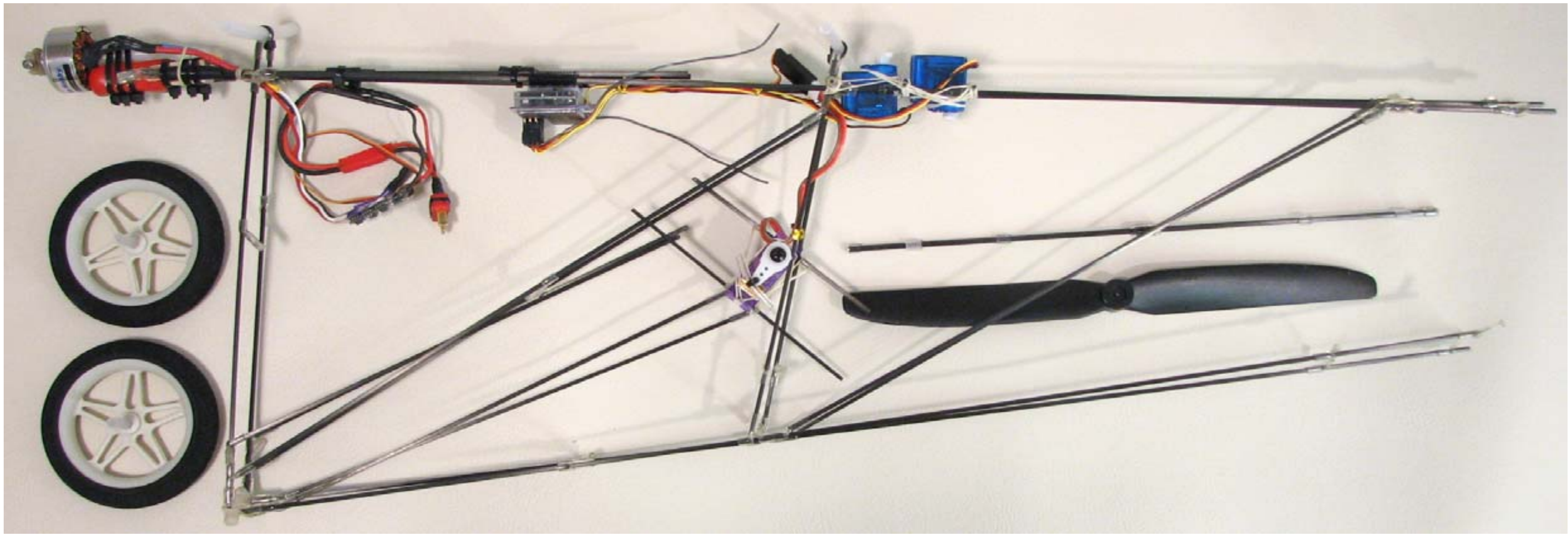
Before we begin assembly let's discuss portability options briefly. Even if you just pull the wing as one piece and store the plane intact, it's durable enough for rough handling and doesn't take up all that much room. Generally, the shorter you need the package, the more work is involved. Removing the wing cover bands releases the two halves with the wing joiners staying on the fuselage. For flat packing you can elect to leave the fuselage full length and just pull the axle and rear A frame base rod, fold the elevators down and compress the A frame uprights together. That's the quickest method.

Next is the need for a smaller and shorter, flat package. Besides the above, the rear horizontal stab pin can be pulled and the folded elevators pivoted forward to take up less height. To shorten the package more, the motor mount extension can be pushed back along the upper booms leaving only a couple inches extended in front of the wing as shown. Next, the upper and lower tail pins can be removed and boom ends disconnected and all tail surfaces removed for another four inch length reduction. For an even shorter package, the motor mount extension can be pulled completely out making it only as long as the upper booms.

If it is too tall, the fuselage can be further compressed by removing one end of the diagonals, removing the lower booms and swinging the A frame uprights flat to the upper booms. Stack the now separate lower booms with the uppers and you end up with just a small diameter bundle of rods the length of the upper booms.

Alternately to all of the above, the axle could be left installed and the fuselage collapsed in the horizontal direction instead of the vertical as described above once the tail is removed.

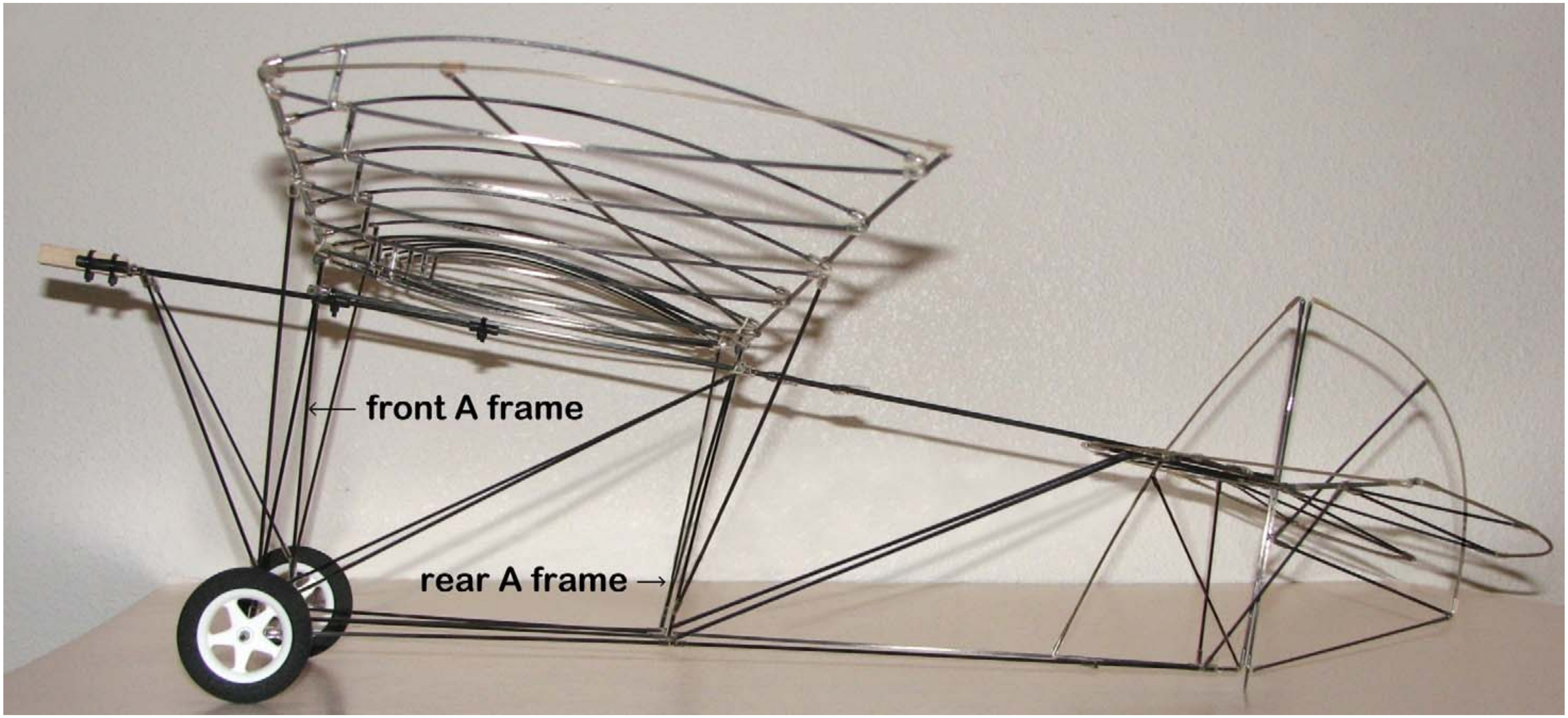
As you can see, there are lots of packing options so consider your needs as you build and don't glue any fittings unless required in the instructions since you may want them detachable later.



Above is the fuselage with axle and tail removed. The A frames are collapsed and motor mount retracted. Size is about 24" x 8" x 2". Wing halves are about 21" x 9" x 1" each un-collapsed.

Fuselage Construction

The fuselage consists primarily of two A frames supporting the wing LE and TE. They are connected at the top to the twin main upper booms. These booms start at the front A frame, connect to the rear A frame and go back to the vertical stabilizer hinge post. The front A frame base is the landing gear axle. The lower booms extend from the axle back to the base of the vertical stabilizer. The remainder of the fuselage is mostly support diagonals and the motor mount extension.



Upper Booms

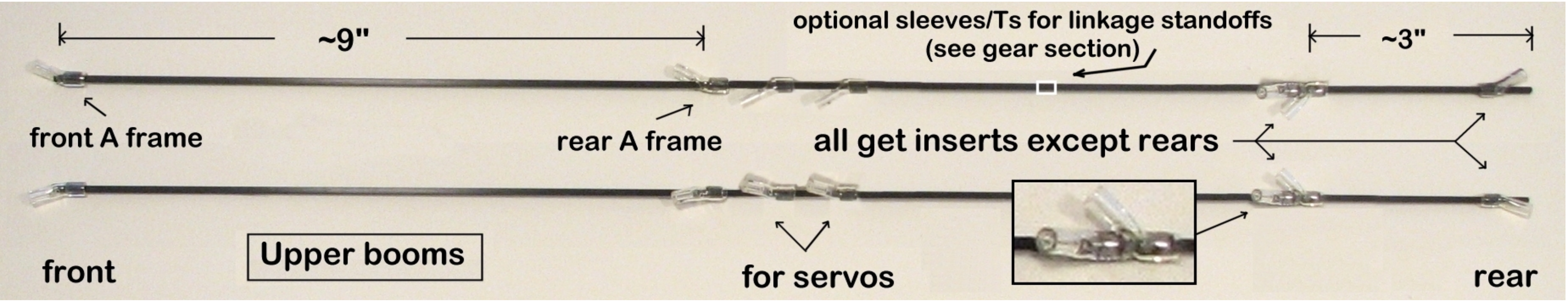
Large T fittings are used with small sleeve inserts on the upper booms to attach the A frames, servos and tail using connector rods.

First locate a small sleeve roughly in position on the boom and then add the T fitting over it and continue to next fitting. All Ts angle forward except for the rears. See the fitting section for more details on this operation since the sleeves are a tight fit.

NOTE: The standard servo installation (shown above) uses the rear A frame connector rod as the front servo rail with the next rail back being shared between the two servos positioned with one servo inverted. If you have other requirements or preferences as to location, position, etc. see the gear section first as you may want to add extra Ts at this time and/or relocate them (like for linkage standoffs). If in doubt, add them now as any extras can be cut off later if not needed but it's hard to add them after the plane is built.

Note that the front two pairs of Ts for the A frames angle outward. The next two pairs back are for the servo rails and angle inward. Next at the rear are the fuselage diagonal connectors which angle down (shown up in the picture). Just behind them are the front tail connectors angled in and finally the rear tail connectors that angle out.

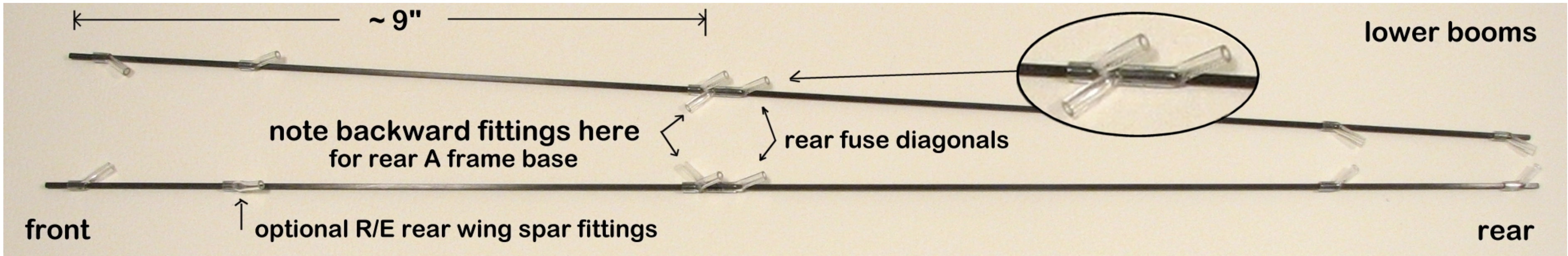
Once in position, add another small sleeve insert glued into the openings of the Ts except for the rear two pair that will use the tail fin connectors instead.



Lower Booms

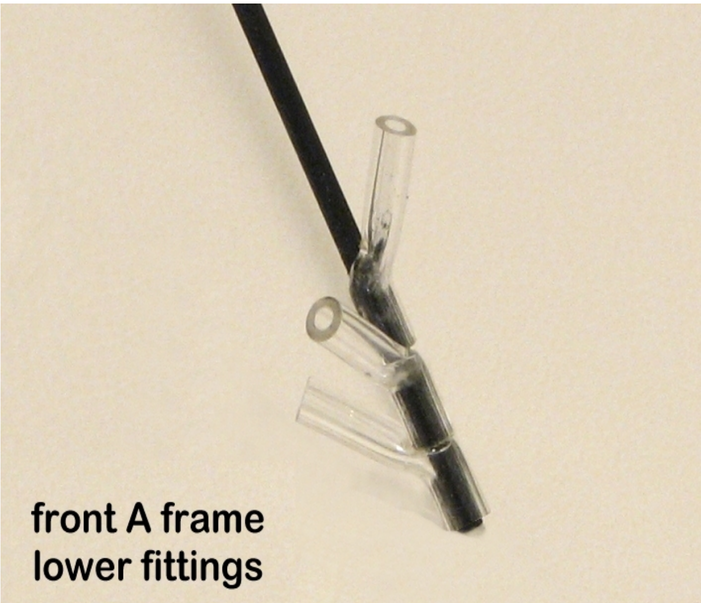
Prepare the lower booms with small T fittings as shown below roughly positioning them to match the locations indicated. (NOTE: using some rubbing alcohol will help slide the fittings into place)

NOTE: Even if you don't plan on flying your plane as a 3 channel R/E model, it's recommended you include their optional fittings now anyway. They are handy if you should want to switch to an R/E trainer in the field to let a student give it a try. Just pull the rear wing struts and relocate them in these fittings and crank in some wing dihedral as explained in the Flight Adjustment section. Then just pull the aileron servo lead and replace it with the rudder servo lead and you're ready to go. I use short extensions so they can disconnected and switched without messing with the receiver plugs.



Front A Frame

The front A frame sides first get three small Ts at their base. It's probably easier to install these from the top of the rods since they angle upward but they can be started at the bottom through their holes with some effort.

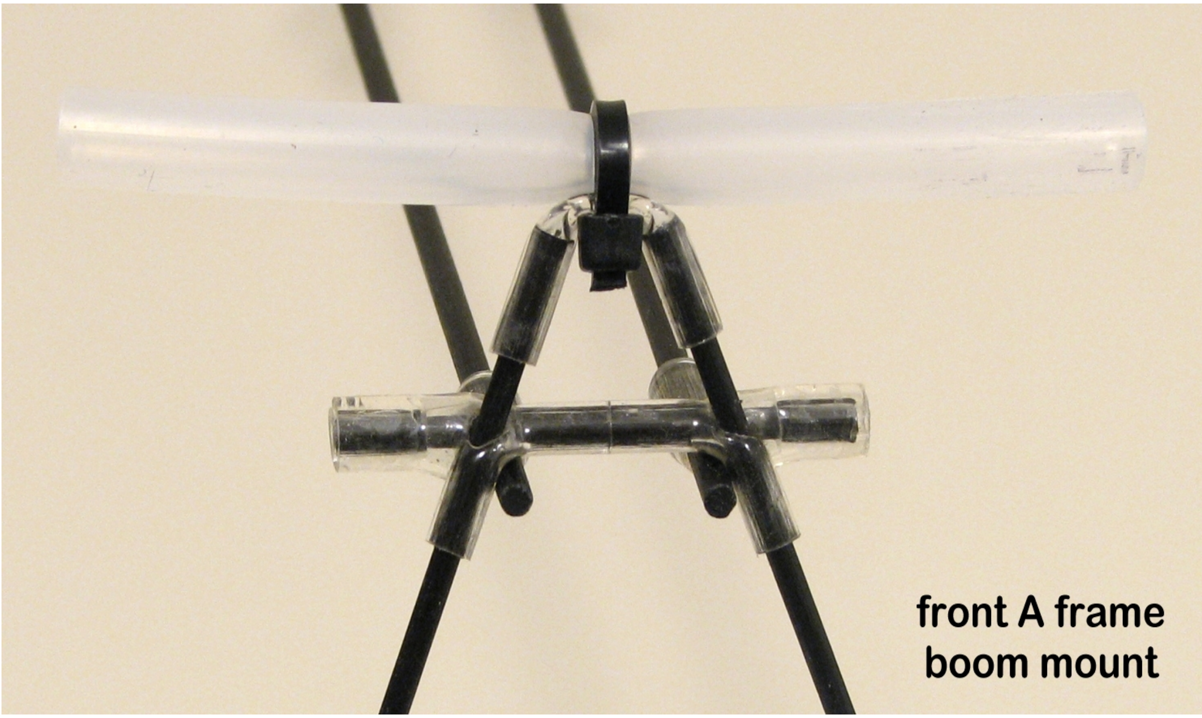


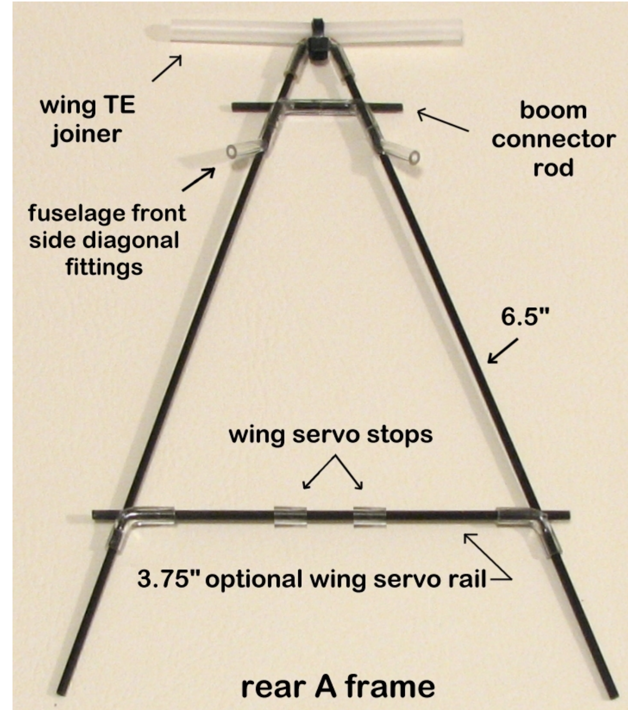
The lower Ts aim back for the front fuselage diagonals. Next up the "tree" is the motor mount fittings aiming forward. The top Ts here are for the wing spars and aim outward.

