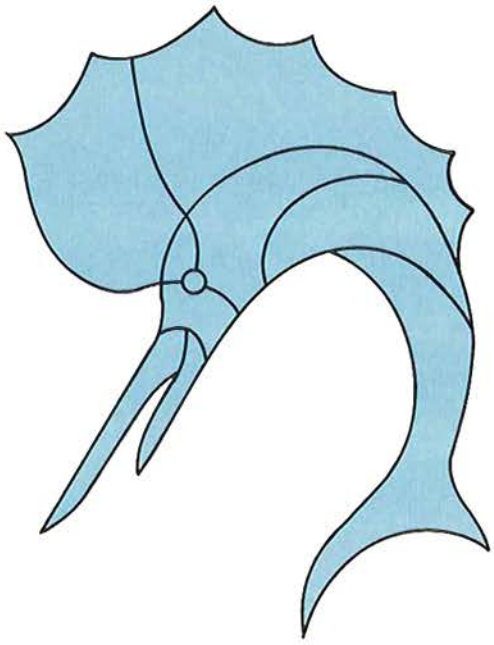


SAILFISH

John Hunter's design objective was a sailplane that would thermal well in light wind and still penetrate without ballast in moderate wind conditions. The Sailfish does just that.

By John Hunter

The Sailfish is a Standard Class sailplane designed to be competitive in thermal contests. Three planes have been built. The first two were built simultaneously, one with the Eppler 193 and the other with the Selig 3021 airfoil. Both performed well in thermals. The E-193 plane could be flown surprisingly slow without tip stall for accurate spot landings. However, the thinner S-3021 airfoil was selected for greater penetration when wind velocities increase as in the latter rounds of some contests. The third plane was built with only minor modifications to simplify the construction.

The design objective is a sailplane that will thermal well in light lift and still penetrate under moderately windy conditions without ballast. Since building is not my favorite sport, it was important that it not be too difficult to construct. An example is the selection of a mid-wing over a high wing design, which allows a simple one-piece hatch with access to everything. If you are not happy with the performance of your current sailplane, try the Sailfish.

Balsa is used throughout, except where noted as pine, spruce, or plywood. A fairly light balsa can and should be used except where noted in such places as the 1/16" inboard wing panel sheeting and ribs #1 to #5, where at least a medium density is required. For wood, I used a white glue such as Titebond everywhere except the rib capstrips, where a CA (Zap-A-Gap) was used. Construction methods should be according to individual preference. For bonding steel, brass, or plastic control cable sleeves to wood, a 5-minute epoxy was used after first roughing up the metal or plastic with sandpaper.

CONSTRUCTION

Fuselage and Fin:

Before starting construction, check the height of the servos you intend to use versus the fuselage depth. Micro-servos and most mini-servos will fit. For larger servos, increase the fuselage depth on the plans. I used Futaba S-32's (not S-32H) for rudder and stab, and a micro-servo for spoilers. Using three micros would leave room for some ballast. An extension cord may be needed for the spoiler servo.

A scroll saw, such as the Dremel, is useful for cutting out the plywood parts. Make certain all formers (F1 to F4) and the nose block are the same width, 1-5/16". The nose can be balsa, soft pine, or other wood. Balsa is easier to work but less ding-proof. First, saw the block to the proper width, then cut the side view with a coping or band saw. Using a high speed cutter in your drill, hollow out the nose ballast cavity. Do not shape the nose at this time.

The fuselage formers and sides are cut from 1/8" Lite Ply. If you like to spear the landing circle, 1/16" ply laminated inside 1/8" balsa is recommended for the sides and 1/8" ply for the formers. Mark the locations of the nose block, formers, servo rails, control cables, and holes to be drilled on the inside of the left and right sides. Stack the two sides and accurately drill the wing rod holes on a drill press if you have one. Also drill holes for the spoiler cables and cup hooks. An easy way to locate and support the servo rails is to glue small L-shaped scraps of 1/16" balsa to each side.

