

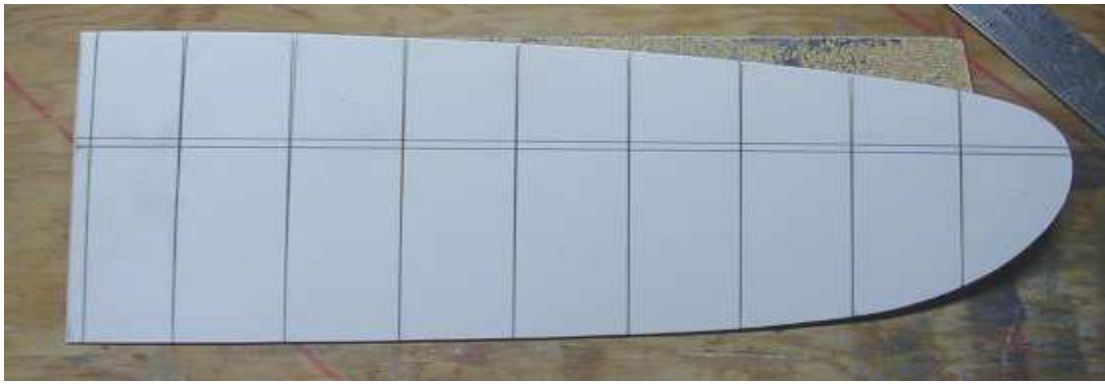
## CONSTRUCTION FILE #2

### BUILDING STAB HALVES, RUDDER, RUDDER HINGING, MOUNTING THE PIVOT ROD

Don't disdainfully view these simple & inexpensive structures. They work especially well. I've experimented for years with stabs of different area, planform & airfoil. Plans sent out after 7/9/07 show a stab half 13-1/2" in span with 7 ribs spaced on 1-1/2" centers. Use it on the Big Genie, the Genie Pro & the Smooth Genie Pro. Reduce length one bay at the root end for the LT/S & Easy LT/S. If using the LT/S composite fuse, the lower stab on the plans fits its wider fin without need to trim off stabs for rudder deflection.

Spars are 1/8" very hard balsa. 1/4" LE, 1/8" TE & the 3/16" rounded tip piece are medium. It's fine to 3M77 1/8" sheet pieces together & sand them or 1/4" down to 3/16". The 3 layer root lamination & ribs are 1/8" light stock. Using these densities, the properly sanded, Monokoted pair combined weight will be around 1 oz. assembled with CA glue.

Nothing, including tail pieces, is built on the plans & working over them would be awkward. For the stabs, place a 5-1/2" x 14" piece of Sintra under the plans. Use a common push pin to outline the stab perimeter. Cut it & sand edges smooth. Squared to the root end, pencil in parallel lines at the spar location. 1/4" from the root draw a chordwise line. Draw another 1-1/4" out from it & a series 1-1/2" apart at rib locations. The full 13-1/2" span pattern then looks like this:



**LE'S, TE'S & TIPS:** A bandsaw makes quick work of preparing a stabs kit. Directly on balsa sheet, mark around the pattern to outline the outer perimeters of the curved 1/4" LE & curved 1/8" TE pieces. Shift it to mark the rear line of the LE with slight taper. Shift to mark front edge of the TE. Cut 1/8" or so beyond the marks. Cut balsa blanks to place under the marked ones. Pin & stack saw matched pairs. Use a 1/8" sq. file, etc. to make notches at rib rear ends. Place a 3 x 5 card under the pattern to mark the tip outer perimeter. Cut that line with scissors. Place it & a balsa LE & TE in position over the full pattern. Eyeball, mark & cut the remainder of the card for the 3/16" tip piece pattern. Duplicate on Sintra & cut two.

**ROOT LAMINATIONS:** Grain is to run chordwise. The aluminum tubes are to be vertically centered in 3 layers of 1/8" balsa. From balsa sheet, rip a strip 1-1/4" wide. Stand it on edge on the leveled bandsaw table to cut it with ends squared up. Clamp a board to the bandsaw table to do the following:

Cut six (6) pieces 1-1/2" long for the front laminations. Cut four (4) 2-3/4" long for top/bottom rears. Cut two (2) 1-3/4" long for center rears behind the rear tube.

If the holes in the bellcrank are on true 1" centers & if the spar is exactly 1/8" thick, 11/16" center layers behind the spar would put the tubes on 1" centers. However, if the holes are off and/or the spar is not exactly 1/8" thick, the length of these pieces will have to be custom-fitted after the rear tubes are attached to the bottom layers. See page 3.