NOTE: These fittings uses are interchangeable. See Flight Adjustments for more information

Next add another T at the top of each A frame side and angle them inward located about 1" from the top for the connector rods to attach to the booms. Add a connector rod through both of these and center it. Finally add the LE joiner fitting.

The upper booms front fittings just slip on the connecting rods but tuck the front boom ends inside the A frame once connected to help lock them in place as shown below.





Rear A frame

To construct, add 2 small Ts to the tops of the A frame sides for the boom connection as you did for the front A frame and install the wing TE joiner assembly on top. Add the boom connector rod though the Ts with it located on the rear of the frame.

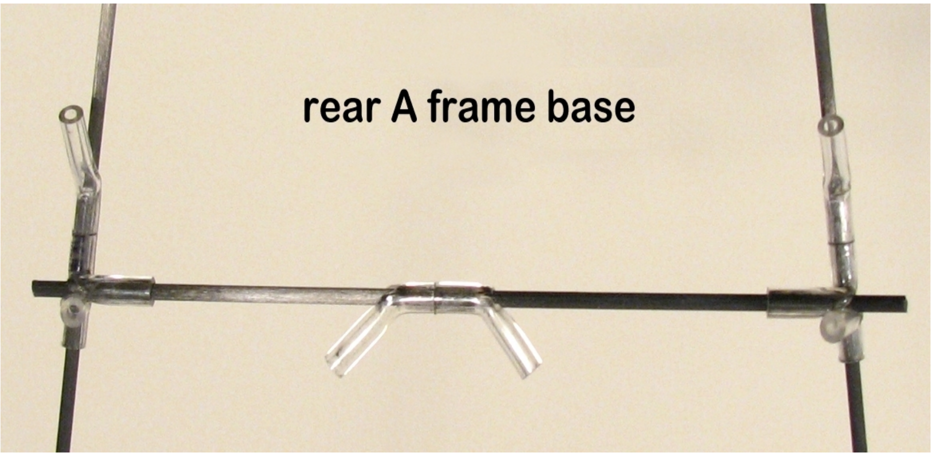
Add 2 more small Ts from the bottom of the A frame sides and slide them up until they butt against the boom connector Ts. These 2 are for the fuselage front side diagonals so angle them forward.

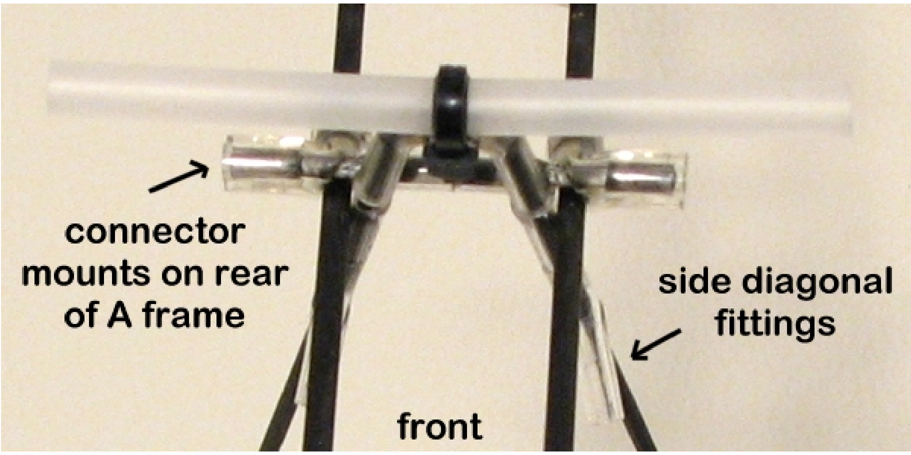
If you are planning on using the 4 channel wing warping feature, add 2 more Ts about 1/4 of the way up the sides from the bottom for the upper servo rail.

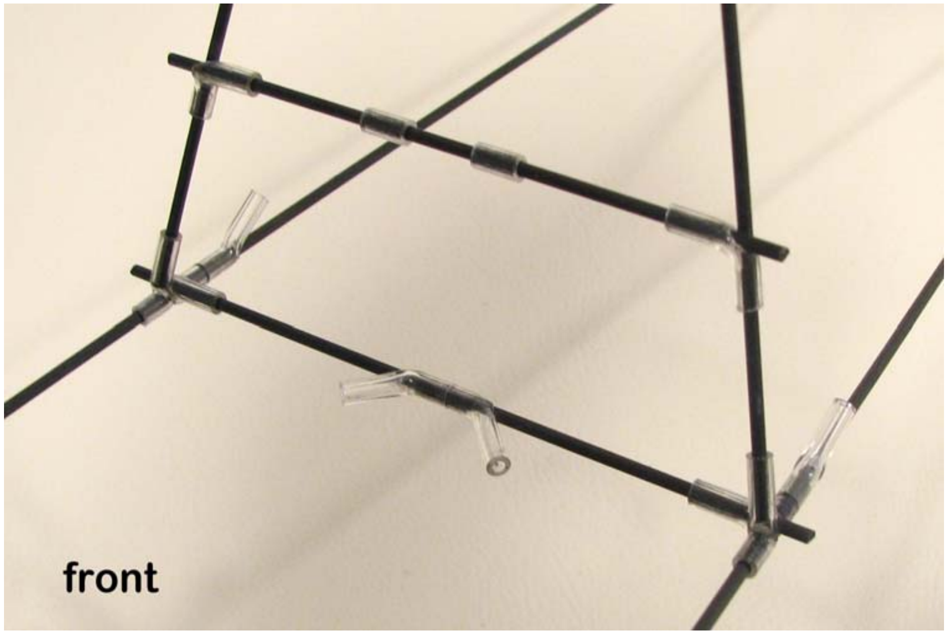
Add 2 small sleeves as servo stops on the servo rail rod before installing it in the Ts.

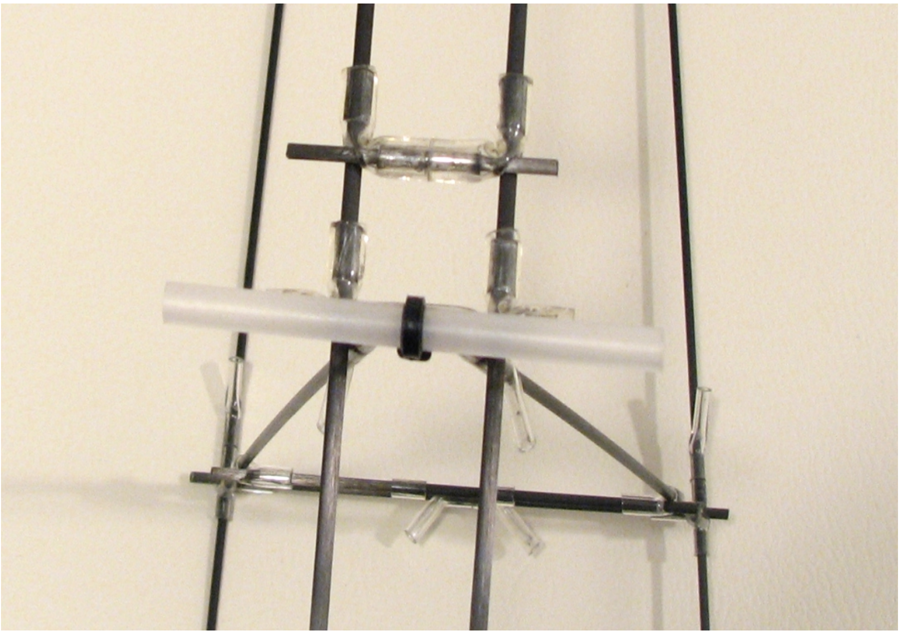
Finally install 2 small Ts on the rear A frame base rod centered and butted together as shown below. Then install this rod to the lower booms and locate it on top of the booms. Now add the rear A frame sides to the lower booms.

The rear A frame attaches the same way to the upper booms as the front one did only you leave the booms on the outside of the A frame uprights here. Check the wing fit into the joiners and adjust the location of the rear A frame connectors on the upper booms as necessary so the wings will fit nicely into them without binding.









You can add the rear servo rail connecting rods through their fittings behind the rear A frame and boom junction now if you want.
(see page 40 for finished fuselage picture)

Axle

The axle is the heart of the fuselage. Besides being the base of the front A frame there is a lot going on with it so please bear with the explanation.

First of all I hate wobbly wheels. Unfortunately CF rod diameters aren't that consistent where you can just drill out your wheel and it will have a nice bushing type fit. After much experimentation, I found that with a slip-fit poly bushing made extra long and press fit into the wheels, the ride is very smooth and wobble free. The wheels will get located with the excess bushing extension inboard so you have the maximum wheelbase available.

If your wheels came with this bushing installed, you are ready to go. If not, locate the 1" bushings and with the wheel on a flat surface, slowly force the bushing into the pre-drilled wheel nice and straight with a hard flat object until it exits the bottom of the wheel and stops on the surface that the wheel is laying on. No hammering is allowed as it will flare the end causing problems with the fit.

Option: You can simply add the required 2 large Ts per side on the axle rod normally with their small sleeve inserts, but by adding the following steps using a bushing inserted into the fittings first, you gain the advantage of faster portability and ease of adjustment. See the Portability section for more details.

Take the 5/8" long bushings and muscle the large T fittings over them butted together as shown. These are really tough to get on and I use thin needle nose pliers to pry open the hole enough to force the fitting in.

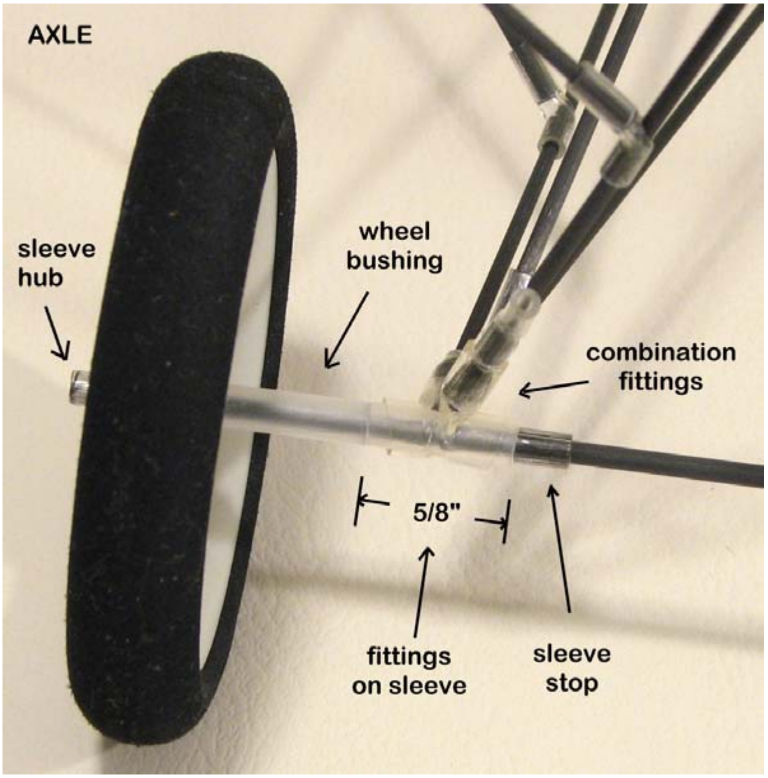
Arrange one pair of the fittings at 90 degrees to each other on the bushing and mirror their positions on the other bushing so the two end up symmetrical. These can be glued in place later after the frame is assembled to keep them on the bushing.

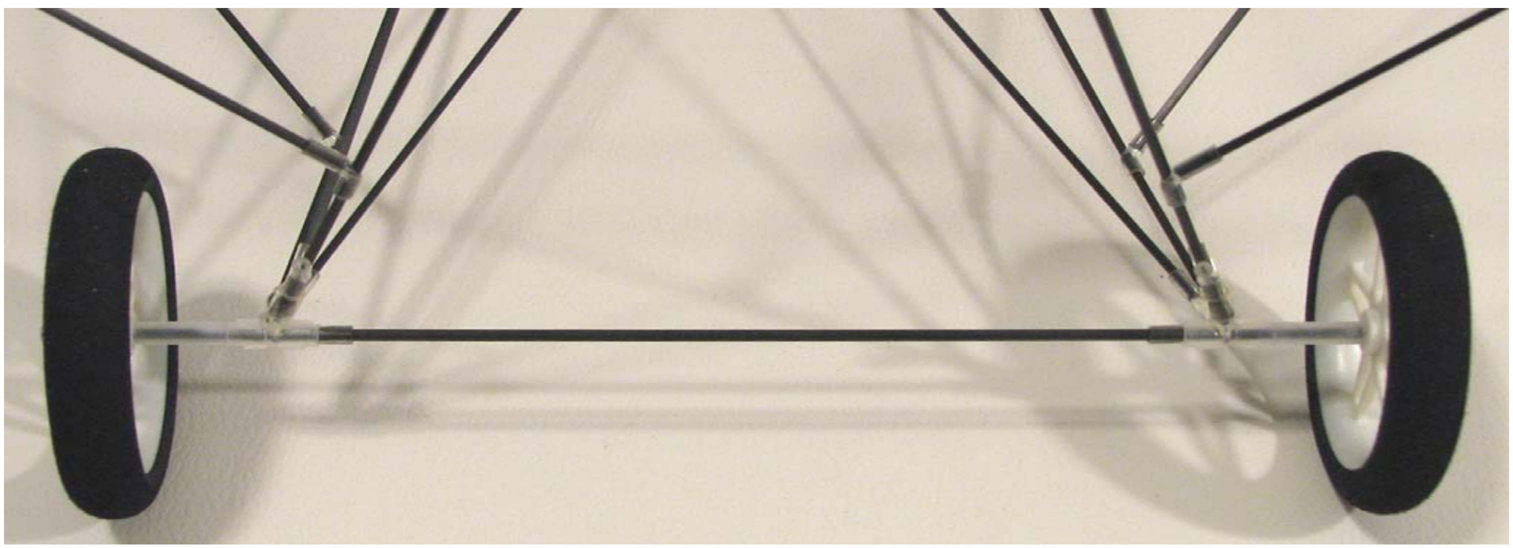
Two of the fittings are for the front A frame bottoms and the other two for the lower boom fronts. No small sleeves are needed in these 4 fittings as they will have the small T fittings on both A frame bottom and lower boom rod fronts used as inserts.

Now slide 2 small sleeves on the axle in toward the center about 1/3 of the way. Add on each end the fitting bushings then the wheels with their extended bushing inward, and finally another small sleeve to act as a wheel hub just to the ends of the axle. Now adjust the inside stop sleeves to take out any excess side-to-side play until the wheels turn freely but have very little movement to the sides. You can glue the inboard stop sleeves if you want but having them slip on a side-load impact could save a wheel and are easily slid back into place to "repair".

The nice thing here is that since the A frame location is determined by the wheel hub sleeve at the end of the axle, no measuring and readjusting is ever needed if things get slid around from a crash. Just stack everything up against the hub, add some clearance for the wheels to turn and you're in perfect alignment again. Also, by adding a shim between the wheel and A frame fitting bushing, minor dihedral settings can be quickly changed.

For the hub sleeves I just carry spares so if I should knock a wheel off I don't have to try to find the lost hub. You want to leave the wheels removable for packing and adjustable so don't glue them on. It takes quite a crash to knock them off.


AXLE
sleeve hub
wheel bushing
combination fittings
5/8"
fittings on sleeve
sleeve stop