ABOUT THE AUTHOR

John Hunter is an old time modeler who originally joined AMA in 1938, flying indoor and outdoor rubber. An ex-Navy pilot and retired aerospace engineer, he has been designing and flying R/C gliders for about 4 years.

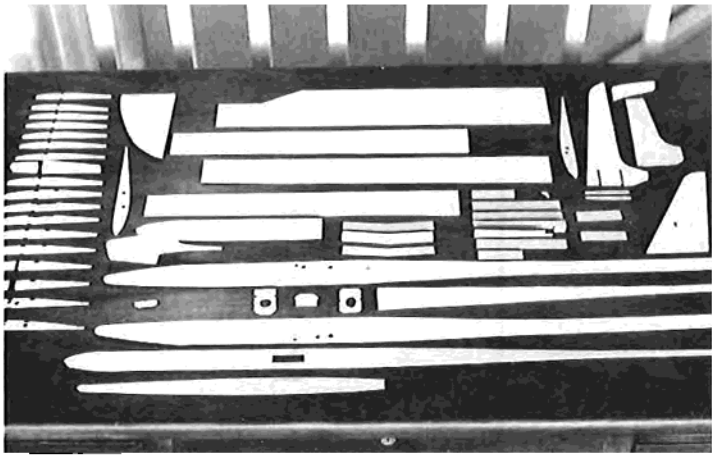
SAILFISH
Designed By:
John Hunter
TYPE AIRCRAFT
Std. Class Glider
WINGSPAN
99.6 Inches
WING CHORD
9" Root; 7" Tip
TOTAL WING AREA
782 Sq. In.
WING LOCATION
Mid-Wing
AIRFOIL
Selig 3021
WING PLANFORM
Double Taper
DIHEDRAL EACH TIP
2¼ Inches; 10 Deg.
O.A. FUSELAGE LENGTH
45½ Inches
RADIO COMPARTMENT SIZE
(L) 12½" x (W) 1-5/16" x (H) 1-15/16"
STABILIZER SPAN
24¾ Inches
STABILIZER CHORD
4½ Inches
STABILIZER AREA
103 Sq. In.
STAB AIRFOIL SECTION
Symmetrical
STABILIZER LOCATION
Mid-Fin
VERTICAL FIN HEIGHT
8⅝ Inches
VERTICAL FIN WIDTH (Incl. rud.)
6⅜ Inches
REC. ENGINE SIZE
NA
FUEL TANK SIZE
NA
LANDING GEAR
NA
REC. NO. OF CHANNELS
3
CONTROL FUNCTIONS
Rud., Elev., Spoilers
BASIC MATERIALS USED IN CONSTRUCTION
Fuselage ..... Balsa, Lite Ply
Wing ..... Balsa, Spruce
Empennage ..... Balsa
Wt. Ready To Fly ..... 45 Oz. (2 Lb. 13 Oz.)
Wing Loading ..... 8.1 Oz./Sq. Ft.

The plans show the stab control cable on the right and the rudder cable on the left, but this could be reversed. The rudder cable exit hole is drilled at a very shallow angle. A small rat-tail file can be used to decrease the exit angle. Trial-fit the cable, sand the plastic tubing, and epoxy every 2" or 3" along the inside of the left fuselage Lite Ply.

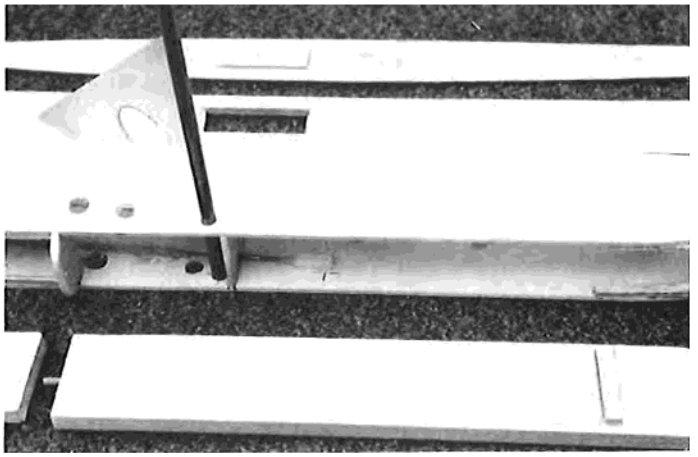
Before installing the stab control cable, the vertical fin is built without the left side 3/32" balsa sheet and pine block. It is then glued to the right fuselage side. Add the 3/16" sq. just forward of the tail skid. Next the stab control cable plastic tubing is sanded and epoxied in place. Note that the 3/32" sheet is chamfered about 45° along the rear edge.

