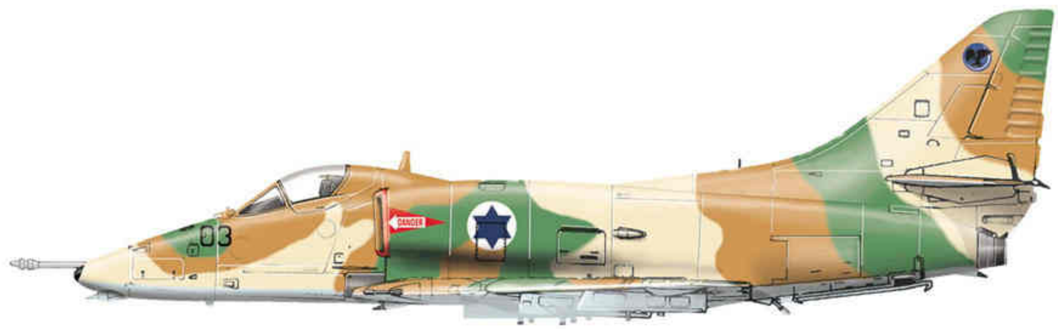
WARBIRDKITS.COM

Skyhawk II

Manual Version 1.0 – August 2009

Scale: 1/12
Wingspan: 26.6 Inches
Weight: 30 Ounces
Power: 66mm EDF



Designed By Eric Barnett
Developed By Steve St.Martin
Produced by Warbirdkits.com

Skyhawk II

Introduction by Steve St.Martin

Eric Barnett designed this jet in the early 2000's as an entry into a RC Groups pusher jet design contest. After many conversations, with Eric, I talked him into enlarging it for use with a Wattage Power Fan, with a cut WeMoTec Minifan rotor at 65mm.

Eric made a gift of the design to me. I then turned the design over to Tom Jacoby at Warbirdkits.com. Tom first had the kit cut out in the original pusher configuration and size. I built it and it flew well with an Eflite Park 370 out-runner. It finally met its demise this year from pilot error, but it proved the flight-worthiness of Eric's design.

The prototype EDF version was built in 2006 and sat in my home till summer 2008. It originally had a HET 2W motor and a CC60 ESC. This required a large 3700-3s PQ pack. The AUW was 38oz, which was just too heavy for the type of construction. After much success using the cut Kyosho rotor in the Wattage jets, I elected to replace the 2W motor with a Mega 16/15/3 and a 4s-2200 Excite 25c pack. This got the AUW down to 29.5 oz. This was more like it! With a CC35 ESC It was more than enough power. And, though I don't suggest it, I did not use a separate BEC or Rx battery pack! Not a decision - I just plain forgot!

After several trim flights, to find the actual dynamic CG, the plane is a pure joy to fly. About 50% exponential is required on the ailerons. She is very sensitive around neutral. This is due to an error on my part, having built the wing with the top surface tapering down to the wing tips. The bottom should taper up. Rolls are quite quick. And elevator is not overly sensitive. She will not snap at the stall. Instead she just mushes to the ground, although quickly.

I retired her after only a few dozen flights, and have taken what I have learned and applied them to this, the final version. As always any suggestions or comments are always welcome. Tom Jacoby is a good listener. Visit his website: warbirdkits.com

This is not a slab sided affair. It is a stick type build, AKA Guillow’s type. You would benefit greatly if you have some skills in this type of build. And, it is highly suggested that these building notes be read before proceeding. You can then adjust to your own preferences.

While I try to cover all areas in this manual, experience will produce the best airframe. There is only so much prefab that can be done with this type. Some parts may have to be sanded slightly for a good fit. Or some may need filling with scrap to achieve the best fit. If you take your time and use your honest best effort, you will be rewarded with an airframe that not too many people (now-a-days) can say they built. The pride of seeing your creation flying overhead beats "hands-down" any foam or fiberglass airframe that are other people’s effort.

While the jet could be covered in film, it would be wise to use 0.5 oz fiberglass cloth with epoxy finishing resin.

If film is used, I would suggest Doculam (document laminating film). It has a sticky adhesive that will give better surface tension versus film covering with heat-activated adhesives. If you are skilled with silkspan and dope this could be a viable alternative. But, glassing is best.

Adhesives are your choice. My preferences vary, according to application. I use all grades of CA, aliphatic resin, epoxy, and Pro-Bond or Gorilla urethanes. But use adhesives sparingly. Extra glue only adds weight, not strength.

Please pay attention to all notes [NOTE:] - I put these in to help you avoid certain pitfalls that may come up later, in the build. There will also be tips [TIP:] that are just ideas that I have learned over the years. They are not critical to the build, and you may have a better way.

Good luck with your version of the Skyhawk! And avoid gravity until necessary…

Steve St. Martin

Building the Skyhawk

Tools, adhesives, and such

Some may be more required than others. If you are an experienced "stick & tissue" builder, you probably already have everything. Tools needed include modeling knifes, razor saw, small and medium T-pins, razor plane, balsa stripper, various sanding tools and grits, wax paper, personal choice of adhesives/finishing materials, accurate rule, flat work surface, wax candle.