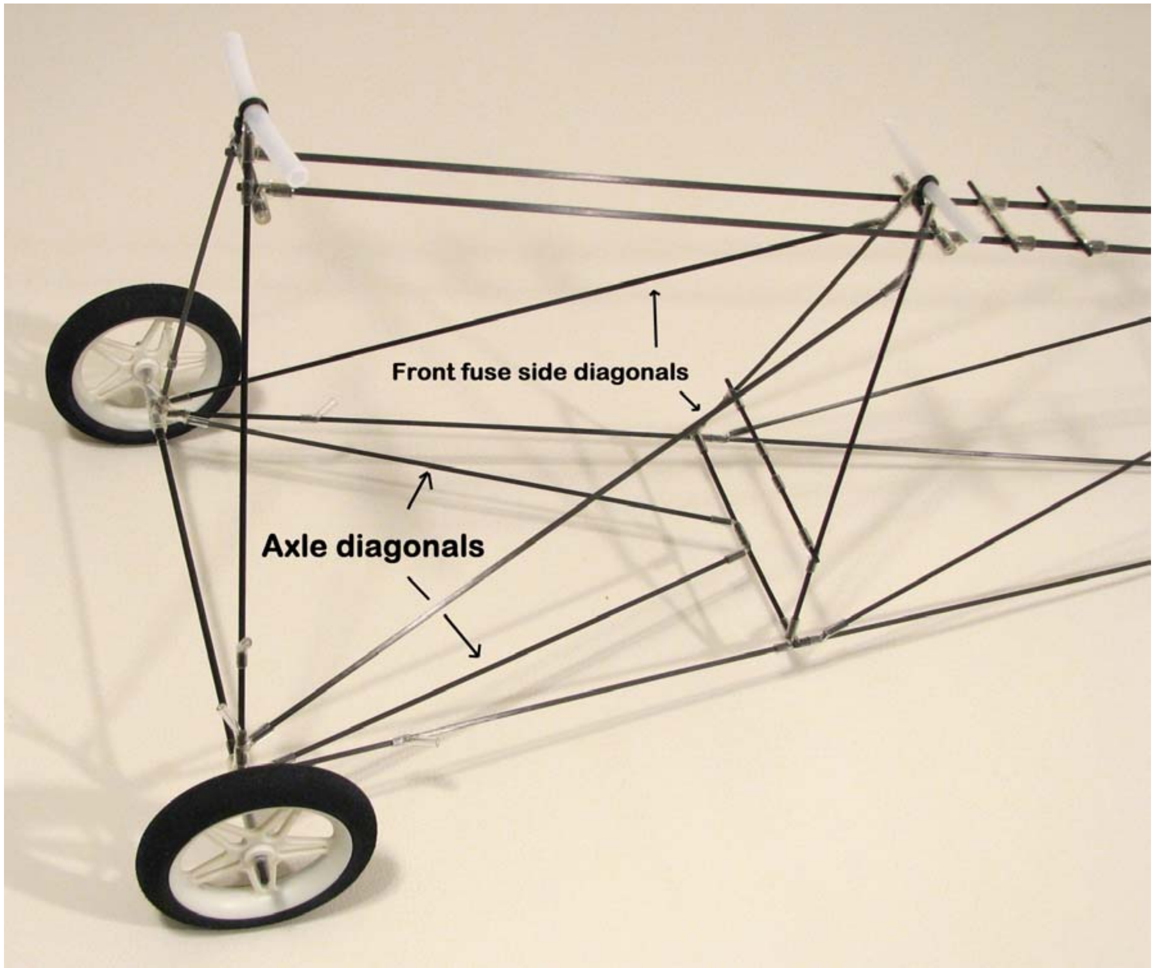


Frame Completion

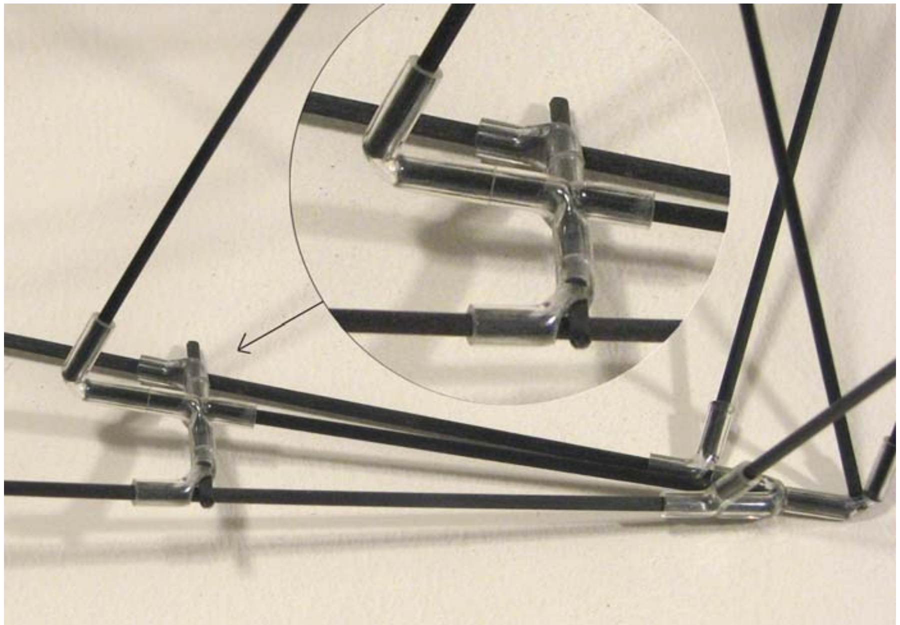
Connect the axle to the lower front A frame and lower booms assuring that the small Ts being inserted are at the proper angles for their use and fully seated into the axle fittings.

Add the 8 1/8" axle diagonals to the rear A-frame base. If they are too long or too short, adjust the rear A-frame base fore or aft as needed on the lower booms keeping the adjoining fittings together with it. Next add the 10.25" front fuselage side diagonals to complete the front fuselage structure.

Slight adjusting of the top of the rear A-frame on the upper booms may be needed but they should be real close with their top fittings all the way up against the connector rod Ts. If the wing joiners end up too wide to match the wing width, the front A-frame top can be slid back on the booms slightly to compensate.

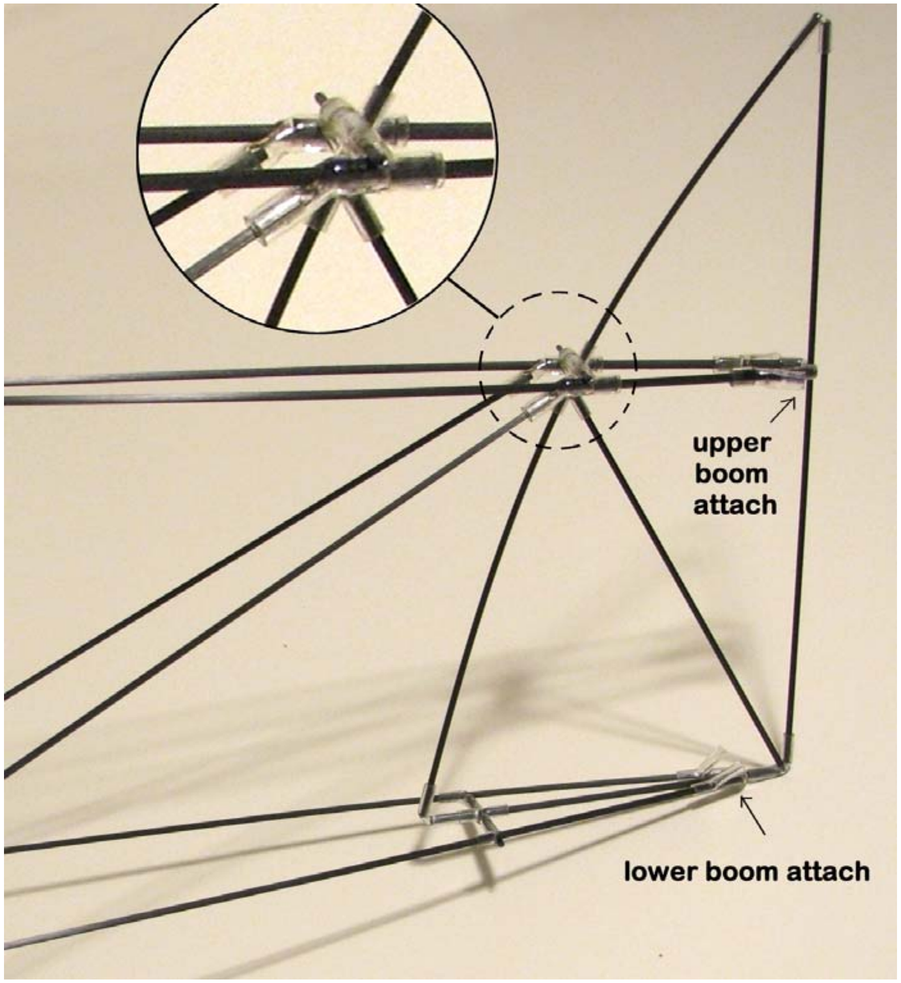


Next install the vertical fin first by plugging the upper and lower boom ends fully into their fittings on the fin. Now add the fins front connector rod through their fittings over the upper booms. The connecting rod for the bottom of the vertical fin first goes through both T fittings at the front of the fin base resting on its bottom. The lower booms then just plug on to the fin bottom with the rod ends exiting the boom fittings through their holes resting on top of the booms.



To square the fin to the rear fuselage requires some shifting of the fittings to get the correct position. The lower booms, fin post or upper booms should not end up being bowed at all. The attachment fitting on the LE of the fin along with the fins diagonal can be relocated up or down as well but generally they should end up pushed together and close to the location shown on the fin scan. To keep the fin post from getting bowed, move the connector fittings on the upper booms forward or backward as needed.

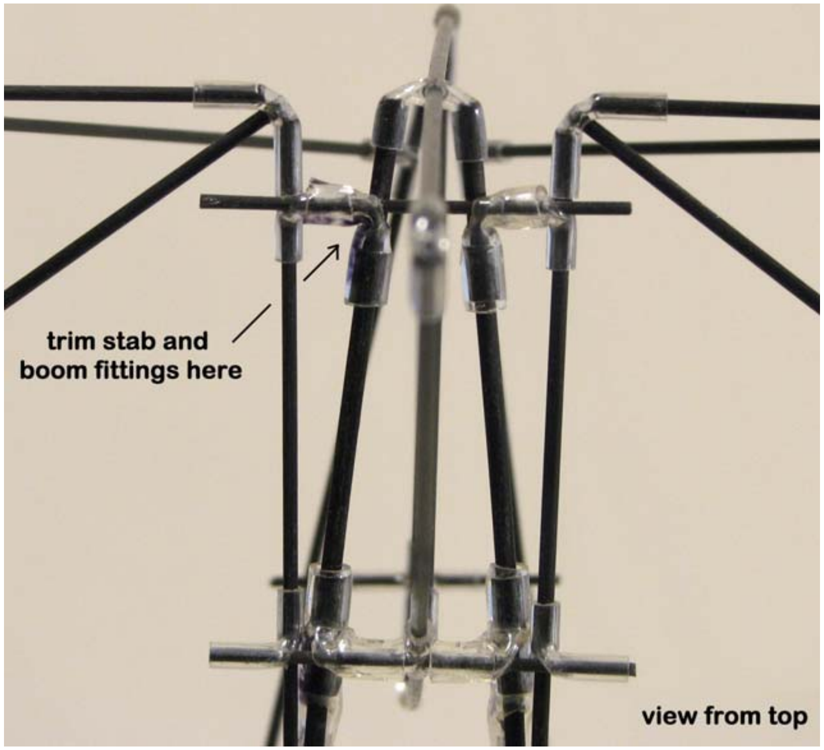
Note that since the fuselage rear diagonals are not installed yet, the rear of the fuselage can rack up and down.



Sight along the booms to achieve the straightest lines you can get as you adjust the fittings. When satisfied with the results, then install the 11" fuselage rear side diagonals into their front fittings and position them near their rear fittings. Move these fittings where needed until the diagonals can be inserted fully without them causing the booms to bow.

Once done correctly, your fuselage should be straight and true, vertical stab square to the wing, and the booms level top and bottom without any bows or distortion.

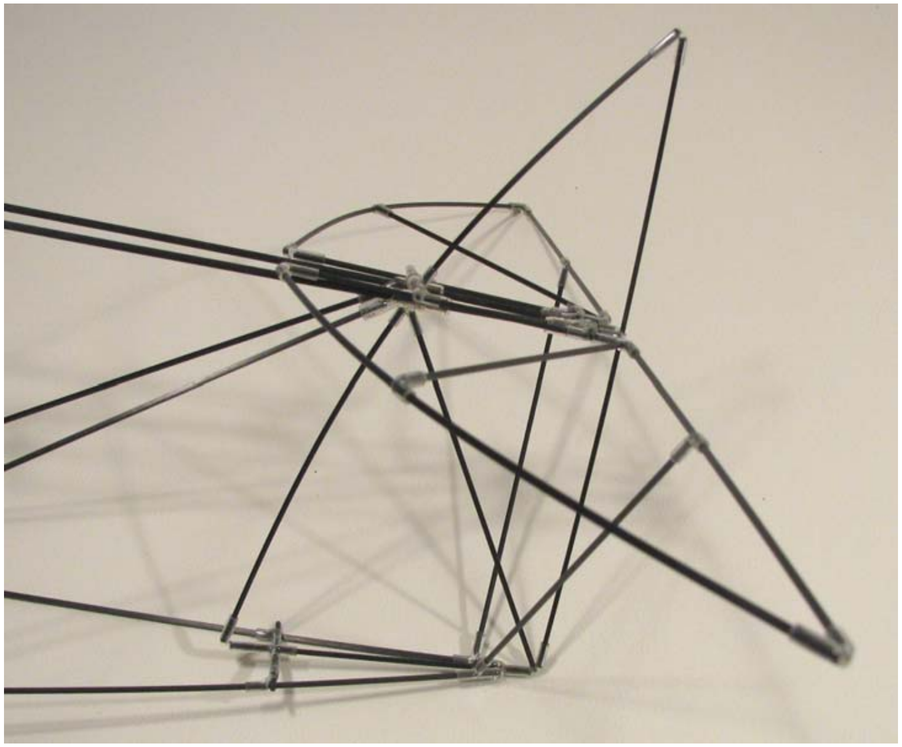
Finally add the horizontal stabs with their front fittings inserted over the connecting rods backward into their holes, not into their ends. The horizontal stabs rear connector fitting on the booms can be moved into position to align with the fittings on the stabs which should stay back as far as possible.



Try to line up the horizontals TEs with the vertical post to allow maximum rudder deflection. The rear fittings are combination type so the stab T ends fit into the connecting rod T as its insert.

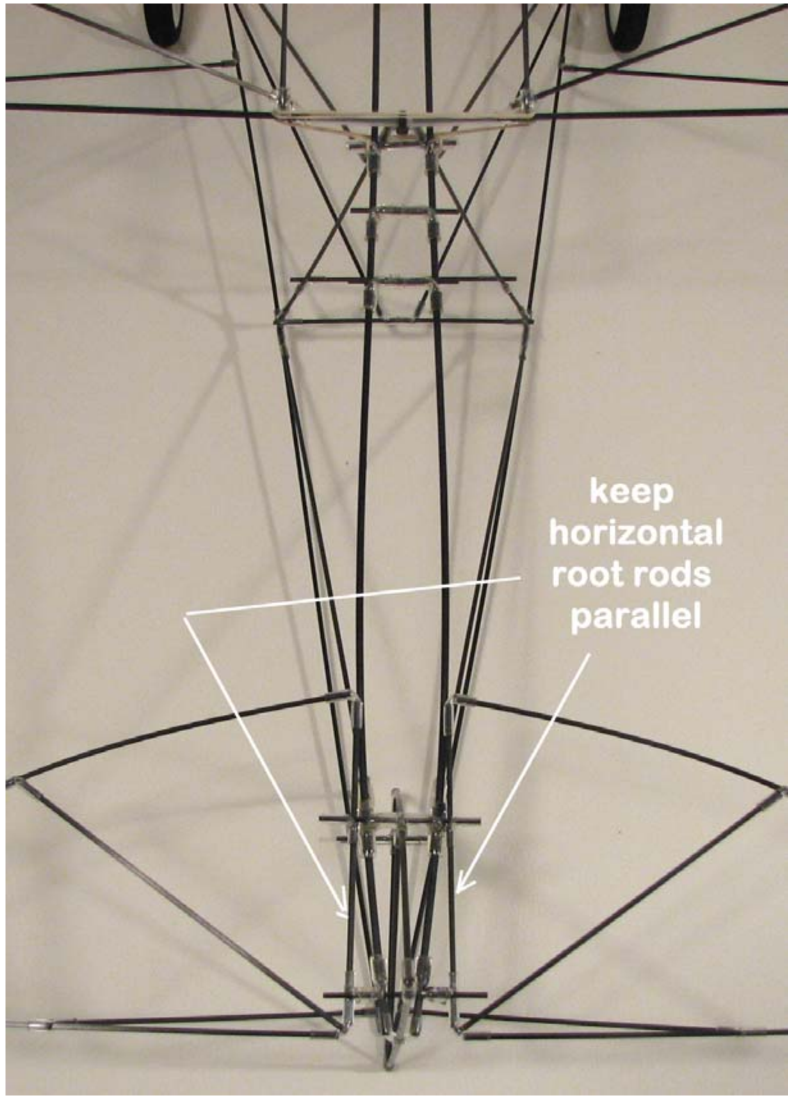
Add bands tightly around the connecting rods as you will have when complete to get the correct alignment. Then add the tail struts to their fittings and adjust their upper fittings to level the horizontals. Verify that the fittings are at equal distances out on the stab posts to square the tail surfaces.

Note that you'll need to trim the rear stab to boom connectors on both the booms and stabs about 1/8" shorter to better align the horizonal hinge posts so they are straight with each other. You may also want to trim the front fittings slightly as well to reduce the upper booms bow there.



You can see this bowing out of the upper booms at the rear in the next pictures.

By shortening the front horizontal stab fittings this bow can be reduced. However when the horizontal stabs are added after covering they will get banded to the connecting rods. This tends to pull them inward and the idea is to keep the root rods of the stabs parallel and able to fold down once their struts are disconnected so don't shorten them too far.



Flight Adjustments

NOTE: It's best to follow this section prior to covering so you can better see, understand and measure your settings.

First setup the plane with the following general settings. Note that except for the CG location (and even it is very forgiving) most changes you may make will not upset the flight behavior to the point that it is uncontrollable. If you go too far, the plane will respond by getting your attention but a pilot with some experience should be able to handle it.

General Trim

There are many ways to change the geometry of the frame to modify the plane but many will just want to assemble and fly and not tinker with it. If constructed as directed, you should end up with a flyable plane "out-of-the-box" once you set the CG and center the control surfaces. If you find you need some up or down trim for level cruise flight, just fine tune the CG to eliminate it and you have the optimum setting but do check the thrust line and wing incidence mentioned below in case it's related to the trim requirement.

Center of Gravity

Balance the plane about 3.6 inches back from the LE. This is a 1/2" behind the location of the tip fitting that holds the tension rod. There is a very tolerant CG range so feel free to see how it flies at different settings once you get the hang of it. Ideally you want zero trim to be needed for a nice glide with the elevators level with the horizontal stabs.

Generally you'll find that if you have a nose heavy CG that the plane will need up trim to keep from diving and may want to stall easily depending on wing settings. Figure about 3" as the forward limit. You will have lots of pitch stability however once trimmed. A tail heavy CG will reduce pitch stability and cause the planes angle of attack to wander and if severe enough can even cause lose of control. Learn to feel when you're starting to go one way or the other too far and fine tune to taste.

Wing Incidence

For most types of flying you want the LE to be about 1/2" higher than the TE relative to the horizontal stabilizer. The "stock" setting is to have the LEs at the root to be positioned about 1 inch above the booms and the TE at the root to be about 1/2" above them which is just about where it will be with all the fittings on the top of the rear A frame junction pushed together. Since the horizontal stab is mounted flat on the booms this will give you the desired wing incidence angle to the tail.

Wing incidence will have a direct correlation between the CG in that the higher the incidence at the LE, the further forward the CG will need to be to balance the plane in the air. Think of if as adding up elevator trim as well as increased pitch stability due to the difference in angle between the wing and horizontal tail. Note that a high incidence will tend to cause the plane to want to fly slower as well.

Thrust Angle

If setup as directed with a few degrees down thrust and maybe a couple degrees right thrust against torque, ideally cruise power will give you hands off level flight without any trim added. Adding power will make it climb without back stick and reducing power will have it gliding down gently again without stick input.

If however this isn't the case and the CG seems correct for a good glide, then the thrust angle must be adjusted. If it climbs hard with power, lower the thrust angle a tad by physically moving the front of the motor stick down slightly in its zip ties and try again. If it dives with power, try raising the thrust angle a little. The CG and incidence should be checked if these changes are not having the desired effect.

Note that the motor extension frame geometry can also be used for mild down thrust angle changes. The horizontal extensions will bow down slightly by pulling them out from the booms a small amount without moving their diagonals.