Add the 1/8" triangle balsa to both sides of the fuselage. Glue the nose block and formers to the right side, making certain the formers are perpendicular to the side by using a square or triangle. The bent wire can be added to F1 before gluing in place.

Temporarily insert the 1/4" wing rod, then glue and clamp the two sides together at the formers and nose block. By slightly shifting the side being glued, make certain that the rod is perpendicular to the side. You will need to trim the triangular balsa near the tail before joining the two sides at the fin. Lay the fuselage over the top view centerline when clamping the aft ends together for symmetry.



The best way to start a scratch building project is to cut a parts kit. Things go much faster that way.



Left side of fuselage is positioned to assure that wing rod is perpendicular to fuselage.

Cut out the 3/8" pine block and drill a 3/32" hole perpendicular to the surface. Place the block in position against the inside of the right 3/32" sheet. Cut out the sheet to fit but do not glue the block in place at this time.

Caution! Before adding the left side to the fin, the stab cable must be installed in the tubing. Using a vise, flatten about a 1/4" length at the end of a 1/8" o.d. brass tube. Drill a 3/32" hole in the flattened end and cut off about 1/2" total length of brass tubing. Insert the cable in the open end and solder. Insert the cable in the plastic tubing from the fin end and leave in place. Add the left side of the fin. Cut out the left side to match the right side for later installation of the stab pivot rod and pine block.

Epoxy the two wing rods (or brass sleeves) in the fuselage. If you want the rods to be removable, use brass tubing the full width of the fuselage. In either case, sandpaper the metal and epoxy four 1/8" x 1/4" spruce as shown on the drawing, two at each rod.

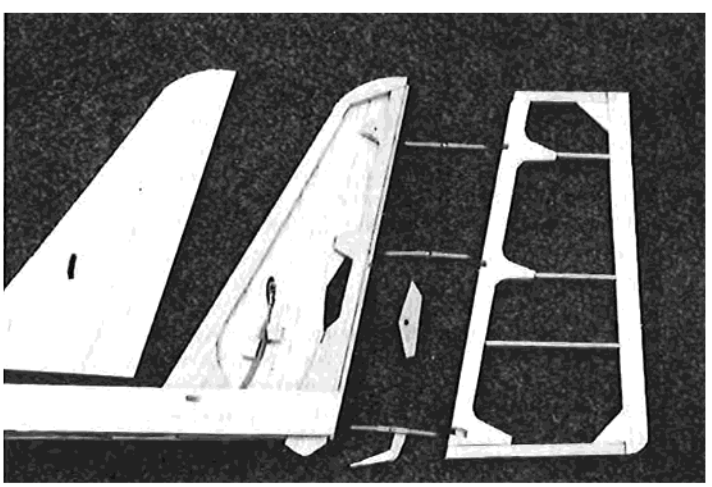
Cut the hatch out of 3/8" balsa, set in place, and mark the dowel location through the hole in F3. Also using the top view, cut out the 3/8" top plank. From the bottom view, cut out the 3/16" bottom sheet, including the rectangular hole at the tow hook. Clamp and glue the top plank and bottom sheet in place, using a good layer of glue along the 1/8" triangles in the area of the tow hook. Cut out the 1/16" plywood skid plate and add the rectangular doubler. Glue in place along the bottom sheet and add the two gussets joining it to the F2 former. A good bond is required as the towing load can peel off the bottom sheets.