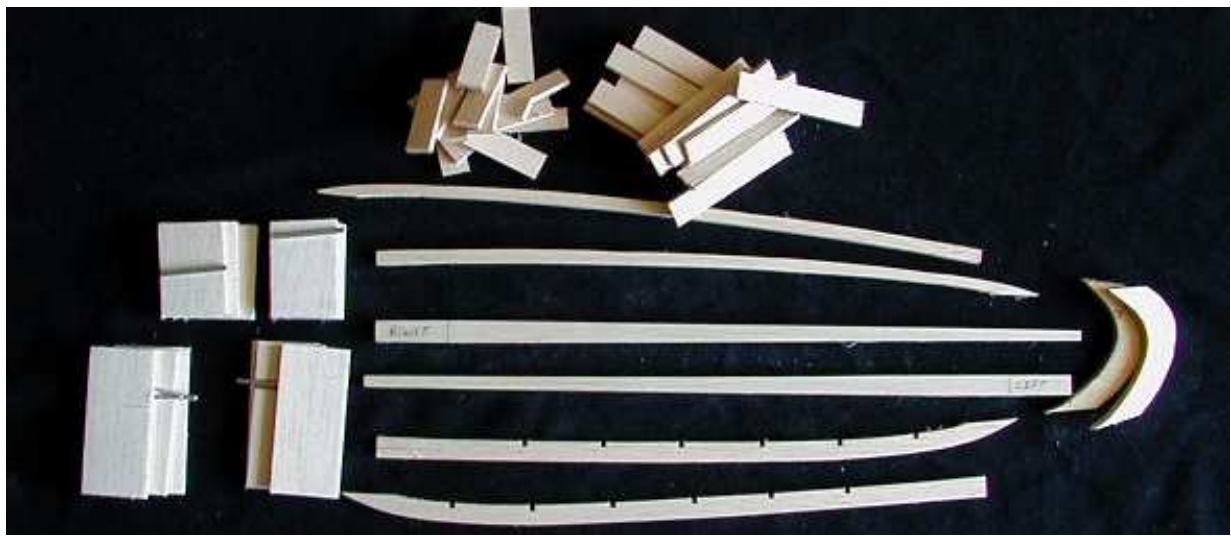
**RIB STOCK:** From 1/8 sheet, rip strips 7/16" wide. Cut 14 pieces 1-1/2" long to use ahead of the spars. Cut 14 pieces 2-3/4" long for the straight ribs behind the spars.

**HARD SPARS: (REALLY HARD!)** You want the inboard 1-1/4" to exactly match the actual thickness of the 3 layers of root laminations balsa. Beyond 1-1/4", on what is to be the bottom edge, mark the spar stock to taper to 3/16". Stack saw & sand to get a matching pair that will sit perfectly upright.

**ALUMINUM TUBES:** These are based on using 3/32" music wire for stab support. If going metric, 2.5mm is fine, with similarly related tube choices as given below in inch fractions.

From 1/8" OD, cut four pieces exactly 1-1/4" long. In two, use instant CA glue to bond 3/32" OD aluminum in 1/2" deep. Trim to leave 1/4" exposed. Smooth & open the tube ends.

After doing the above, except for continuous strips for the diagonal ribs, you'll have a stabs kit ready to assemble that looks like this:



**.025 FLAT SURGICAL RUBBER AS FRICTION GRIP RETAINERS:** Scissor 1/4" x 1" pieces. With those 1-1/4" spar ends down & toward each other, mark the spars as "L" & "R". The stab halves will appear to have a little dihedral, rather than sagging. Mark rubber location on their fronts. Too much CA is trouble. Make micro-dispensers by heating & stretching fine Teflon tube or slipping the needle cut from a small syringe into it. Practice attaching rubber pieces to scrap. Apply a drop of instant CA at one end & let it wick toward the other. Finish from the other end.