General measurement procedures

To start, be sure the LE at the front A-frame is about 1 inch above the booms and the TE should be already at about 1/2 inch if the fittings there are all snug together. More about wing incidence is in the section above.

To set dihedral and align the plane, simply prop up the tail until the LE and TE are at the same heights above your table. Then measure the difference at the tips from the table and compare to the root height. Do both wings to assure they are even. Adjust the LE and TE wing strut locations to achieve the desired settings and you are set.

Washout is simply more dihedral on the TE than on the LE that introduces twist to the wing and a lower angle of attack at the tips than at the root. This helps prevents tip stalls but if set too high adds drag and lowers the effective wing incidence.

Once the settings are made, verify the fittings distance from a reference point to assure they are equally located. Sometimes these will be equal but the wings will still have some twist so be sure the fuselage frame is straight and true and that the wing is square to the booms.

You can check this by measuring between the wing tip TEs and to the rear of both pair of booms. If not equal on each side, the booms may need to be tweaked slightly in their fittings as one side may be bowed more than the other. This type of misalignment is usually easy to spot in the field by just sighting up the booms from the tail.

While it's propped up, eye-ball the wing from the tips and note the relative angle of each tip to not only the root LE and TE but to the booms as well. You should see the washout equally between wings and the tips should end up close to level with the booms with the wing root raised slightly at the nose.

The actual measurements aren't nearly as critical as maintaining the symmetry between wings and tail.

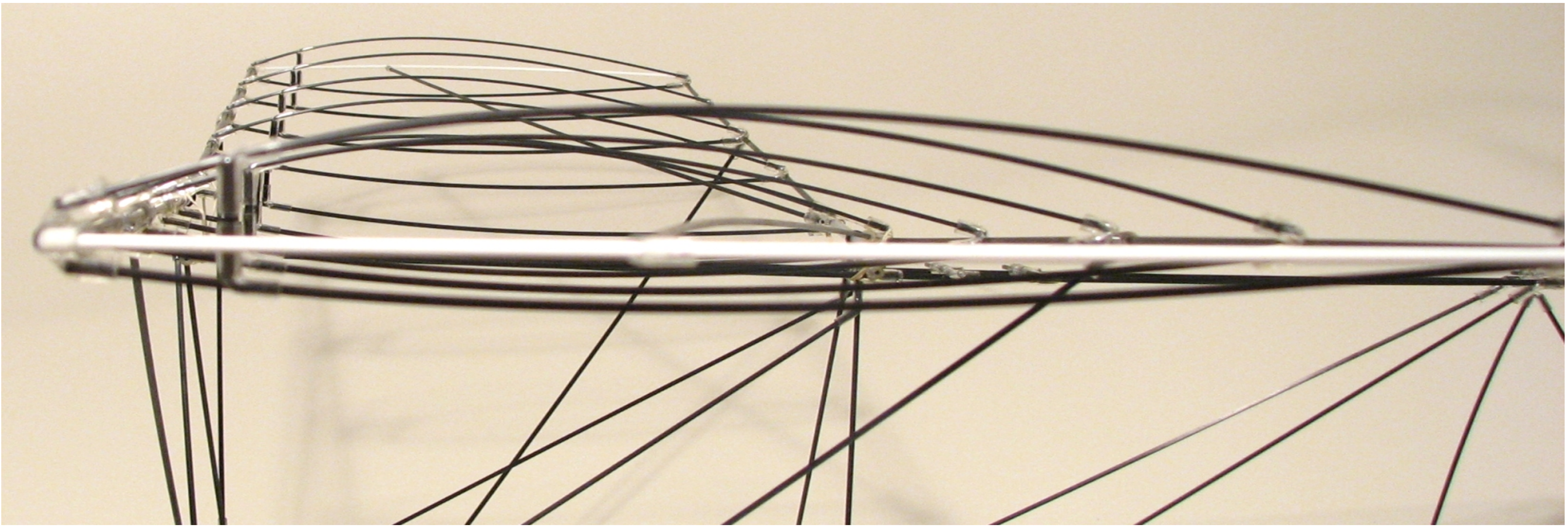
3 Channel Adjustments

For rudder and elevator flying you need dihedral to turn the plane. Basically the plane yaws with stick input to the rudder, the leading wing sees a higher angle of attack then the trailing one and climbs creating the bank. The more dihedral the wing has, the faster the control response. Too little dihedral and it may not turn at all, only wag its tail.

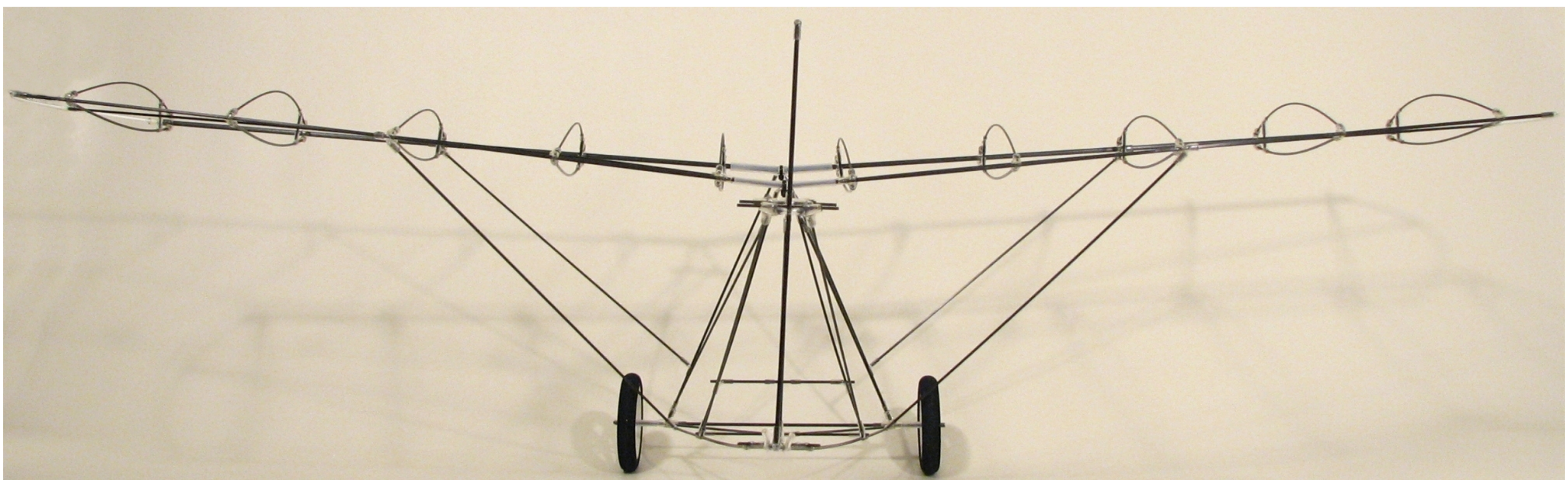
The stock 3-channel dihedral should be set to 2 inches of rise at each wing tip LE compared to the root LE of the wing. Do the same at both the LE and TE and adjust the TE to be about 1/4" to 1/2" higher than the LE at the tip for some washout. Again, the exact amount here isn't as important as having both wings equal or you'll have turning problems.

Slide the front wing strut fittings up or down on the front A frame rods and verify they are equal by measuring them from a fixed location. Check the left and right wings to verify the settings are the same. Next adjust the rear wing strut fittings located on the lower booms fore or aft as needed to get the TEs the correct height.

TIP: you can add stop sleeves next to the strut fittings to lock in your settings. For switching between 3 and 4 channel operation, you can also add an extra T fitting on the front A frame sides for each type flying. These can be glued once the best settings are found. The rear struts will just get moved to the wing servo for "aileron" use.



Wing dihedral and washout for 3 channel rudder/elevator flying. Tips are parallel to booms with root LE raised above booms.



Shows fuse twisted and effects on wing washout viewed from rear. Note lower booms are straight, uppers angled back to the right.
Plane will turn to left due to more washout introduced on left wing. Learn to spot these for quick field realignment.

4 Channel Adjustments

Dihedral

Normally for the most roll rate you want minimal dihedral angle on the wings for either a mid or high wing design. This setting is good for doing axle rolls and other stunts where a pure roll is desired from the "ailerons". The trouble with this setup is that you need to continually fly the plane keeping it level, especially in other than ideal conditions.

For rough air stability or training or just real relaxing flight, more dihedral is better assuming you don't sacrifice too much roll rate. Since the more dihedral you have the better the rudder response becomes in roll however, by coordinating the two you can get the most turn needed as well as better hands off stability. In fact, with the stock settings you can fly the plane with aileron / elevator only and still make nice coordinated gentle turns without using any rudder at all and continue hands off for multiple revolutions with the right trim.

Instead of having to measure fitting locations and wing rigging at the field to make a minor change, it's better if a set distance stop is available. By simply mounting the front wing struts into the highest fitting on the A frame "T-tree", you have a nice blend of dihedral for stability and roll response with the wing warping. This setting should measure out to about 1/2 inch rise at each LE wing tip compared to the LE height at the root (not the boom height).

Washout

Normally the TEs should be about 1/4" to 1/2" higher than the LEs for washout at the tips. Since your rear wing struts are fixed length to the wing servo, adjustments for washout need to be done at the LE. Lowering the LE tips relative to the TE tips will add a little more washout to help prevent tip-stalls.

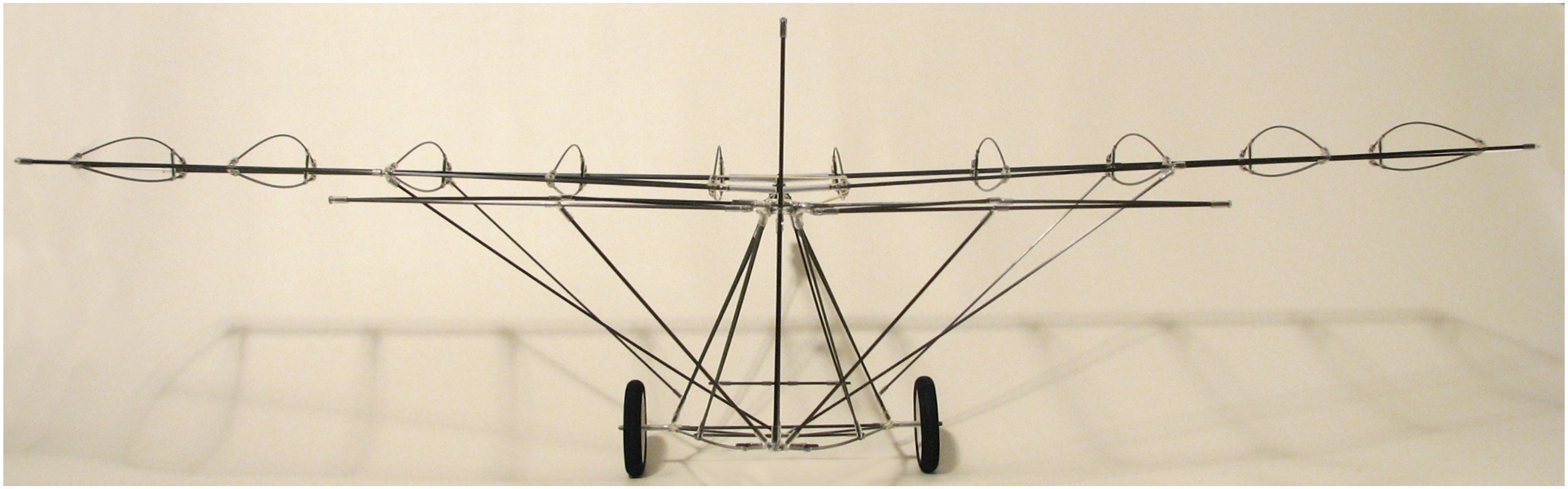
If not enough washout is pre-set already, (or you feel you want more) and you used the axle fitting bushings, you can lower the LE tips slightly by just pushing the wheel hubs inboard a little at a time and checking it. Otherwise you'll have to relocate your axle A-frame fittings slightly inboard to narrow the front A frame.

To flatten the dihedral to near flat and reduce washout for sport and/or speed flying, adjust the wheelbase or front A-frame fittings on the axle as above even more and raise the TE at the root. By sliding the rear A frame sides up through their boom connector a little, you reduce the TE dihedral as well as some of the wing incidence.

A reduced incidence and washout has the benefit of allowing a slightly rearward CG for more speed and faster control response if you are going for the max performance. (See Wing Incidence section above) For speed this is better than holding down elevator that adds drag. For sport this makes the plane more neutral in pitch between upright and inverted and the reduced washout helps in snap maneuvers as well.

TIP: An alternate quick method of changing the LE from "stock" 4 channel dihedral to near flat is to simply swap the LE struts from the top fittings on the A-frame sides to the next ones down. You'll use the top ones then for your motor frame diagonals so thrust angle adjustments may be needed to restore the correct thrust line.

Between all these adjustments, you can achieve just about any flight configuration desired. At the very least you should understand the basis for measuring dihedral and washout for assuring proper "stock" performance.



"Stock" 4 channel dihedral / washout setting with front strut fittings pushed down on A-frame and rear struts in position for servo. Note that you are viewing straight down the upper booms from the rear so you see the washout at the root with the LE raised. With the fabric on, it's best to sight along the bottom of the wing at the root and see the washout at the tips.

Fuselage Complete

Once you are happy with the frame alignment and have double-checked all measurements to verify equality, you can glue specific fittings to hold their position.

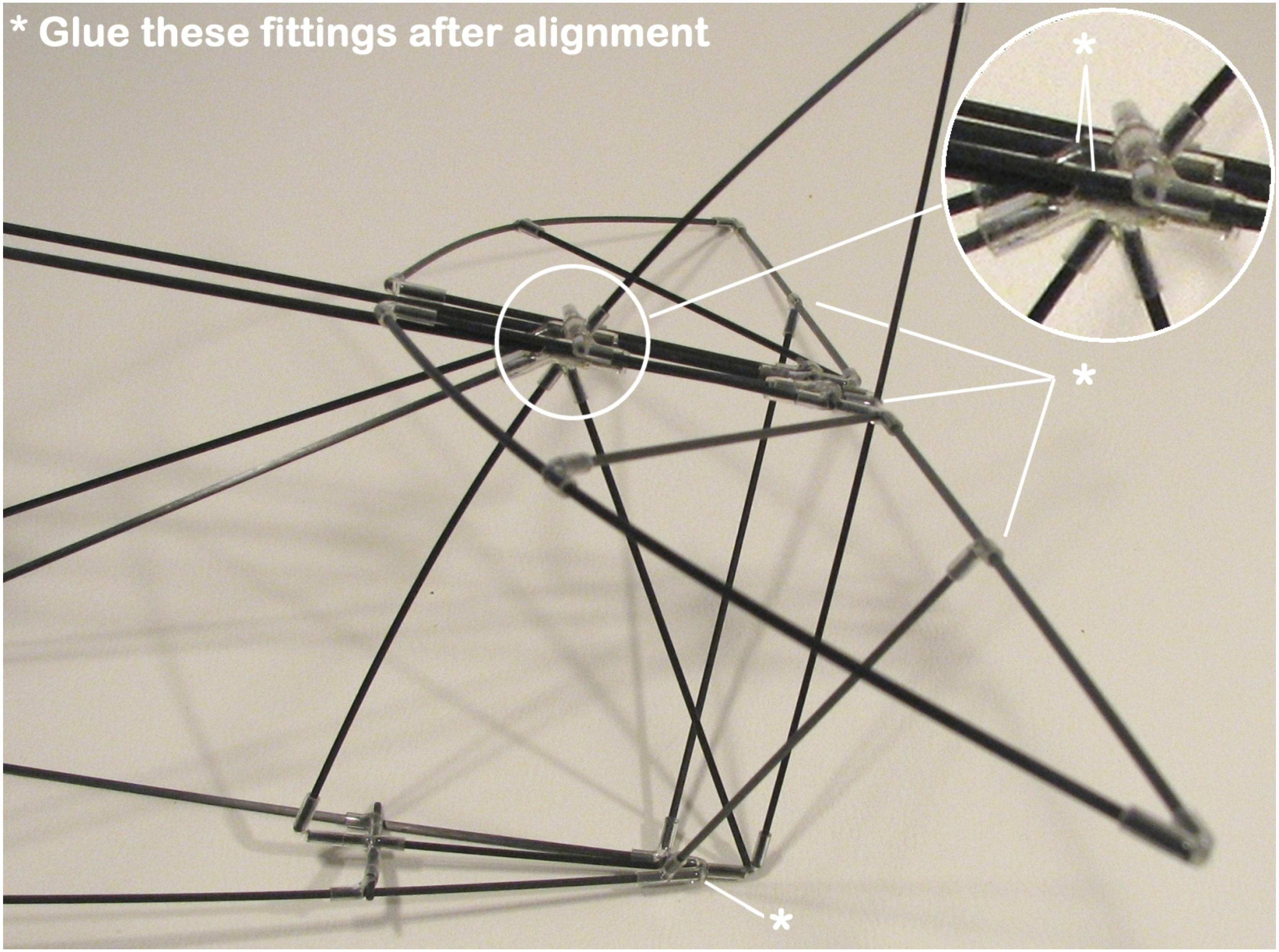
The key fittings to glue are the upper rear fuselage diagonal fittings where they slide on the upper booms. These can rack on a crash and throw the tail out of alignment. The rest of the diagonals fittings are nestled snugly against frame members so should be fine.

Do assure that the stabs TE isn't being bowed from its front boom attachments being positioned too far forward. The upper tail diagonal fittings where they slide on the horizontal stab booms should be double checked for level, equally spaced and glued as well.

Also glue the upper and lower boom fittings on the vertical stab where they can slide. Once covered, these fittings will exit out through the fabric and should not need to ever be moved again.

For both boom fittings, only glue them where they fit on the vertical stabs, not to the booms themselves as the booms will still need to disconnect from them for most portability options.