Insert the 3/32" stab pivot rod in the pine block and glue in the fin, making certain that the rod is perpendicular to the fin and parallel to the wing rods by line of sight.

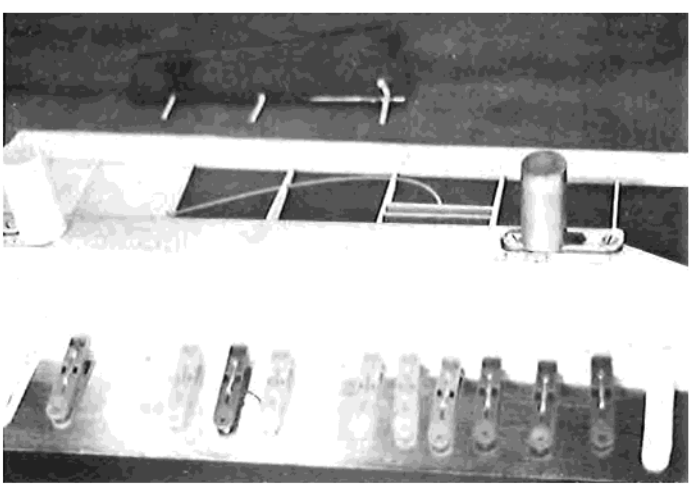
Add the 1/4" balsa fairing at the leading edge of the fin and the fuselage is ready for shaping and sanding. With the hatch in place, use a sharp carving knife to roughly shape the body, then sand with progressively finer grit paper. The bottom and sides can be fiberglassed for increased strength and durability. After fine sanding, the fuselage may be covered or spray painted. This is easier done before attaching the rudder.

Rudder:

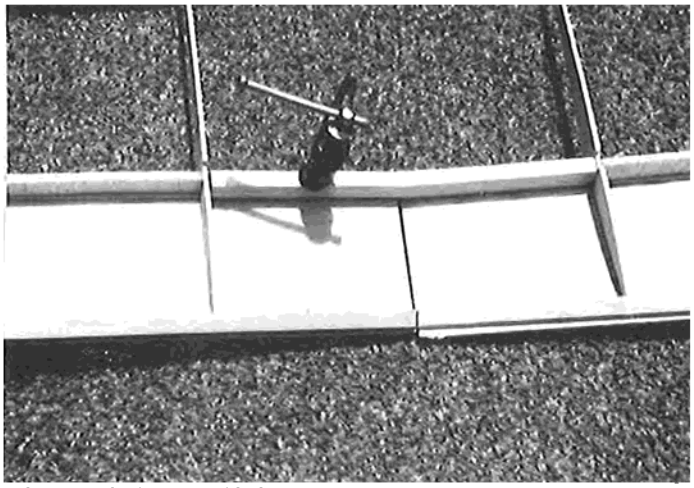
Lightweight balsa should be used for the rudder and stab. Use MonoKote backing or other transparent material over the plans. Place a 1/16" shim under the T.E. The 1/4" members and 3/32" ribs are tapered from 1/4" at the hinge line to 1/8" at the T.E. Before rounding the front edge of the rudder, drill three matching 1/8" holes in the rudder and fin. Round the front edge of the rudder and cut slots for the hinge pivots. These instructions assume the use of Robart type hinges, but other types may be used. Final sand the rudder and cover before installing the hinges. Cut a small hole in the covering at each slot, add a drop of glue to each hinge and press into the rudder. Then add a drop of glue to the other end of each hinge and press all three into the fin.