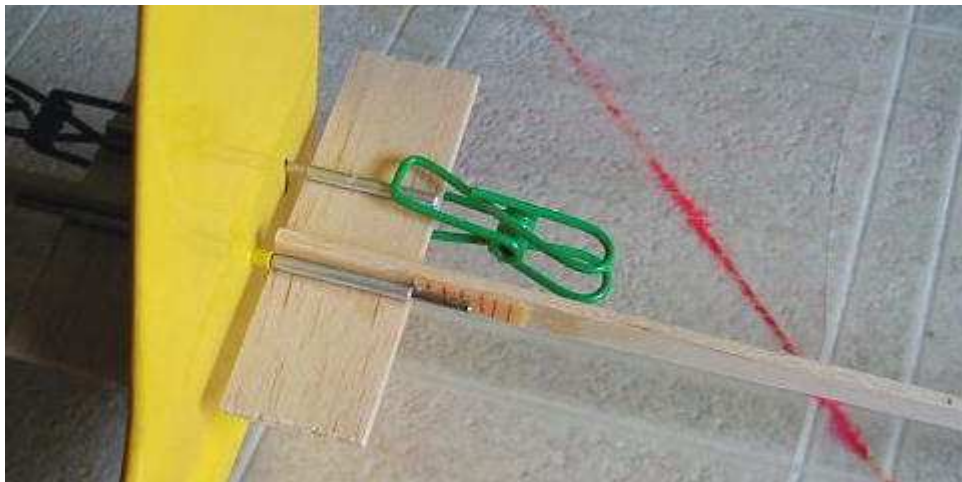
When you can do it without the rubber curling, attach pieces to the plain real spars. It must lay flush to the spar, not curled. Start at the inboard end. Dampen a rag with acetone to wipe off any CA residue on the rubber.

Over Saran wrap, etc., position the “R” spar perfectly upright between the front & rear bottom laminations. With all 3 parts pressed precisely flush to a flat work surface, lightly wick-join parts. Inspect the work! Bottoms must be in plane. Make a matching, but opposing “L” assembly. Bottom to bottom, the root layers must fit perfectly flush to each other. Discrepancy means the stab halves will be working at different angles of attack & prevent a steady, level, hands-off flight path.

As plans show, prepare the 3/32” main stab support wire with the aluminum tube centered on it, bonded with CA glue. Round the ends of the wire to slide over the rubber.

Tube walls are thinner than the .025” rubber. Press a plain tube into the corner where the front bottom lamination meets the spar. A friction grip should be noted when the support wire slides over the rubber. If not, gently file down one side of the tube to increase grip.

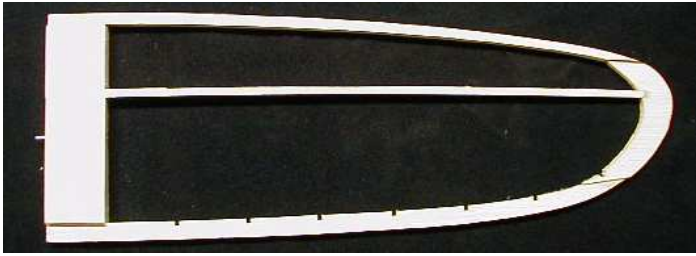
When all fits well, press & hold the tube in the corner & tack it in place with instant CA glue. Run the support wire & 1/16” drive wire thru the fin. As shown below, slip on the stab sub-assemblies. The red marks are on the rubber face.



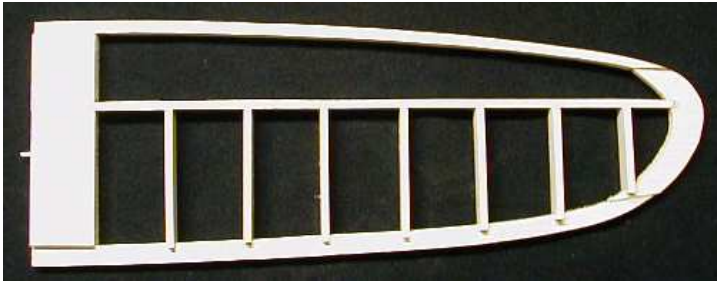
Slip the rear tubes on the drive wire, so the inner tubes protrude beyond the inboard edge of the bottom rear lamination. Lightly clamp both tubes as shown above & view from the tail end to see if the two assemblies are in true plane with each other. If not, put a suitable shim under the tube on the high side. A 1/8” wide strip of CA hinge, business card, etc. works well. With everything squared up, apply a tiny drop of CA to lightly secure the rear tubes & any shim.

Glue on the other 1/8” pieces to firmly bond and surround the tubes in place with CA glue. Trim off excess lamination ends, front & rear on one stab. Use it, bottom to bottom, as a pattern to equally trim the other one. Attach the 3/16” tips with all flat to the workbench, so the tip pieces are in plane with the root assemblies.

In the hands, position a TE on the root & tip so it’s level & vertically centered. A dab of instant CA glue quickly joins well-fitted parts at the two points.



Similarly, vertically center the LE's creating frames with no ribs. This visual vertical centering helps prevent building any twist into the structures & helps get identical LE & TE alignment on both stabs.