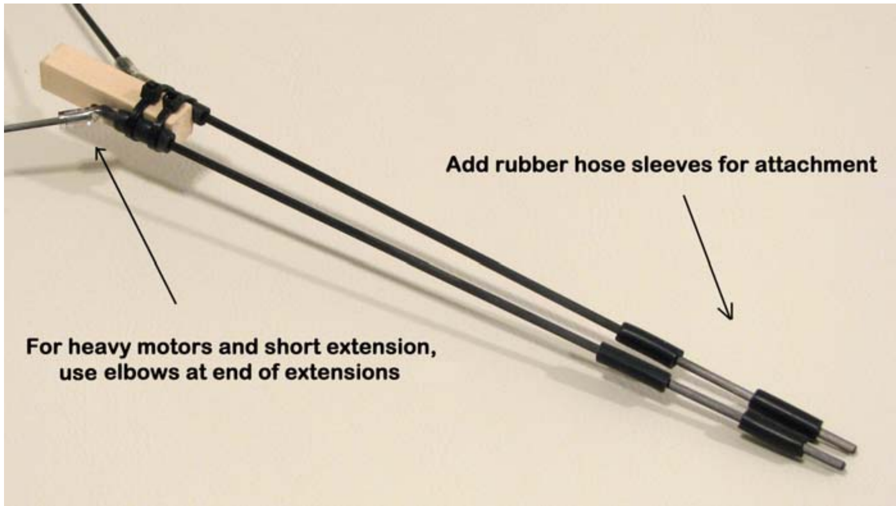
Finally with the wing true, glue the strut fittings on the LEs and TEs so they can't slide on the spars. This is more important for 4 channel wing warping than for 3 channel use.



Since most everything else is either adjustable or removable for portability, you should now be ready to go.

Motor Extensions

The motor extension frame consists of the 9" extension booms and 8" support diagonals. The extension booms overlap and attach to the upper booms with zip ties. First place the rubber sleeves over the extension ends. Position them roughly in place outside the A frames and hand tighten the ties for now.

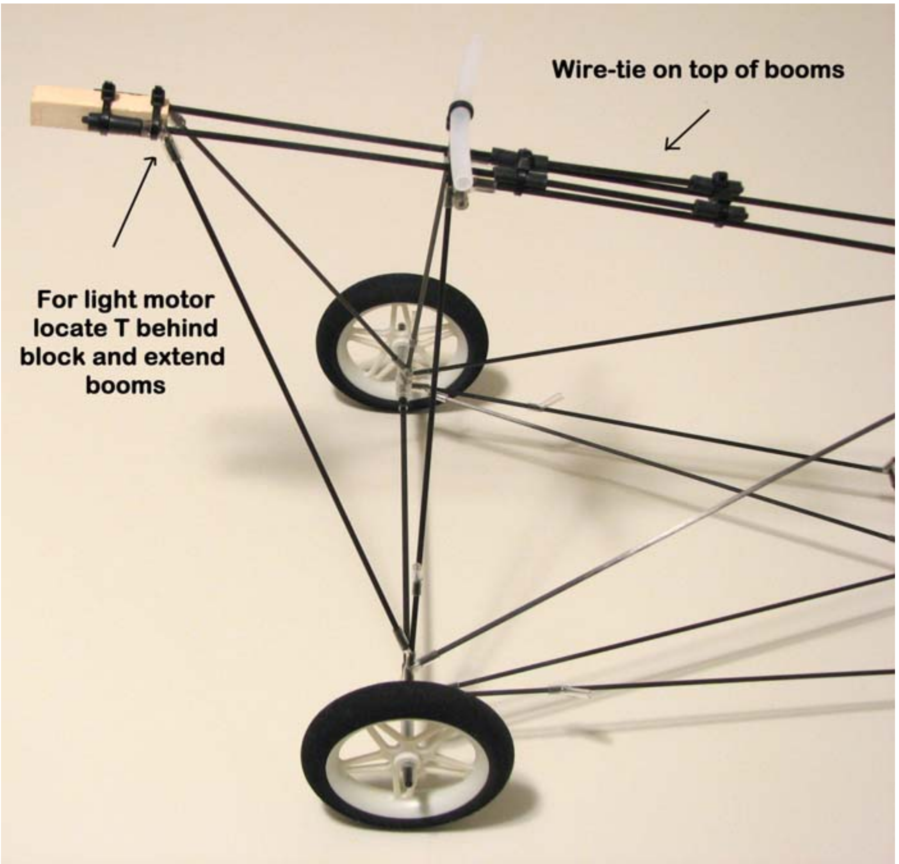


Attach the extension support diagonals with large Ts with inserts and secure the motor mount block tightly with more zip ties over another pair of rubber sleeves.

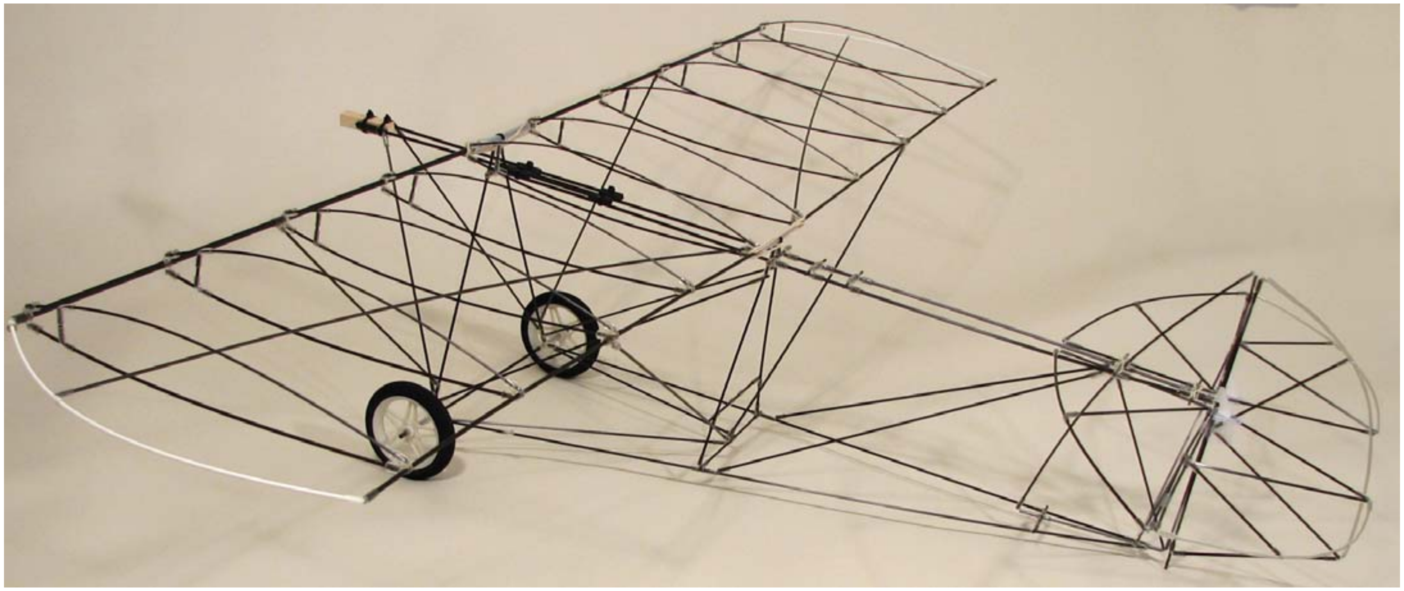
With the extensions level with the booms and the diagonals in the proper T on the A-frame sides, you can position the motor in two positions. For small light motors, put the Ts at the rear of the motor block or for a shorter extension and heavier motor, add the Ts for the diagonals to the front of the extensions mid-block as shown above.

Once the location is found for the extensions on the booms to have them level, tighten the boom wire-ties more securely. If you get the right pressure, they can't slide on the booms but by rocking them slowly back and forth they can be worked in and out of the sleeves and moved to make adjustments or retract for storage.

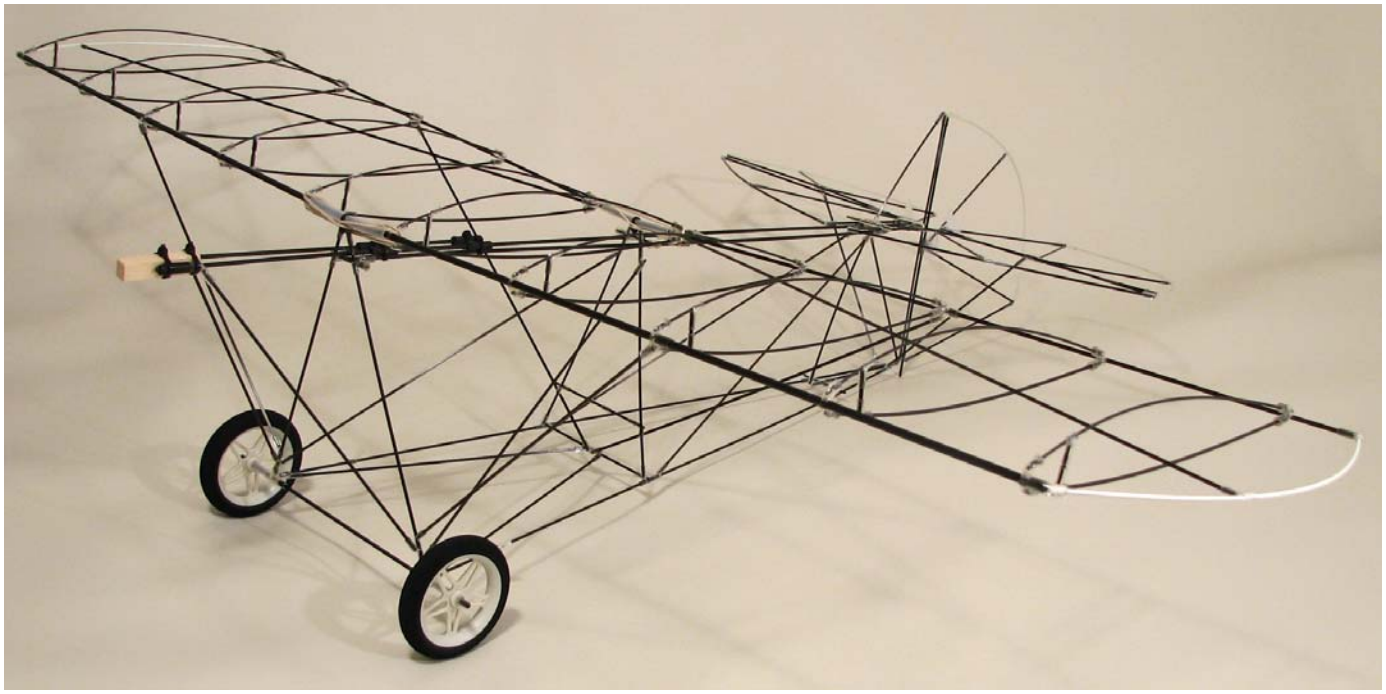
Note that the following pictures shows the boom extensions inside the A frame but we found out later that the motor is less prone to twisting the extensions from torque if they are located bowed slightly around the outside of the A frame sides.



The motor post can be manually angled in its wire-ties for thrust line adjustments. Be sure to use enough ties for your motor weight and that they are as tight as possible. A longer stick for more support may be required for real heavy motors.



Completed frame with control surfaces temporarily taped on - Total weight as shown, 5.25 ounces.



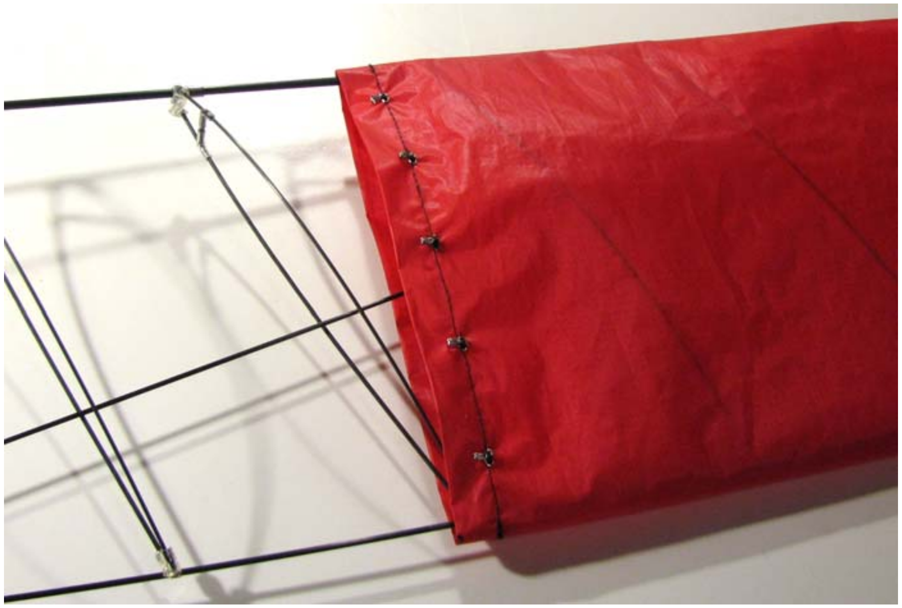
Covering

Wings

The wing covers are pre-made and ready to go. First however you'll need to locate where the wing strut fittings need to exit and make small holes for them to pass through in the fabric.

Start by having the strut fittings snug up against the ribs and in position as shown in the picture in the wing section. To find the needed hole position, install the covers temporally.

To install the covers, release the wing tension rod fitting by sliding it off the TE root rod of the wing frame. Next while holding the frame with tip away from you, partially collapse it by pushing the TE away from you as you pull the LE toward you so it ends up partially racked as shown earlier in the wing construction section.



Position the wing covers to match the LE and TE offset of the covers at the tips and insert the frame so the TE tip gets seated fully in the corner of the cover.

You want the seam on the LE to rest just above the center of the tube so you'll need to shift the cover some into position. The excess hem fabric on the inside of the wing cover should end up above the LE tube adding some extra stiffness to this location.

Get the wing tension rod fittings started on the TE and as you work at racking the frame square inside the cover, push the fitting fully against the root rib on the TE rod.

Work the LE tube forward into the cover until the tip is snug in the end. Since the cover is a tight fit on the frame, some adjusting will be needed to get it straight, square and even.

The ribs may want to lie down on you as you work the cover on but they can be stood back up easy enough once the cover is fully installed. Don't worry too much about small wrinkles as once the two wing halves are pulled together at the root with the supplied mini bands they will snug up nicely.

Now mark the locations on the covers by feeling for the strut fittings on the bottoms of each wing. For now, just poke a small hole near the LE and TE edges of the covers at the strut fitting location centers.

It can be tricky to fish the fittings out through the holes once the cover is installed without an oversized hole to work with. A trick here is to simply have the struts installed in the fittings on the frame first, fold them out toward the tips and have them exit the holes as you install the cover. Once up to the fittings with the cover in place, you can trim just enough fabric to allow the fittings to exit and end up with them in the right place.

rack frame to insert

Joining Wings

Getting the correct wing cover tension is important for maintaining the airfoil shape as well as allowing proper wing warping for roll control. The items to be aware of are chord-wise tension and span-wise tension. Depending on how careful you were when assembling the frames, the chord-wise tension shouldn't be a problem. Some small slack is normal which can be felt at the TE by pinching the fabric. This is necessary for ease of twisting by the aileron servo as well as to allow the covers to not be overly tight at the rib junctions.

BTW, you can iron the covers TEs flat once you find the fold line at low temp setting for a cleaner airfoil if desired.

Span-wise tension is held with the bands added to the root hooks connecting the two covers together. Note that earlier prototypes just used hand-sewn individual hooks as shown above but production models have strips with the hooks already attached. This method also helps reinforce the ends of the covers and allows better overlap to seal the gap between the wings.

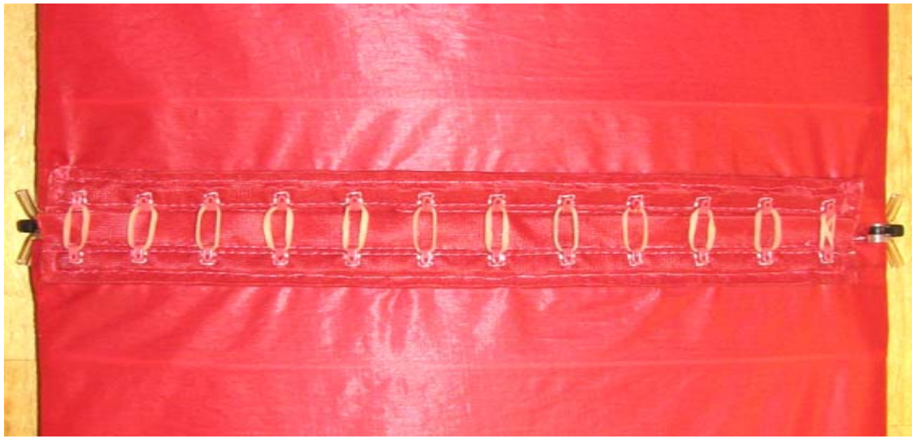
Normally a single band on each hook should be sufficient but if you needed to adjust the frame spacing to eliminate sweep by trimming or spacing the wing joiners mentioned earlier, then you may find that doubling the bands and/or using only every-other hook makes for a better fit. Also over time if the bands tend to stretch you can double them and add to their lifespan.

The idea is to end up with the hems beyond the hooks at the root overlapping each other evenly from about half of their width to nearly fully covering each other. You don't want any gaps between them or bunching up from them trying to overlap too far.

The other thing to watch out for is uneven tension between the LE and TE causing a sag in the root area. Be sure the TEs are butted right up tight to the joiner center tie. Since the tension bow is pushing inward on the TE joiner, you really can't tell how the wings will align until they are put under compression together with the bands and you verify the LEs and TEs are tight together viewing them through the joiner tubes.

Then if the LEs should tend to sweep slightly forward you may get a sag near the LE at the root in the covers. This is very poor for performance as well as stability. If this should happen you need to shorten the TE joiner. If the hook hems do not have room to overlap more and bunch up then "lengthen" the LE joiner instead by adding large fitting spacers to the LEs up against the inboard ribs that the joiner seat against.

Note that if being used as a R/E plane with dihedral, the lower hook strip hems may end up with a small gap which is okay. The upper hems however do need to overlap so "lift" can't leak out completely through the wing.



Horizontal Surfaces

Start by inserting the stab and elevator frames in their sleeves to check for fit. All sleeves are the same size with only the vertical stab frame being slightly different.

Next once fully seated, trim the corners and center hinge area so the excess can be tucked in and folded over neatly. Plan on having the outer taped edges on the bottom for looks.

Start with the elevator sections and tuck in the lower flap first and then overlap the upper one tightly and tape.

Holes for the strut fittings will again need to be made on the bottoms. Lay the stab frame over the sleeve to locate their positions and make a small hole near the hinge line. Install the strut and insert it out the hole as you insert the frame.