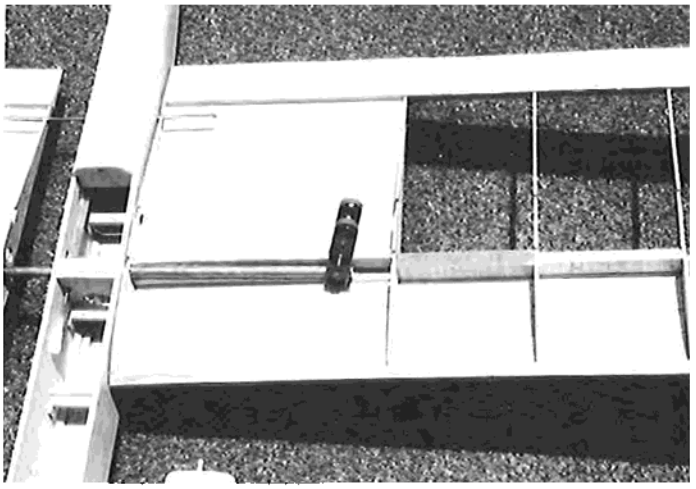
Stab control cable is installed prior to adding left side of fin.



Top sheeting installed on inboard wing panel.



Outboard wing panel is joined by clamping the dihedral brace to the lower spar.



The root rib is aligned with the fuselage side when bonding brass tubes in place.

Stab:

Cut out two 1/8" and four 1/16" sheets to the pattern shown on the plans. The slots for the 1/8" o.d. brass tubes are cut in the 1/8" sheet. Spread on a thin layer of glue and laminate only the bottom 1/16" sheet to the left and right 1/8" sheet. Books make a good press while drying. Lay these over the plans with a 1/16" shim under the T.E. near the root. The diagonal braces can all be cut from 3/32" x 1/8" stock.

The brass tubes are sanded and glued in place before the top 1/16" sheet is added. This is done by inserting the two stab rods in all four tubes and then pressing the tubes into the left and right slots. This assures a good alignment. Position the tubes so they protrude 1/16" at the root for later addition of the cap rib. Glue the top sheet on, add the cap rib, and sand to the symmetrical airfoil shape shown on the plans.

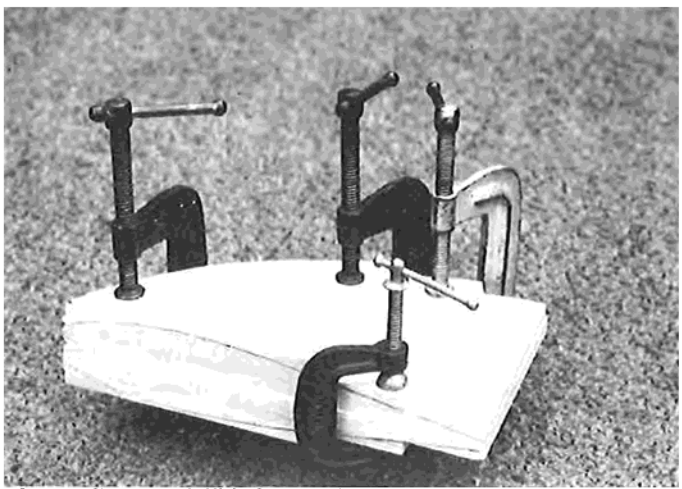
Wing:

Probably the most difficult part of the wing is the leading edge. If you have a problem with the spruce, a hard balsa can be used for the L.E. Mark the two lines on the same side of the 1/4" square spruce, at 1/32" and 3/32" from each edge. A tilt-bed scroll saw, set at 7° and 21° can be used to cut just outside of these lines, or it can be roughly cut with a knife. In either case, a long sanding block with coarse grit will bring it to a final shape.

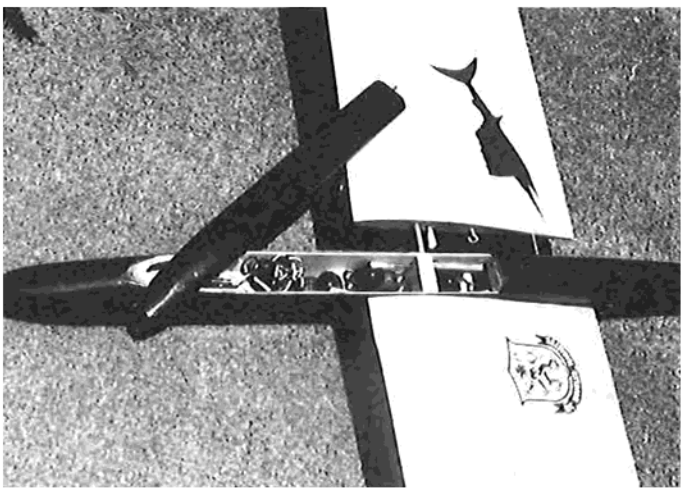
For the trailing edge, cut a straight 1-5/16" wide strip from a 1/4" sheet of balsa. Trim roughly to shape. Then, with the thin side placed along the edge of a flat surface, sand to approximately 1/32" while being careful not to reduce the thickness of the 1/4" side.