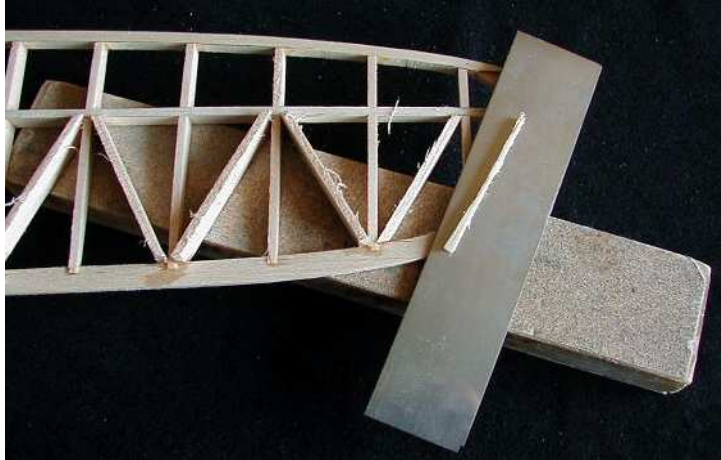
Rear ribs are attached as rectangular shaped pieces. Mark to length, trim & tack one by one only to the spar at this time to get assemblies as shown here. Size ribs so the spar is not bowed. Don't trim the ribs to airfoil.

Eyeball a stab from its end. As needed, adjust the notched TE's vertically on the rib ends so the TE looks straight, true & centered relative to the spar. With instant CA, lightly tack rib rear ends in the rear end of notches. Avoid saturating the front of the TE's so the diagonals can be easily bonded.



Cut some pieces for the diagonals about 3-1/2" long. Position one upright under a stab to mark the angled diagonal ends. As shown, make a support to hold a razor saw upright to cut the angled ends for nice fit. Cut the pieces about 1/32" longer than marked to sand to a fine fit.

Fit & attach the front rib pieces. With razor saw replacement blade it's easy to trim the straight, light balsa ribs one by one. As shown below, the blade can be bowed to impart curvature as seen on the trimmed off piece in the picture below. Then add the diagonals.



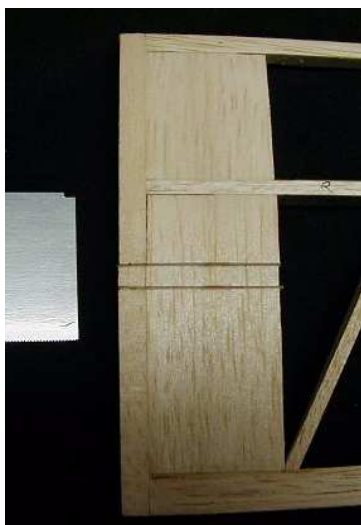
The blade here is the 1-1/2" x 6-1/2", 32 tpi Zona. Pull the larger Exacto blade out of its back/handle to use for the purpose.

To fine sand without putting strain on the glue joints, hold a rib in one hand & sand it lengthwise with a small block in the other hand. The airfoil is generic & symmetrical. Ribs may be sanded flat or rounded. No flying difference is noted but rounded looks nicer. Covering will dip between ribs, anyway.

As viewed head-on, the tapered LE can be sanded progressively thinner toward the tip. Do one stab half first & use it as a pattern to make the other one. By counting strokes, equal amounts can be sanded off the top & bottom of the LE & later the TE. Bear the work on one sanding block while sanding with another one. Gently round the LE. Bevel the TE down to a thickness of 1/32". Taper the 3/16" tip down to 1/32" or so at its edges.

See next pic. Using 1/4" light balsa for endcaps, initially drill a 3/32" hole to slip over the protruding rear 3/32" tube. Carefully mark the center of the front tube locations & make 3/16" openings. Wick-join endcaps in place.

To get the root assemblies the same shape, sand each down some, then butt both together on 3/32" & 1/16" wires to simultaneously sand.



**STAB MISALIGNMENT?:** Before adding the 1/64" ply finishing endcap, slip the stabs on to make a last check that they're in plane with each other. If, in spite of your prior efforts they are not, slit both sides of a rear tube as shown here to raise or lower it as needed. Shim the slits & glue parts back together. Fill & sand as needed. Slip the main support wire & drive wire through the fin. There's a little play between the brass tube & the aluminum tube on the support wire to help with alignment to the saddle & fin. The wire doesn't pivot. Stabs pivot on it as the rubber grippers "give". Slip on the stab halves to first check fit to the fin in bird's eye view. If the support wire can be positioned to square the stabs to the fin, stab ends can be left as is. If not, trim as needed. Finally, make 3/32" & 3/16" holes in 1/64" ply on 1" centers to cap over the balsa endcaps. Wick these in place & trim excess.