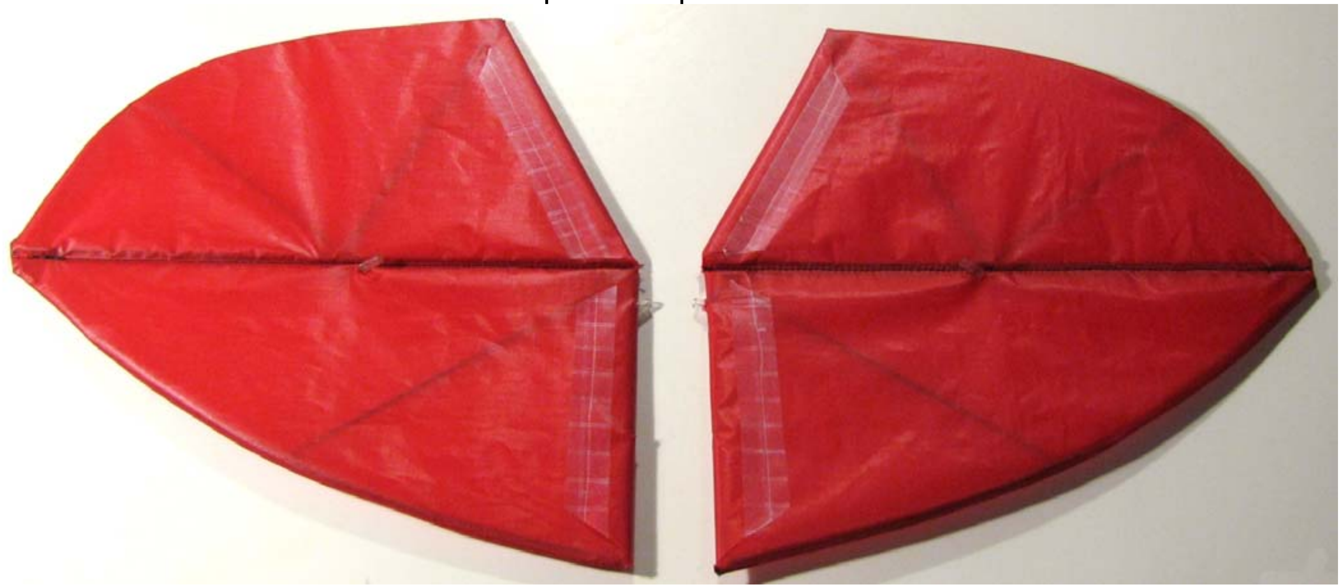
For the Horizontal stabs, holes through both flap layers will need to be located for the fuse connection fittings. Locate the front fitting on the top surface and the rear fitting straight out.

Bottom view showing strut and rear fuselage attachments.

Top view showing both fuselage fittings

Make the holes for each horizontal stab fuselage fitting first in the inner flap, then outer flap and position as shown. Tape the overlapping flap tightly once complete.

Horizontals surfaces complete - Top view above - bottom view below



Note: If the inner flap is pulled and taped inside first then followed by the outer one, the covers can be installed tighter than shown.

Vertical Surface

The rudder covering is the same procedure as for the elevator.

For the vertical stab, again position the frame over the sleeve and mark the hole locations. Make the upper holes very near the seams. Once you fish the fittings out of the holes, install the connecting rod.

The lower fittings are done the same as for the horizontal stab except instead of a single hole through each flap layer they ideally get two holes in each. This can be tricky to get aligned evenly so if you find you are having trouble with it, you can just cut slots in the flaps between the two holes to make assembly easier.

Using the connection rod partway into the lower fittings helps fish them out through the holes.

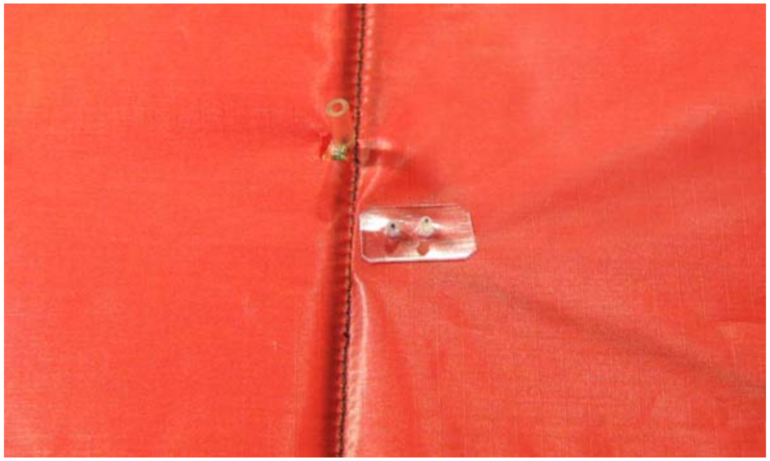
Completed vertical stab and rudder.

Control Horns

Use your "poker tool" and find the holes in the brackets for the control horns through the fabric. It helps to hold the surface up to the light to find it.

Depending on how you want to install your servos, you can put the rudder horn on either side. The Gear Install section covers the servo installation with the horn on the right side as viewed from the rear of the plane.

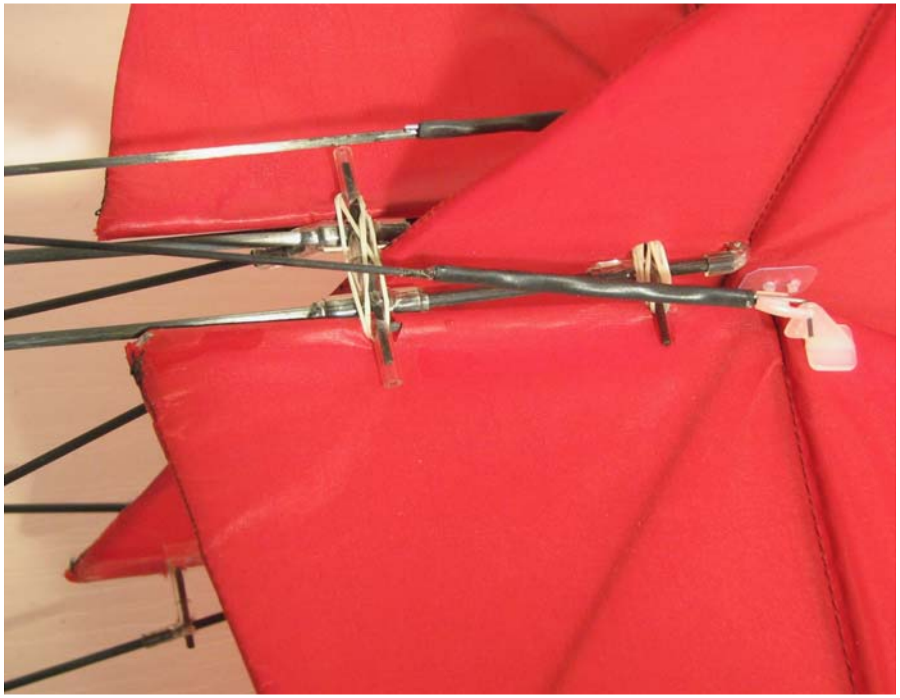
Elevator horns go on top the elevators for a direct pulling action for up control. This is preferred so you never have to worry about a linkage flexing under compression causing a control lockout even in the worst dive.



Rudder horn lock installed and vertical surface mounted on fuselage frame on the left. Note rear fuselage connecting rod through fabric. Below is the elevator horn installed.

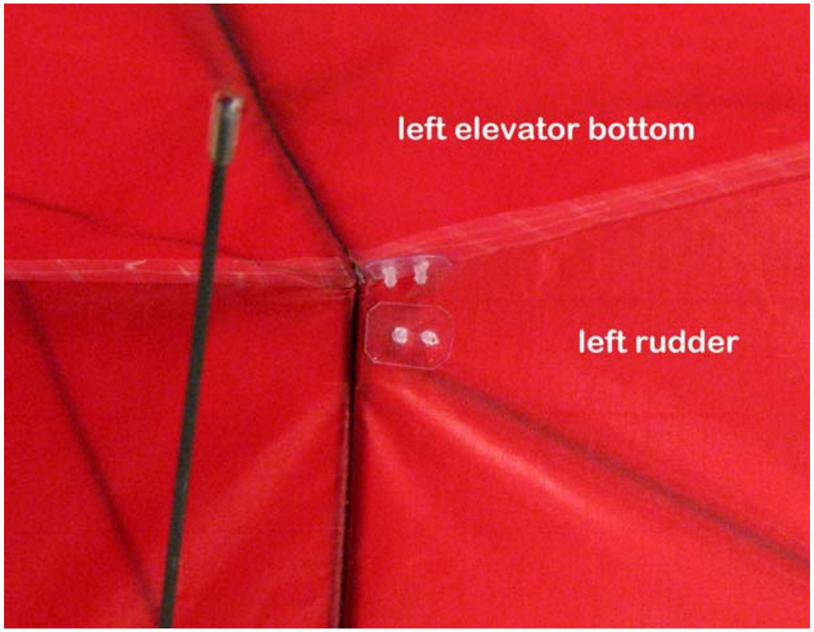
Cut and trim the horn lock plates so they don't interfere with the control surface movement. Be sure they lock well and the pins hold the horn from any movement.

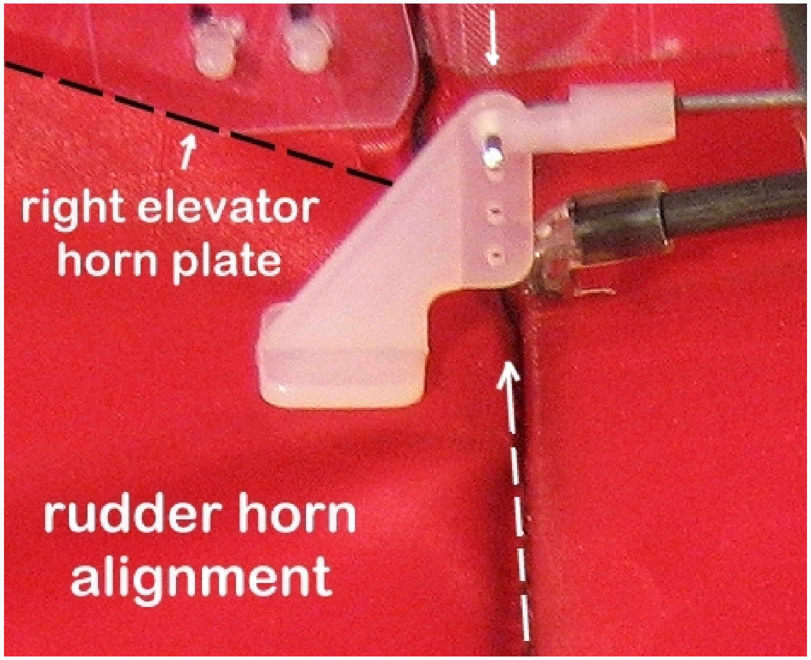
Install the horizontals as you did earlier but this time you'll need to add a hole through the fin fabric for the rear connecting rod to pass through. The securing bands will also need to go through this hole. Double wrap the bands on each rod so the stabs can't easily get knocked off.



Again be sure the hinge lines are straight with each other and that the stabs are level. Also check that the control horns don't interfere with each other at maximum control surface travel.

Note use of L bent music wire and DuBro Mini E/Z link attachment method option for linkage on horns (or at servo). CA and heat shrink to CF rod and to keep the wire from coming loose, add some wavy bends to it. Other options shown later in the Linkage section.





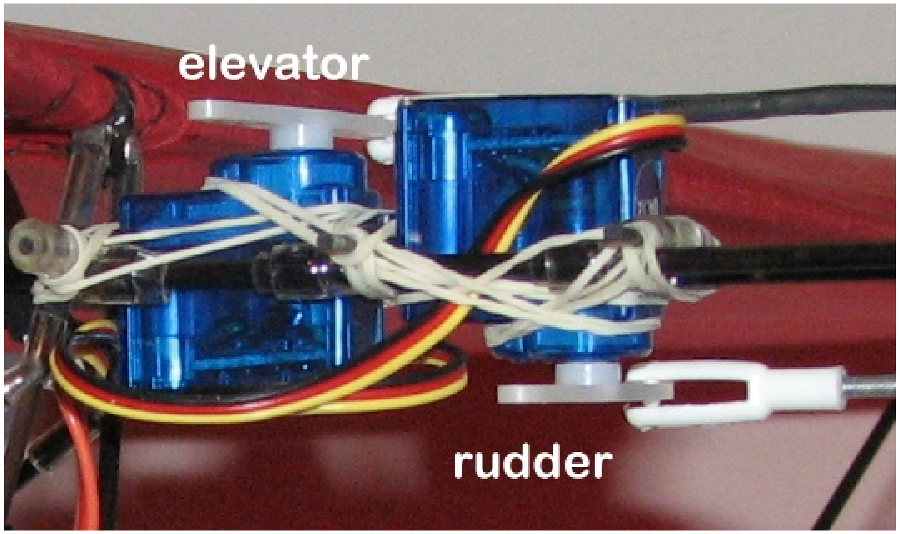
Gear Install

Rudder/Elevator Servos

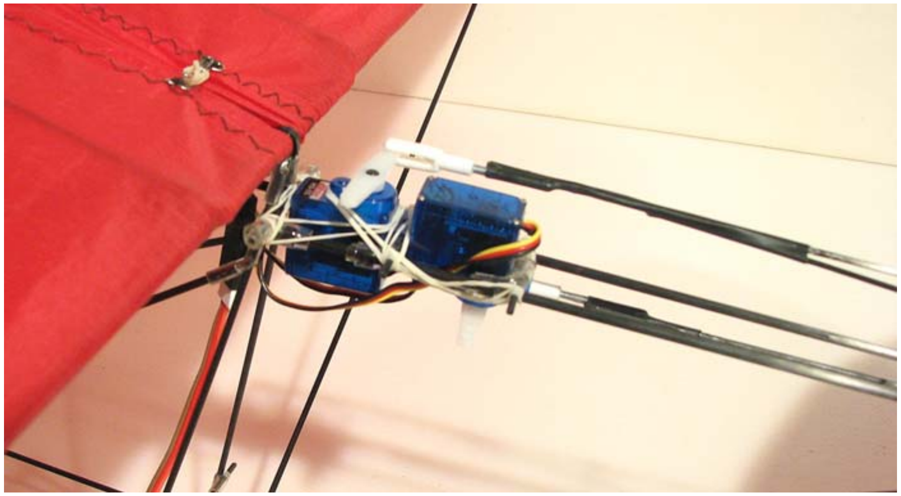
For most operations, typical 8-9 gram with about 16-20 oz/in of torque are fine for elevator and rudder. For example, Hitec HS-55 or 56s are good choices.

For the wing servo a 10-12 gram one with about 30 oz/in of torque won't have any trouble warping the wings. For example, a Hitec HS-81 is a good choice. We use Blue-Bird BMS-371s for R/E and a BMS-380 for the wing.

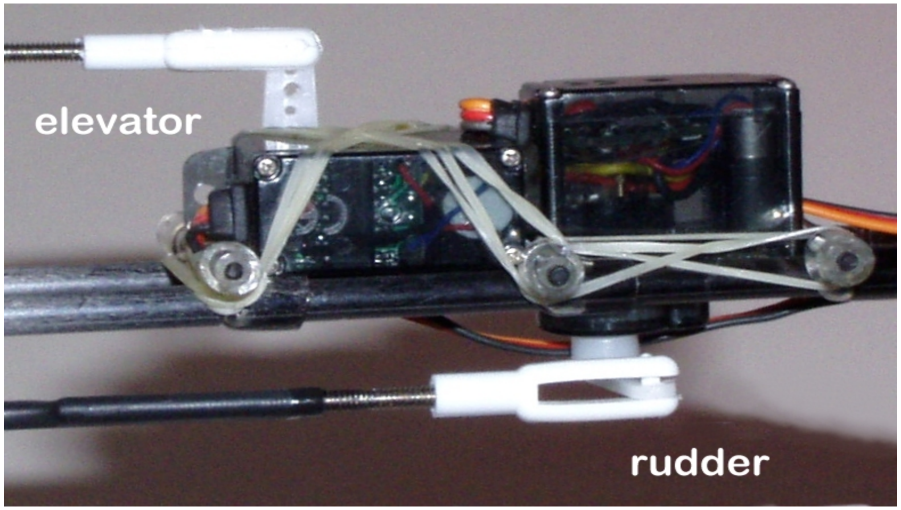
Rudder and elevator servos mount between the servos rails in tandem with the rudder servo inverted. Space the rail tightly up against the servos once pushed into it's "box". They can be held in place with bands stretched cross-crossed over them to the extended posts or with zip ties if desired.



It's recommended that you loop the band all the way around the servo in a number of directions to hold securely from all angles. Wire-ties can also be used but the bands allow the servo to pull out in a severe crash reducing the possibility of gear damage.

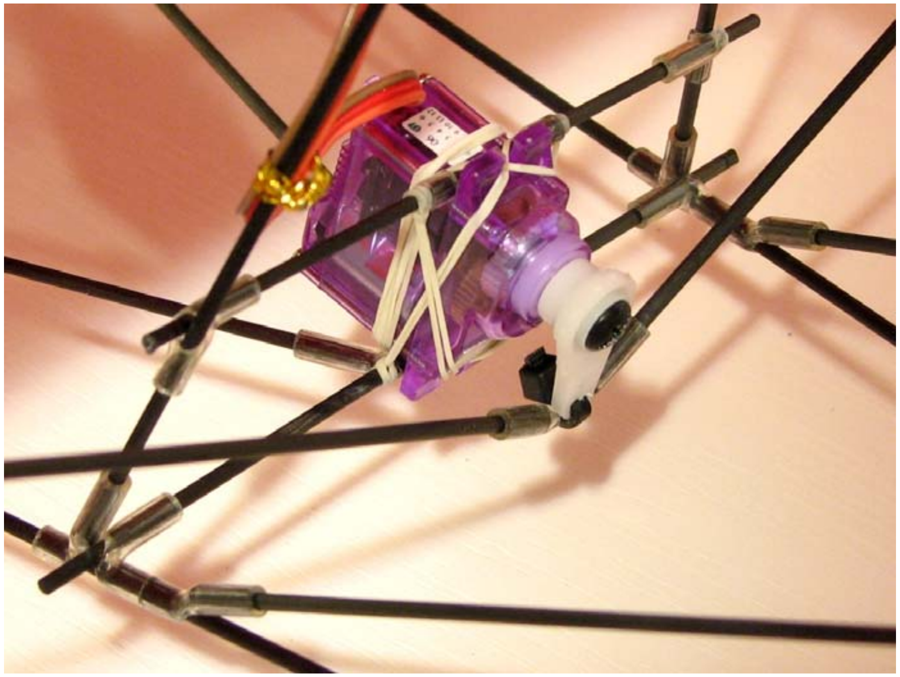


Since the elevator linkage must be split to two control surfaces, a mounting option for the elevator servo is laying it flat on the booms for more equal linkage travel shown below.