The rib patterns can be cut directly from the full size plans, carbon copied or traced on vellum. A french curve and straightedge will help you get a smooth and accurate airfoil. Using a fine line black pen, trace around the rib patterns on the 1/16" sheet. Number each rib with the pen, forward of the main spar if you intend to use a transparent covering. The french curve and straightedge will also help in cutting out the ribs. Do not forget to drill 1/16" holes in ribs #2 to #6 for the spoiler control cable. If you plan to use the plastic Goldberg type wing skids at the polyhedral break to protect your covering, drill two 1/8" holes in the bottom of rib #10.

Again, do **not** use a soft lightweight balsa sheeting for the inboard wing panel. At least a medium density 1/16" sheeting is required. Cover the plans with MonoKote backing or other transparent material and start the inboard wing panel by pinning down the lower spar. The main spars are trimmed to taper from 3/8" to 1/4" wide between ribs #8 and #9. Butt and glue the bottom 1/16" sheet to the front of the lower spar. Temporarily hold ribs #5 and #9 in place and push T.E. stock under the sheet leading edge until the sheet fits flush against the bottom of ribs. Add the aft bottom 1/16" sheeting which extends from the root to underneath rib #4. Then pin down the trailing edge, which butts against the bottom sheet.



As an alternate, 1/4" balsa can be laminated for wing tips.



With hatch removed, everything is accessible.

Ribs #4 and #9 are glued in place by adding shear webs as you progress outboard. Shear web grain is vertical and they should be flush with the spar cutout in each rib. Since the end grain absorbs glue, two coats will assure a good bond with the spar. Shear web thicknesses are called out on the plans. The 1/8" web between ribs #6 and #7 is offset forward to clear the spoiler horn. See View A.

Strength is more important than weight inboard of rib #5, so use sufficient adhesive. Study View B and the isometric sketch in the lower left corner of the plans. The 3/32" web (horizontal grain) and 1/4" wedge shaped piece are glued in place, then the root rib #1 is canted outward about 2° and glued in place.

Glue the leading edge in place and then remove the partially completed inboard wing panel from the plans. Cut the 9/32" and 1/8" brass tubes to length, sand, and slide over the wing rods. Now, while supporting the wing, slide the wing over the brass tubes until the tubes only protrude 1/16" between the fuselage and root rib. Adjust the position of the wing so that the root rib is parallel to the fuselage and the brass tube bears against the 1/4" balsa wedge. With the wing supported in this position, epoxy the forward tube in place. Then epoxy 1/8" x 1/4" spruce on either side of the aft brass tube. Epoxy the 1/4" L-shaped piece against the 3/32" web and the top of the brass tube. Glue a small pine or spruce block to the root rib for later addition of the cup hook.

Accurately cut out the 1/4" balsa joiner that fits between rib #9 and #11. Glue to rib #9 and the lower spar. Now add the 1/8" x 3/8" top main spar.

Cut and fit the 1/16" plywood that extends from the root rib to #4, #1 to #3, and #4 to #5. They should be flush with the top of the spar, then glue and clamp in place using epoxy next to the brass tubing. Do not add the 1/16" plywood at the polyhedral break at this time.