From the front end, see that the stabs can be squared to the fin & the saddle. Determine how the support wire should be positioned inside the brass tube for best alignment. If more play is needed, file on the aluminum.

To protect the fin paint, wax around the brass tube. While holding the support wire to best align things, with fin horizontal wick instant CA between it & the brass tube.

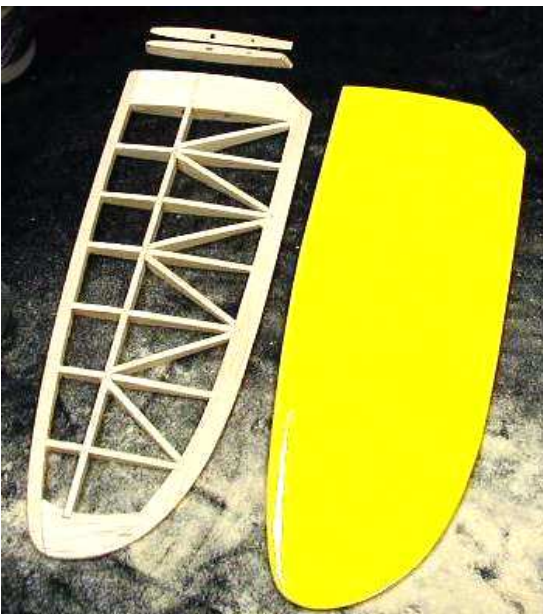
**ALTERNATIVE REMOVABLE SUPPORT WIRE:** Get best possible alignments of the main wire to the brass tube. Smear the aluminum tube on the wire with bee's wax, etc. Run it into the short brass tube. Good fitting rubber grippers on the spars of the stabs will secure the whole assembly and allow pivoting of each stab on the wire.

**ANOTHER OPTION:** More or less permanently secure one stab half to the wire with a light coat of spray adhesive, etc. Then, for deflection on that side, the wire needs to pivot in the brass tube.



The fin should be left flat where stabs butt.

Ends of the non-rotating main support wire are rounded to slide over the rubber strip indicated by the red marks. The rubber provides a friction grip to secure the stabs but "gives" to not impair deflection.



Working the simple assemblies to airfoil profile can also be done with sanding blocks alone. Witness the uncovered one & the actual sawdust created in the shaping process. The generic symmetrical airfoil has proven to be totally suited to the job. Crisp response to stick input occurs at very low airspeeds due to the stabs being under the wing wash, as partly accounted for by the droop snoot fuselage profile.

These simple stabs will produce very tight loops & hold the ship inverted after intentionally tucking under. Tight 360 degree turns after rolling the wing on a tip can be done with them. Their light weight helps minimize the potential for damage to the fuse near the fin in a hard dork.

## CF CAPPED SPARS FOR HIGH STRESS TOWING, SUCH AS 2-MAN F3J:

While towing I've never broken a stab built as detailed above, strength can be materially increased as follows: (thanks to Chris Boultinghouse of Austin, Tx for this suggestion) Before adding the 1/4" balsa endcap, with triangular file make a "V" groove along the spar top & bottom. From your CF cloth, pull a strand of CF. Tack it around the root & twirl it in the fingers to make a "rope" out of it. Lay this snugly down in the groove. Secure it with CA glue.



In the picture, partial ribs of 1/16" balsa were put in to support the covering behind the LE. On this one, the ribs were rounded to make the stabs more pleasing to the eye.

**COVERING:** Monokote, with its drum tight ping, is my favored covering. It sags less cut lengthwise along the roll. For the top, cut a rectangular piece 1" longer than the stab & 1/2" wider than its maximum chord. Lay a stab inverted over the inverted top piece. With ball point pen, mark about 1/4" beyond the LE & TE. Scissor that out. With sealing iron, tack the Monokote at 1" intervals along the root edge, the back edge of the TE & a bit behind the front of the LE. Seal the excess around the TE, around the LE front edges & then along the underside.

Near the highly curved tips, scissor the excess to about 1/8". Run the iron around the vertical edge & then progressively work inward at the bottom to maximize shrinkage & minimize crinkles. Flatten the edge all around & come up fully up the endcap. Trim excess there. For the bottom, cut a similarly sized piece. Position it flush with the extreme tip, none to wrap around. Tack along the LE, TE & root on top. Working out from the rear of the LE & the front of the TE, seal the bottom Monokote to the frame & to the wrapped edges of the top covering.