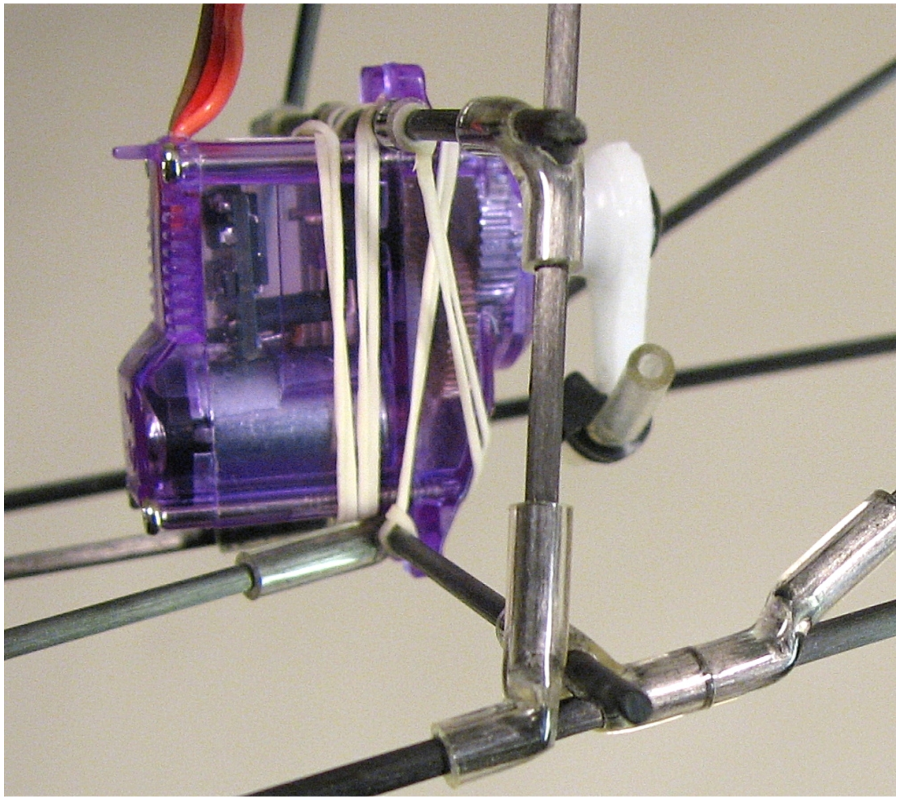
Wing Servo

The wing servo gets mounted vertically between the rear A frame base and the servo rail directly above it. Position the servo so the rails are snug to it and its output shaft is on top sticking out toward the tail. You want the sleeve stops that you placed on the servo rail to be centered and snug up to the servo sides. The lower mount tab of the servo sits on the axle diagonal fittings. Band it tight by making half-hitches in the bands around the rods on the sides of the servo to help keep it centered and criss-cross across the top of the servo and around the opposite rail then over the entire servo case bottom to secure. Do from all four corners.



Use the longest horn you have and carve or drill out the outer hole and secure a long elbow to it with a zip tie. The wing dihedral / washout has been set for the rear spars resting on the rear A-frame base. If your horn isn't long enough to reach that low, just adjust the front spars to compensate as mentioned in the setup directions or get a longer servo arm. You want the most travel you can get from your servo for max roll authority.

Alternately you can add another servo rail to the A-frame so both can be adjusted up or down to suit your needs but we never found a need to try it. Just be sure to keep the horn directed downward for proper roll differential. (More up travel and than down)



Note this horn is slightly short and creates a little extra washout and/or dihedral. The roll rate with it is fine for most flight conditions but don't expect snap rolls. ☺

Linkage

Here are a couple of methods. (Also see the Control Horn section for more L bend connection pictures)

With the supplied music wire and connectors, use the clevises at the servos and L bends at the control horns. CA and heat shrink the threaded rods to the servo ends. Screw the clevis about mid-way on the rod for the most adjustment travel. Connect the elevator linkage halves together the same way with CA and heat shrink. Leave the servo arm wire straight to the control horn on that side and angle the short wire elevator half side to align it to its horn.

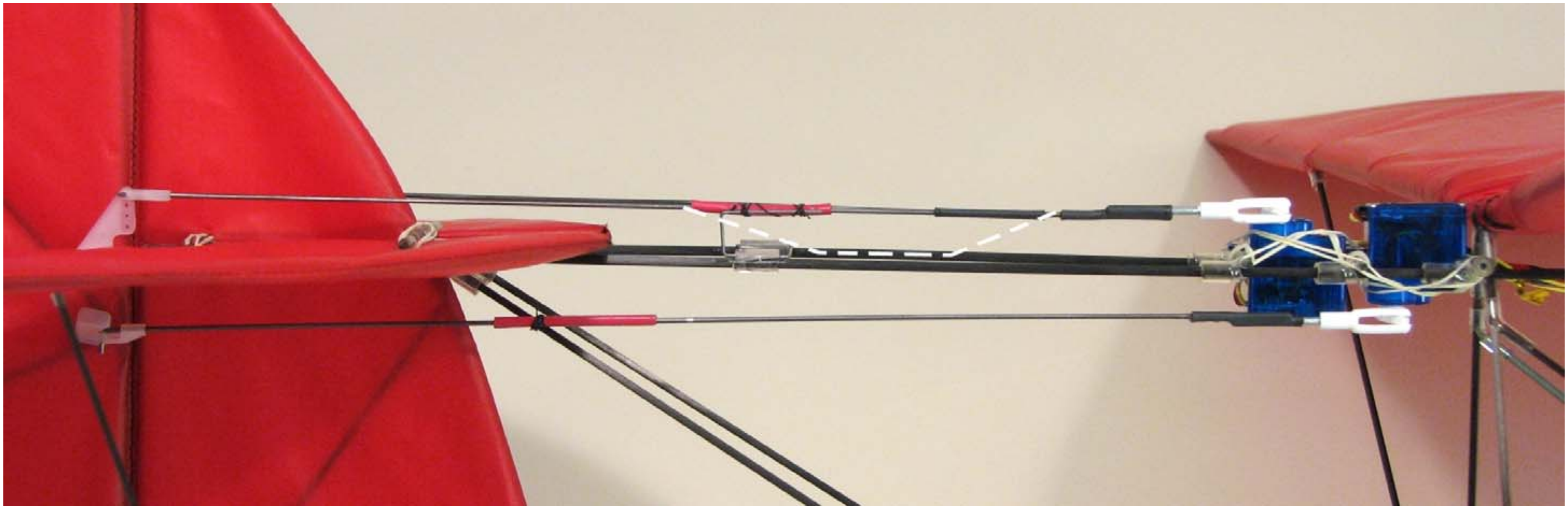
Add a guide sleeve to the wire for the rudder attached to the fuselage side diagonal. For the elevator linkage, attach it to the upper boom. These can be lashed or held on with fittings. I added a riser to the elevator sleeve above the booms to better align the linkage between the servo and control horns. I used a formed scrap of thin music wire but a heavy paper clip will also work. Or you can just form the linkage wire so that it angles down to reach a sleeve attached to the boom itself then angle the linkage back up to align with the servo.

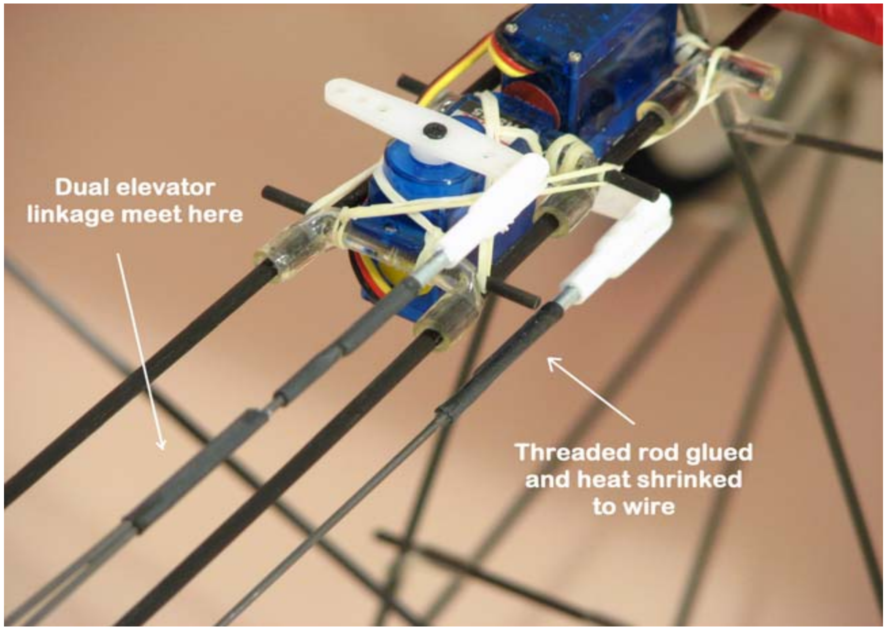
Any way you want to add guides is fine as long as you don't get any binding or restriction of the linkage. Also, the closer they are located to the centerline of the linkage the better.

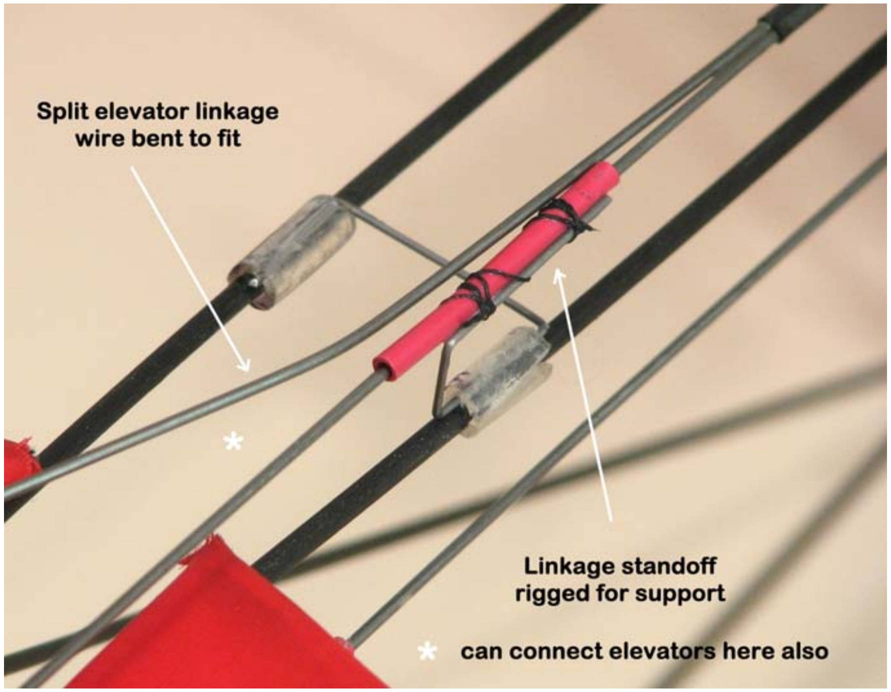
Note that the heavy-duty HS-55 servo arms shown here have oversized holes so they work well with the clevises without the need to drill out the holes. If using this type servo arms, use the L bends at the control horns.

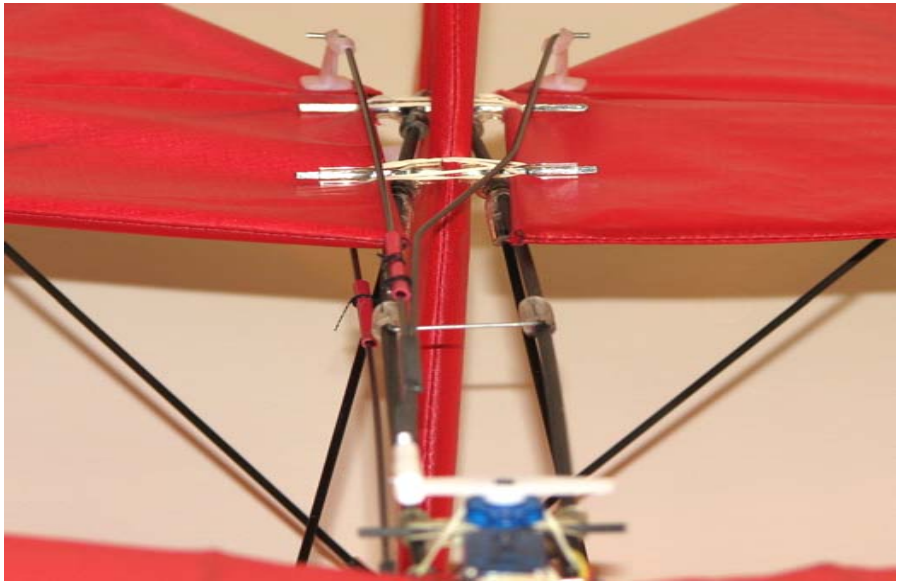
To adjust the separate elevator halves using the wire linkage method, just bent the short side angle to increase or decrease the effective length of the linkage. You still want to get the two halves as aligned as possible during their install of course.

Also, be sure your servos are centered before making the L bends at the leveled control surface.

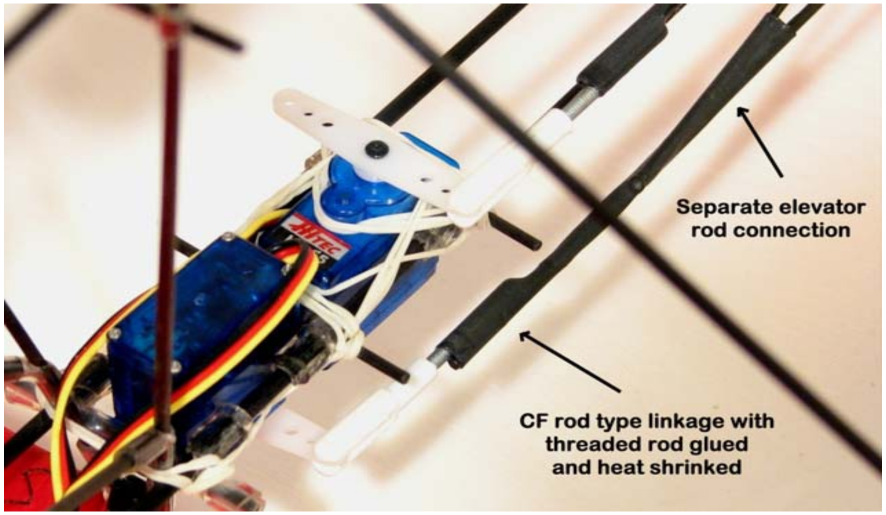






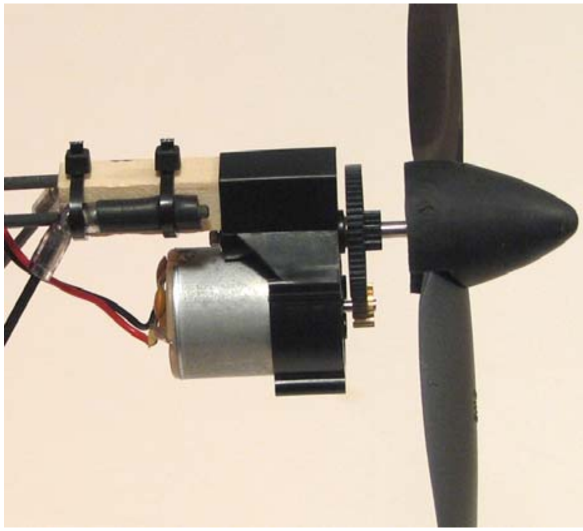


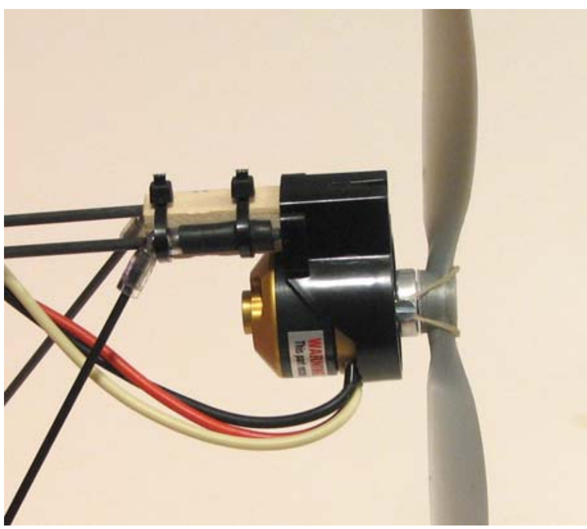
For CF push rod type linkage, use at least .06 diameter rod and CA as well as heat shrink threaded rod connectors to at least one end for clevises or use Z bends in the wire to allow adjustments. Separate elevator rods can just be crossed, glued with heat shrink added. You can lash for more security.