Install ribs #2 and #3. Cut the two 3/32" x 7/16" balsa pieces that fit between ribs #6 and #7. Drill a 1/16" hole in the center of each and glue in place. Rough sand the spoiler control cable tubing and feed through as shown on the plans. Add a drop of glue on either side of each penetration. With the spoiler servo installed and the wing in place on the fuselage, cut the cable to the proper length and solder or epoxy the threaded couplers on the cable. The aft 1/8" x 3/8" spar may now be glued in place.

The outer wing panel is constructed in a similar manner starting with lower spar, bottom sheeting, trailing edge and ribs #11 to #17 with vertical grain shear webs. The inboard end of the leading edge, spar, and trailing should be cut at a 10° angle to fit the other wing panel. Trial-fit to the inboard wing panel and sand until a good fit is achieved. Then glue the two together by clamping the 1/4" balsa joiner to the lower spar. Add the top spar to the outer wing. Glue and clamp the 1/16" plywood to the forward and aft side of the spars. Add the 1/8" balsa splice to the leading and trailing edge, then glue in rib #10.

Use at least medium density balsa for top sheeting the inboard wing panel. I hold down the sheet along the spar with weights and clamp the sheet along the leading edge with clothespins. Add a narrow strip of scrap balsa under the clothespins to prevent damaging the surface.

After sheeting the top of the wing, the rib capstrips are glued in place. You may have to trim the top of some ribs slightly for a flush fit with the trailing edge.

The top sheet is now cut out between the two top spars from rib #5 to rib #8 for installation of the spoiler. A sharp pointed knife can be pushed through the sheet from the bottom to locate the corners of the cutout. Using a straightedge, cut out the top sheet. One inch trailing edge stock is fitted to the opening, leaving a very small gap at the ends and rear edge of the spoiler. A slot is cut in the bottom center of the spoiler for gluing on the 1/16" ply horn as shown in View A.

The 1/16" ply root rib cap is fitted over the two brass tubes and glued to rib #1. Two wingtips can be carved from a block of soft balsa 3/4" x 4" x 12", or you can laminate three layers of 1/4" balsa as shown on the plans for the right wing.

For sanding the wing use a large sanding block at least 3" wide by about 12" long. You can use View A to make a leading edge template from 1/16" plywood. After fine sanding, balance the wings by inserting short lengths of 3/32" and 1/4" rods, balancing at the middle, and adding a small amount of weight at rib #17 of the lighter wing.

Two small flush hinges may be installed at the forward edge of the spoiler, or covering can be used as a hinge. By covering the top of the wing first, it is possible to back up the spoiler by hand while ironing on the covering. After covering the top of the wing, cut along the ends and rear of the spoiler with a sharp blade. It is important at this point to raise the spoiler and iron on a reinforcing strip about 3/8" wide along the forward edge and top surface over the rear spar. If this is not done, a fast dive or zoom launch will peel off the covering aft of the spoiler.

The trailing edge is quite thin. If warping occurs, try clamping it between two heavier pieces of balsa during heat shrinking. A small amount of washout in the outer wing panel is all that is needed. About 1/16" under the trailing edge at rib #17 will suffice.

Flying:

Small elastic bands are used for the hatch restraint and the wing restraint cup hooks. With battery, receiver, and servos installed, determine the amount of nose ballast required. An easy way to do this is to tape a small plastic cup to the nose block and add lead shot until the plane balances at 3¼" aft of the root L.E. This should require about four ounces. Remove the battery, stand up the fuselage nose-down, and pour in the ballast, then some glue. Leave in this position for at least several hours as this mixture hardens very slowly.

With the C.G. at this location, which is 36% of the chord, the plane is marginally stable in pitch. This is where I like to fly the plane and is a good starting point, since weight can be added in the battery compartment. Even 1/4 oz. will make a difference in the way it flies, so use a small amount. With the C.G. at 36%C, the plane will sometimes pitch up slightly entering lift or down entering sink.

The horizontal tail moment coefficient is 0.42 and the vertical tail moment coefficient is 0.019. What this means is that the stab area is in the low range and the vertical tail area about average.

The first two flights of the Sailfish lasted 20 and 15 minutes. The spoilers are effective and the plane has placed well in the first three contests entered.

□

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