Scissor around the perimeter to remove excess covering, but leave some to come around the root. Seal the bottom over the flattened edges of the top. It will look nice if you trim the bottom piece to come halfway up at the root. Open the covering over the tubes with sharp #11 blade. The top can be shrunk with a heat gun, but it's safer to use the iron on the bottom as the gun may unseal the overlapped edges. If warps develop, gently heat the covering, untwist & hold to cool.

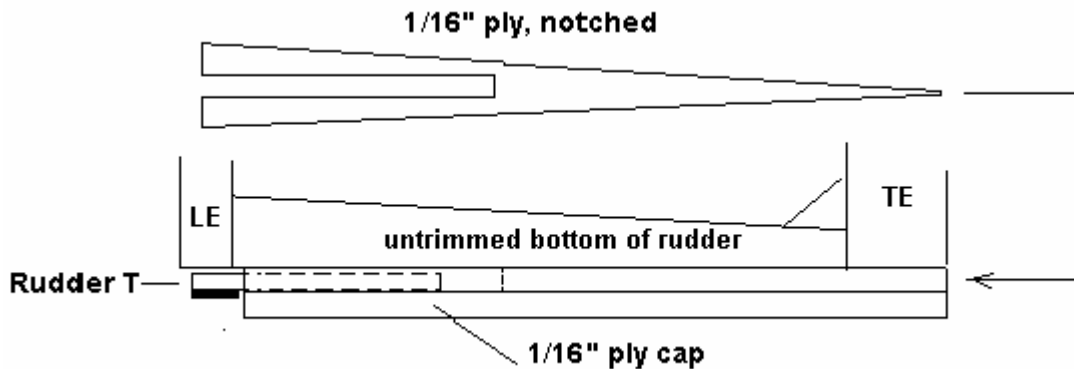
**RUDDER:** Without pinning, build this similarly to the stabs. It operates by pull-pull cables. Between the 2-way output arm & the "T" fitting a parallelogram is to be formed. Radius at the output arm & the T must match for precise & smooth operation.

**RUDDER T:** This consists of a 1/16" wire nail soldered to 1/4" x 1/32" brass strip.



Solder parts & then drill tiny holes at correct radius where cables attach. The softer nail wire is easy to solder to the brass with a tiny butane torch, such as available from Tower. The nail will bend to help avoid damage to the slot detailed below if the tail whips around & slams into the turf. It can be manually straightened on the spot or re-soldered if the solder joint breaks. Spares can be made up & kept in the field box along with spare cable & crimps.

The drawing below details how a strong slot is made at the bottom of the rudder to receive the T. Clearance is made at the bottom of the rudder so the cable holes in the



brass part will be at right angles to the pivot point of the hinges. It will be apparent where this is after the hinging is done. Up front, the ply pieces are easily bandsaw trimmed.

First make the slotted ply piece that tapers from 5/16" at its front, back to the rudder TE. Position this centered on the unshaped bottom balsa member & attach it by wicking thin CA along its outer edges & inside the slot. After the rudder is sanded to airfoil, cut a ply cap wide enough to wick to the slotted piece. Use the Dremel to sand the cap even with the structure. If the hole for the nail end is tight, open it with a #51 bit.

A rounded balsa cap can be placed under the 1/16" ply cap. Monokote will stick better to it than to the ply.

### KNUCKLE HINGING WITH FOURMOST PRODUCT'S "SNAP TIGHT" HINGES

This is a neat & easy way that makes the rudder removable. It involves a 3 layer LE shown on the plans & detailed below.



Do a web search for "Fourmost Products". Click on "HINGES" in the ONLINE catalog. Get the #144. As the instruction sheet shows, hinges snap on pieces of piano wire recessed & secured in the rudder LE. The instructions don't address a thin, tapered fin & rudder. Some innovation is required.

The threaded, cylindrical hinge part anchors in the fin, but must not interfere with BK motion. Using these hinges, the frame housing for the BK should clear the fin TE by 3/4". The rudder will operate linearly if the holes in the brass part of the T match the spacing of cables on the two-way output arm & are located at right angles to the rudder at the pivot point of the hinges. See the picture on page 10.

The pic below shows 4 hinges, but 3 are okay, too. The straight section of wire from a springy 2" paper clip works for the wire needed for hinges to snap over. An easy way to secure them, all nicely centered & all aligned in a straight line, is detailed below using a 3 layer LE of 1/8" balsa attached in stages. It's much simpler than may appear at first glance.