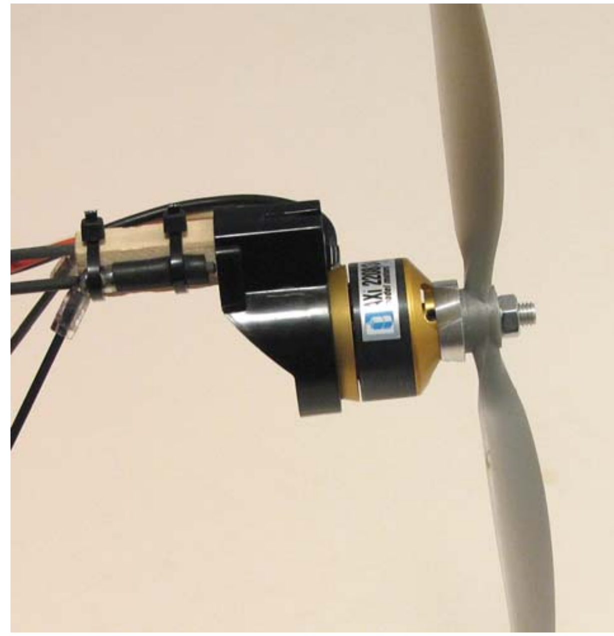


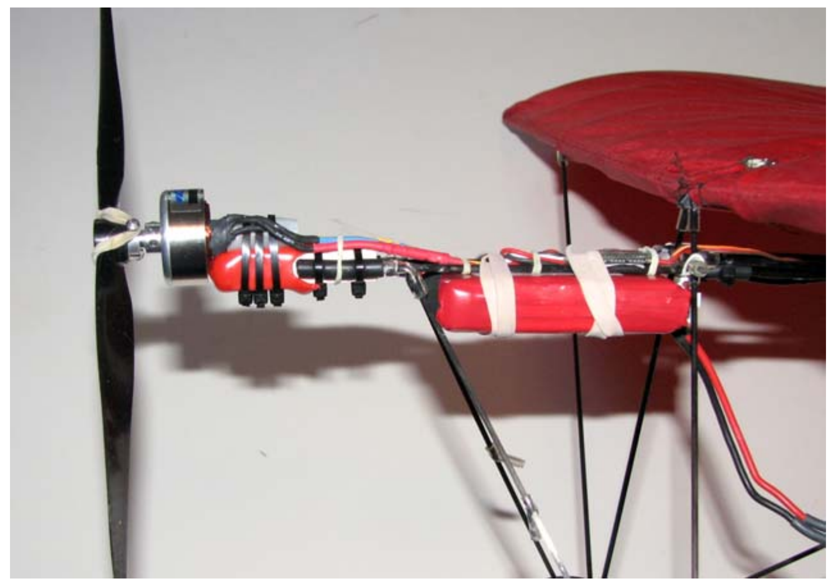
Motor Install

A variety of motors can be used with the "stock" GWS stick mount ranging from GWS EPS 300+ gear drives to CD Rom style post mount motors. With the addition of a brushless adaptor mount, many firewall mount style brushless motors are also easily used such as the AXI and many other brands.









CDROM style post mount - add groove to top of stick. The orange rubber cap was added to stick for better grip but can be heat shrink. Poly tube is added to motor post to lengthen.

Motor Choice Basics

The Carbon Prime can be outfitting with lightweight gear for slow indoor flying or beefed up with lots of extra power for AP, stunts, towing or whatever your needs are. This said, it's hard to recommend the "ideal" power system for the plane.

Since the plane only weights about 7 ounces empty, then with radio, servos etc. you should end up to about 9 ounces. With 5 ounces added for motor/battery, you have a nice low wing loading of only 5.6 oz per sq ft. for slow flight and low stall speeds. This is best for indoor flying.

To balance the plane with a light motor however, the pack needs to go out on the motor frame extensions. This limits you to a minimum of about 5 oz total for motor and pack sideways all the way to the front. This is assuming you locate your servos and receiver as shown. This could be a 2 oz motor and 3 oz pack for example, etc. The small brushless outrunner shown above weights 1.5 oz and the pack is 3.5 oz with the plane balanced at near the aft CG location.

For outdoor use the options are greater since weight isn't as big an issue and the pack can be located all the way back as far as needed to balance the plane.

A common question I get from beginners is what motor should I buy? Instead of recommending any specific model or brand of motor, it's better to understand how to select one yourself for not only this plane but for others you're sure to own.

Generally you can figure the heavier the motor, the more power however brushed motors weigh about twice their brushless equivalents so this is something to consider.

As for brushed motors with gear drives, any 300 to 400 class motor should be fine on the CP. Prop size can be anything from 9 to 12 inches or so depending on the gearing required for the motor system.

There is lots of information on this subject already so let's just stick to the basics and get a feel for it. Since brushless motors are the motor of choice these days, we will limit this lesson to them but you can learn a lot from the following even if you plan to use a brushed motor and don't know where to start.

You'll see lots of motor charts, specs and numbers that unless you have a real interest in electronics you really don't need to learn about. The important ones are: Thrust, prop speed, max amp draw, and pack volts. Lets make it even simpler, amps times volts equal watts. Thrust is the weight the motor can lift in ounces straight up at rest (static thrust). Prop speed is the potential speed of the plane based on how far the prop travels through the air per each RPM. That's about all we really need to figure out to see if a specific motor will work on pretty much any plane.

You can use any number of battery voltages, and battery types but most everyone are using Li-Po (Lithium Polymer) since they are so light. Usually in either 2 cell or 3 cell packs (2S or 3S). 2S is a 7.4 vt pack and the 3S is 11.1 vts. I mentioned a "100 watt motor" earlier. Quick quiz - If you have a 10 volt pack, how many amps will a 100 watt motor be safe to draw. Answer? 10 amps. Simple eh?

Now take the total plane weight and depending on what you want the plane to do, figure the thrust you want. If the plane weights 16 oz and you want to be able to hang on the prop at full throttle, you need a motor that can put out 16 oz of thrust at least. If you have an acrobatic plane you want to go straight up real fast, maybe double the thrust. This is the power to weight ratio. Generally 0.5:1 gives minimum flight, 1:1 ideal for most normal flying and higher values for aerobatics and 3D.

Komodo Motor KH2407-16												
Color indication:	High Thrust		High Speed		Not Recommend							
Propeller Diameter	Propeller Pitch	Type of Propeller	Power Supply Voltage	ESC Voltage	Amps	Watts	RPM	Thrust (g)	Thrust (oz)	g/W	Pitch speed (mph)
8	4	APC E	11.1v	10.98	7.0	76.86	8760	515	18.17	6.70	33.18
8	6	APC E	11.1v	10.65	9.3	99.05	7875	551	19.44	5.56	44.74
8	8	APC E	11.1v	10.82	11.2	121.18	7065	479	16.90	3.95	53.52
8	4.3	GWS SF	11.1v	11.00	6.8	74.80	8805	527	18.59	7.05	35.85
9	3.8	APC SF	11.1v	10.91	9.8	106.92	7680	676	23.85	6.32	27.64
9	4.5	APC E	11.1v	10.89	9.4	102.37	8040	705	24.87	6.89	34.26
9	6	GWS SF	11.1v	10.68	14.0	149.52	6570	705	24.87	4.72	37.33
10	3.8	APC SF	11.1v	10.73	13.0	139.49	6825	817	28.82	5.86	24.56
10	5	APC E	11.1v	10.89	10.8	117.61	7230	728	25.68	6.19	34.23

This chart shows the specs for the above pictured 1.5 oz CDROM style, post-mount brushless outrunner motor that the prototype was tested with. The actual chart is very long with many different voltages but we'll just look at the 11.1vt 3S (3 cell in Series) LiPoly options. Let's go straight to the prop that produces the most thrust. That's the 9x4.5. I use a GWS 9x5 direct drive prop knowing that it pulls about the same amps from the motor.

The larger diameter and/or pitch, the more power it needs to turn as you can see. You'll have almost 25 oz of thrust available on a 14-16 oz plane. Since the motor can handle about 10 amps max, we're safe running at full throttle at 9.4 amps. Note the watts - at about 100. Also note the prop pitch speed of 34 mph which should be plenty for our needs.

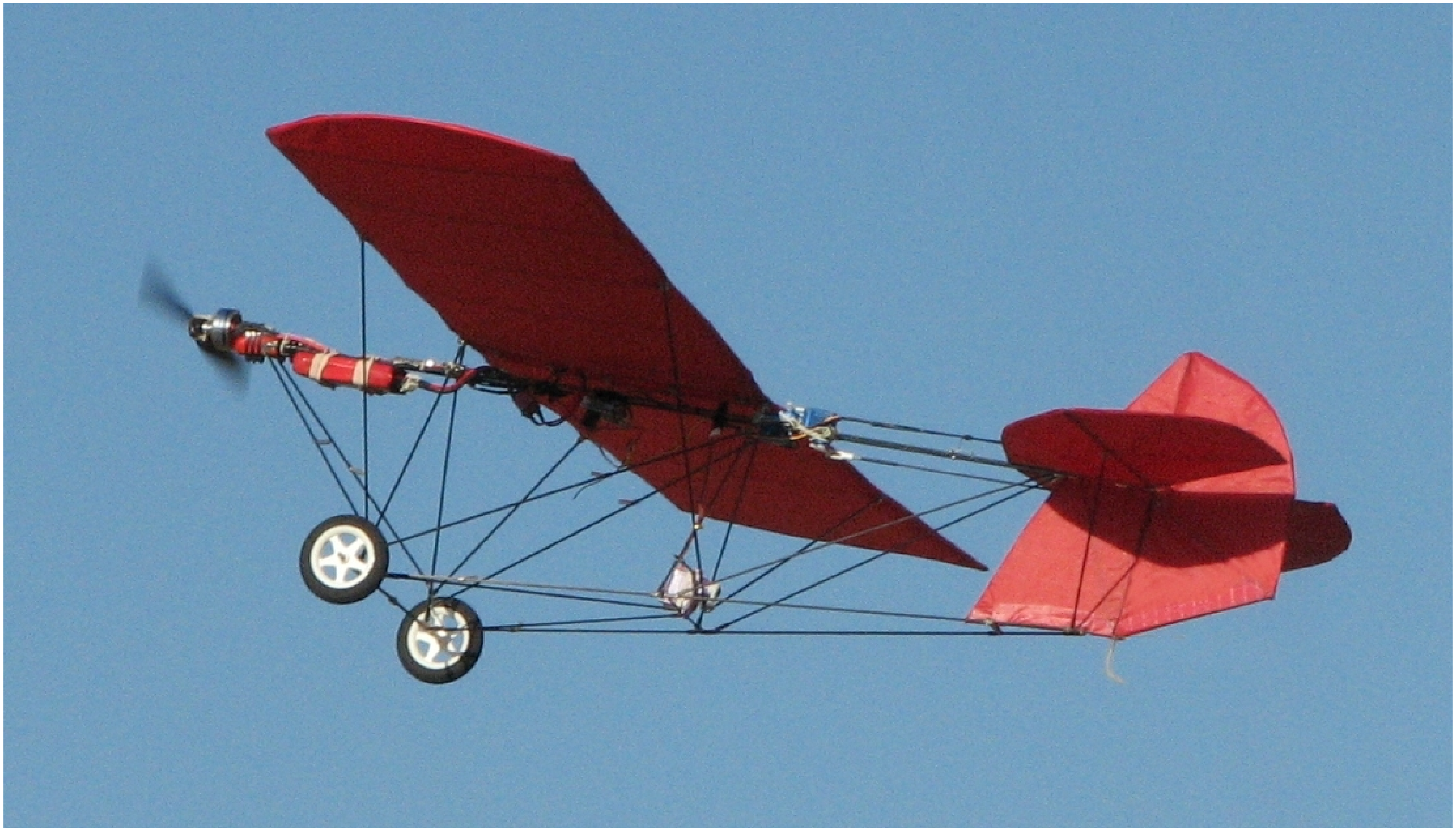
Now lets go the other way. Lets say you have a racer you want the fastest prop for. Go with the 8x8 for about 53 mph. Note however that if you run the motor full throttle for longer than short bursts, you risk overheating it due to the 11 amp current draw. Best to drop down to the 8x6 for about 45 MPH at 9.3 amps.

For 2S or 7.4 vt packs, since they weight less, you can use a higher capacity one for longer duration. Back to watts, using the same 10 amp maximum, 10 times 7.4 is only 74 watts so you won't be getting the same amount of thrust but the motor will be running more efficiently adding to the duration. The chart (not shown) for the 7.4 vt pack lists a 10x7 drawing 9.4 amps, producing close to 16 oz of thrust and giving a pitch speed of 28 mph. I use a 10x6 with this motor on 1650 mAh 2S packs and get almost half hour flights with plenty of power.

For a reference, a 3S 1500 mAh pack weights about the same as a 2000 mAh 2S pack. If you don't need the thrust, trade it for duration. BTW, to figure out how long you can fly on a pack, just take the pack capacity in amps (2000 mA = 2 amps) and divide by the AVERAGE current your motor will be using for the flight. Lets say we have a 3 amp cruise so 2A/3A=0.67 then times 60 minutes for a 40 minute flight!

Hopefully this will give you a logical basis of how it all works together and make your choices easier as well as assuring great performance from whatever you fly.

Battery Placement



Ideally you want the battery located on the CG so that changing to different size packs will not require repositioning it.

Unfortunately in the case of smaller lightweight motors, you'll need it well forward out in front under the motor boom extensions as shown. Use Velcro and bands to secure it from moving as well as wrapping it in foam to protect it.

Wherever you locate the pack, do put the receiver behind it so if the pack comes loose in a crash it won't take out your receiver when leaving the plane. ☹

The speed control is just banded to the top of the motor extension so it is close to the motor yet out of the way of the pack and still in the airflow for good cooling.

Flying

For 3 or 4 channel flight, adjust your elevators and rudder to even with their stabs. You want the most travel possible for the rudder. Elevator travel should be adjusted to taste but 1 inch up and 1 inch down should be good to start. About twice that is good for acrobatics.

For 4 channel wing warping, the more travel you can get the better. Measure the up-going wing since the mechanical differential in the linkage will restrict the down-going sides travel. With a long servo horn used, expect to get about 1 inch up travel max. Shorter horns give maybe 1/2 inch up travel.

Since the wing warping only changes the washout at the tips and not the angle of attack of the entire wing half, don't expect exceptional roll rates at low speeds. If you feel you don't have enough roll, just speed up a little and roll will get nice and responsive.

We won't try to teach you how to fly here, as there are many sources of information on the subject. If this is your first plane, do seek out the basics and start by setting it up as a rudder/elevator 3-channel model. Do taxi the plane around on the ground for quite some time to get the feel for the controls.

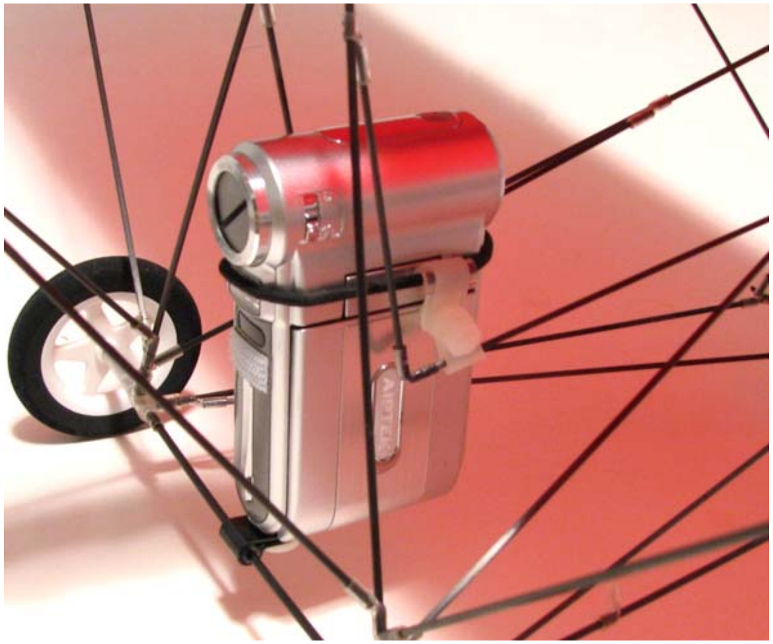
Once you break ground, immediately cut power, land and repeat. Once you can fly around comfortably a couple inches off the ground, land on one wheel, then the other, keep the tail up and keep going without dragging a wingtip, you'll have a good feel for the plane and be ready to explore more altitude.

Aerial Photography

Depending on the camera you intend to use, most should have a tri-pod mount fitting on the bottom. I've found that a large nylon wire clamp can be drilling out to fit a nylon bolt that fits the tri-pod mount and shortened to fit the depth of the fitting in the camera. By adding a sleeve on the middle of the axle, this clamp assembly can securely grip the axle and support at least most of the weight of the camera.

You still need more support however so the camera doesn't rotate which can be a floor piece or better yet, some adjustable struts from the A frame sides connected to more nylon wire clamps held to the camera with a thin bungee loop around it. This allows the mount struts to be slid on the A frames to adjust camera angle and offers a shock mount as well.

Whatever you use, do add a safety hanger strap up and around the main booms so that under no circumstances can your camera completely fall out of the plane even if everything else comes loose. Try to keep the camera weight forward in the frame for best ground handling and readjust the flight pack location to correct CG.



Definition Of Terms

General Abbreviations and Terms

A of A = Angle of Attack - positive or negative angle wing is traveling through air
A/E = Aileron / Elevator - type of model using only these for control - with throttle uses 3 channel radio (see also R/E)
AP = Aerial Photography
ARF = Almost Ready to Fly - model mostly built but needing some final construction and gear installation
AUW = All Up Weight - weight of plane and all gear needed to fly
BEC = Battery Elimination Circuit - part of ESC that lets receiver to be powered by motor battery
Brushless = type of light and efficient electric motor for model use - required brushless ESC
CA = (cyanoacrylates) - Hot Stuff, Crazy Glue, Zap, etc.
CF = Carbon Fiber - rods, tubes, plates - very light and strong
CG = Center of Gravity - location where model balances level on ground required for proper flight
Channels = number of controls available in radio. 4 channels needed for elevator, rudder, aileron and throttle for example
Chord = distance of wing profile from LE to TE
ESC = Electronic Speed Control - circuit that controls motor speed with throttle stick signal
FG = Fiberglass- rods are more bendable than CF type
LE = Leading Edge - front edge of wing
LG = Landing Gear
LiPo = Lithium Polymer - light and efficient battery type used for RC models
mAh = Milliamp hour - 1000 mAh = 1 Amp per hour
R/E = Rudder / Elevator - type of model using only these for control - with throttle uses 3 channel radio
RC or R/C = Radio Control
ROG = Rise Off Ground (or Grass) - able to take off under own power
Root = front to back center line of wing
RTF = Ready To Fly - plane includes everything needed to fly and is fully assembled
SF = Slow Flyer
TE = Trailing Edge - rear edge of wing
vt =volts
Washout = wing twist - tips at lower A of A than root
Watts = measurement of power = volts times amps

Terms Specific to the Carbon Prime

Bow = outer circumference frame rod that shapes a panel
Bushing = rigid tube piece used as bearing surface around rod
Booms = two main structural rods running the length of the plane
Control Surface = rudder or elevator panel
CP = Carbon Prime™ of course!
Fitting = thin flexible tubing used to connect frame parts to form panel shape or connect panels together
Panel = built up frame piece from rods that when covered becomes a section of the plane
Spreader = rod within frame that holds the panel shape
Wing warping = type of aileron control for roll where entire wing twists

Now quit monkeying around and go fly!

Best Regards,

Ken Hill – Ace Sim RC
http://www.acesim.com/rc