In the picture above, the most forward part of the 3 layers is shown laid flat with the rear side pointing up. It has small holes at hinge locations where the wires are shown. After LE assembly is done, notches will be cut at the small holes to snap on the hinges.

Three full length LE layers are made. For a pattern, pin a strip of 1/8" balsa to the fin TE to mark around. Stack cut & sand three to match the fin's taper. With a shaped piece, assemble rudder to the stage shown above with ribs, TE, balsa top & bottom frame members attached.

Plan to locate one hinge about 1" from the rudder bottom. Place the top hinge as far up as possible & still get a hole in the tapering fin. Space the others equally. The shaped, slotted ply piece for the rudder "T" is shown attached on the bottom. The ply cap is adjacent. It & the separate harder wood top go on last.

Mark the location of each hinge on an edge of the attached LE piece. Position the loose, shaped LE piece against it & mark locations. Centered, make a 1/8" hole at each mark on this loose LE piece. Notches will later be made there after it is rounded.

The third (center) strip, is cut as shown to groove for the wires. The remainders fit between those. The bottom one needs to extend to the bottom of the attached 1/8" piece. Cut 1-1/2" wires from springy 2" paper clips. Make centered 3/16" holes in the balsa pieces & groove them down their centers so the wires will be fully recessed.

With thin CA glue sparingly applied, wick the wires into the grooves. Glue each piece to center the wire over the centered holes in the unattached, most forward LE piece. The wires are to face forward. Fill between these. Trim excess. Finish the assembly, ready to round the LE.

The rudder needs to recess just enough to prevent a gap. About 1/8" will do. The shallow & narrow concave at the top of the fin prevents recessing much of it there. After the rest of the rudder is rounded to nicely fit, the upper part could be trimmed back if it wants to jam the fin when deflected.

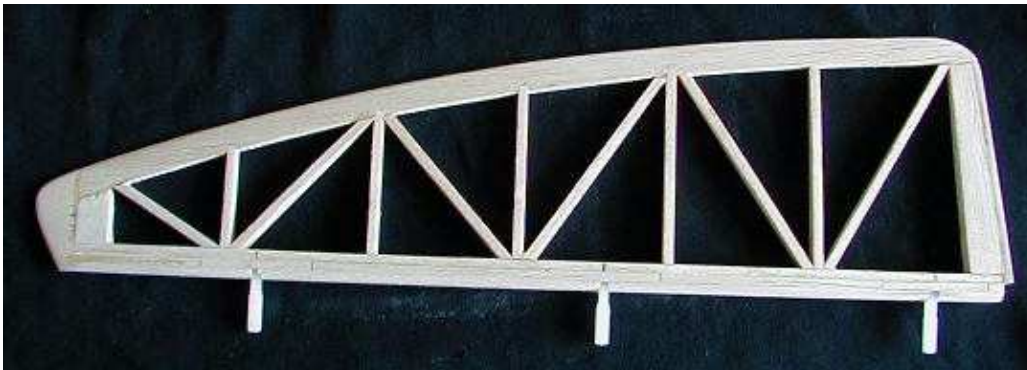


Begin concaving by first making a centered groove top to bottom with a triangular file. Use it as a track for larger round tools to groove to the fin edges.

Sand down the edges of the rudder LE until it nicely works manually in the fin.

Loosen up hinges by repeatedly snapping them on & off a separate piece of the wire. You may want to open the slit a little with a sharp razor blade for easier attach/detach if using 3/64" wire.

Notch the rudder LE where hinges go, wide enough to allow hinges to freely swivel.



Here's a finished 3 hinge, SGP rudder frame with notched & rounded LE, ready to cover.

**PRE-INSTALLATION TIPS:** Mark hole locations in the fin to align fin & rudder at their tops. Centered, progressively open holes to 11/64". With hinges snapped on the wires, insert them without adhesive. Manually check operation. If all looks good, hold the structure at each hinge to pop hinges off.

**COVERING:** Cut a 7/8" wide strip of Monokote to go from the bottom of the LE to around the top. Centered, tack it along the LE. With pin, center punch it at hinge locations. Seal the strip it to the rounded LE. At the top, slit at each side to tack along the edge hard top. Trim to 1/8" on either side & seal it down. At each pinhole make a top & bottom slit for the hinge to fit between, then slit vertically. Tuck ends on either side of the music wire pieces.

Cut separate pieces for each side. Seal one down along the applied strip & trim to wrap around the bottom & a little around the TE. Repeat with the other piece, then shrink.



Coat the concaved area & the rudder LE with paste wax to prevent inadvertent bonding. Attach the hinges in the fin using a little Elmer's wood glue, etc. applied in the holes. Avoid excess that would ooze out between fin & rudder.

The holes in the rudder T should align with the pivot point of the hinges. The T can be precisely positioned in its slot to do that. Secure it there with a tiny drop of CA around the wire.

Before installing the rudder, groove the fuselage sides to provide clearance for the brass arms of the T as the rudder deflects.

If the solder joint ever breaks, detach the rudder output arm from the servo for slack. Pop the rudder loose. Twist out the wire nail. A small butane torch for soldering parts back together is handy to keep in the field box.

**CABLES:** After the rudder is installed, clamp it in neutral. Cut 1/8" pieces of 3/32" aluminum tubing for crimps. Cut two cable pieces. Tie a simple knot at cable rear ends. Insert one through bottom of the T. Nose down, dangle end forward to butt F2. Avoid the pushrod tube. Fish out with long tweezers. Tape cable to saddle. Repeat with other cable. Cables are to pass under the main bolt block. Attach rigging couplers to clevises using just a few threads. Run crimp tube on cable. Slip 2-way output arm on servo. Fasten clevis. Take up slack. Crimp tube. Repeat on other cable. Keep cables snug or the rudder will buzz at higher speeds.

**KNUCKLE HINGING THE RUDDER IN THE LTS COMPOSITE FUSELAGE:** This calls for a post to be installed between the skins at the rear of the fin, after the stab support, bell crank & pushrod are first installed.

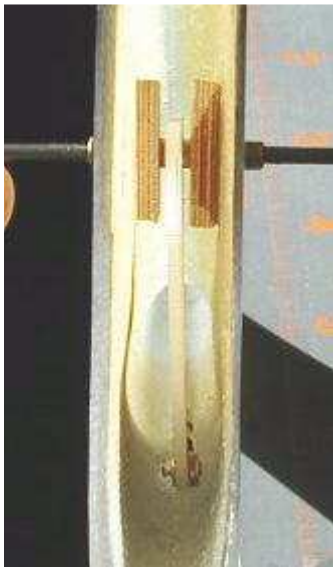
Make the main 3/32" stab support wire with aluminum tube at the center as on the plans, but 4-1/2" long. Make the drive wire 3" long. Cut a 7/8" long piece of 5/32" OD brass tube. Round the ends of these three items. See that the aluminum tube will go into the brass.

The holes in the fin for the 5/32" brass tube were drilled using a jig that assures alignment. However, as a fuselage progressively cures, the alignment of the two holes to each other may change. Preferably with a long length of 5/32" wire or tube, check this alignment from the nose end, in bird's eye view & relative to the wing saddle. If not squared up in any direction, there are 2 ways to fix it, "A" & "B".

For "A," file the alum. tube so it can be wiggled inside the brass tube to get alignment. Insert the brass tube & then the main support wire assembly. Decide how to file the alum. to get alignment. To later get the main wire in the tube to achieve alignment, mark which end of the wire assembly goes which way & how the wire has to be rotated.

For "B" use the Exacto knife to open one of the holes up, down, forward or rearward to square up the tube. Record which direction a tube end is to be positioned to do that.

Having done A or B, the bell crank/pushrod assembly can next be installed. From 1/8" ply cut a pair of plates 3/4" square. Drill 5/32" holes at their centers. Slot them to one edge to slide over the 5/32" brass tube from its rear edge.



As shown in this view from the rear of the fin, mount the waxed up bell crank with pushrod on the brass tube. Apply quick epoxy to a plate & get it over the brass tube on one side. If you did "B" that would be the side where the hole was not enlarged.

Let that side cure, then insert the main support wire to push the brass tube in the direction needed to square all up. Apply epoxy to second plate & hold it until cured enough to stay put.

Lastly, wick the main support wire to the brass tube with CA glue & build up little fillet where the tube & fin meet.

If you did "A", it does not matter which plate goes on first. Just get the wire rotated & held to square all up & wick in CA.

Now the rudder post can be fitted & glued in. Use very light 3/8" balsa to make it. Where hinges go, center 3/4" long doublers inside of the 3/8" balsa. Epoxy the post in place. Concave the post similarly & build the rudder similarly as detailed in CONST File #2, but wider to fit the wider fin. To avoid "oversize" shipping costs, the integral fin does not extend up as high as the balsa fin on the plans, so adjust rudder profile accordingly. Take artistic license to shape it, keeping the area similar. Size the rudder in profile so the "T" fitting at its bottom will directly align the cables toward the micro-nacelles.