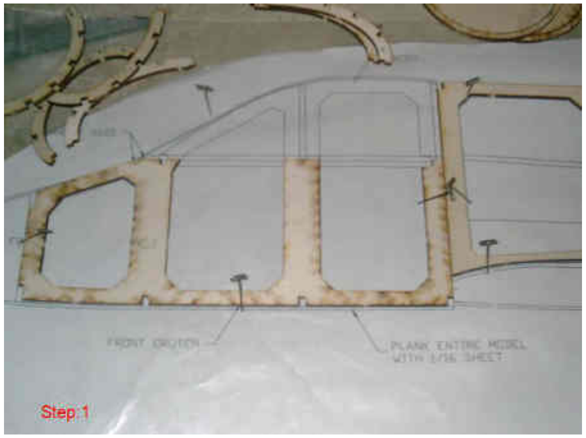
Wood Needed

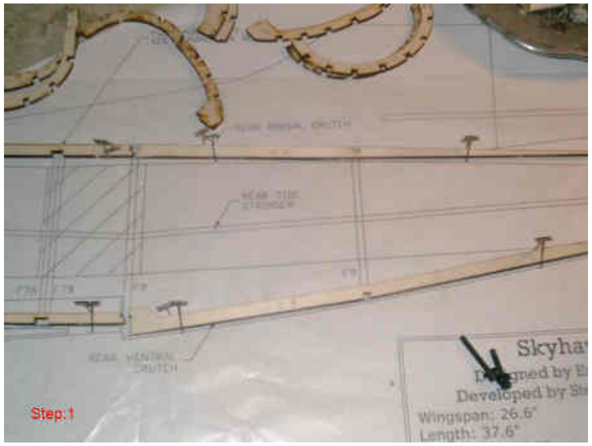
* about 2 dozen 1/8" square balsa sticks
* 8 to 10 sheets of soft to medium-soft 1/16" x 4" balsa
* 1 sheet 1/8" x 4" balsa
* miscellaneous balsa stock for fill and landing gear fairings.
* 3/16" x 36" alum tube or glass arrow shaft
* 2 heavy-duty nylon landing gear straps

Fuselage

As with all kits, the first step is preparation of the parts. Sand all cut tabs off the laser-cut parts. For good, clean glue joints, wipe the burn residue from the parts with a paper towel and rubbing alcohol.

☐ Lay the vertical crutch parts C1, C2, C3, C4 and C5 on the fuselage side view. Use pins to hold the parts in place. Do not try to force the pins through the ply. Angle the pins from the edge of the parts. Note also the edge of the parts position on the plans. Allow the image of the 1/16" fuselage sheeting to remain showing. Glue C1 and C2 to C3, then glue C4 and C5 to C3.

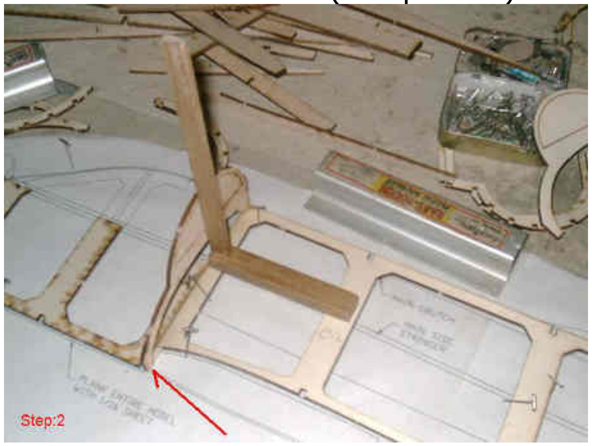




☐ Prepare F7 and F7A by placing a piece of wax paper between them. F7 must be forward and F7A aft. Note that the fan hole in F7A is larger to accommodate the fan mounting collar. DO NOT GLUE bulkheads F7 and F7A together! The fuselage splits between F7 and F7A for fan access

☐ Press 1” lengths of 1/8” dowel through the holes in the bulkheads to align the bulkheads. Trim the wax paper closely around the parts, and cut the wax paper out of the notches.

☐ Glue F4 in place making sure that it is perpendicular to the building surface. Note that the bottom of F4 rests up against crutch C1, and the foot does not rest on the building surface. It is elevated 1/16", splitting the thickness of the crutch, allowing the opposite side bulkhead the same position. Use a small piece of 1/8 square balsa as a filler above the foot to the crutch C1 and C2 (see picture).



☐ Glue F5 and F6 in place. Tack glue the bottoms of F5 and F6, since these portions of the bulkheads will need to be removed later for intake duct installation. Also be sure that bulkheads are flush with the edges of the crutches, top and bottom.

☐ Glue F7 and F7A in place. DON'T USE THIN CA! Use caution attaching the F7 assembly to the crutches. Use glue sparingly. The F7 bulkheads must be separated later for fan installation and access.

☐ Glue F8 and F9 in place.

Glue the side keels C7 and C8 in place.

☐ Remove the fuselage frame from the building board.

☐ Glue the opposite side bulkheads and side keels in place. Make sure they are in line with the opposite side bulkheads. Adding two pieces of scrap strip wood to the front of F4 will help line up the opposite side F4 perfectly. Then the side keels will line up the rest of the bulkheads. Trim the scrap wood off after framing. Also, the bulkhead "feet" may have to be trimmed for the bulkhead to rest completely against the crutch.

☐ Glue F10 in place. This can be tricky. The side keel notches may need a little trimming. Use the top and bottom crutches as your starting references. These were set using the plans. View from the top to be sure it is square.

☐ Add ply parts CR to both sides of the crutch where C1 and C3 meet.

☐ Mark a line around the fan shroud 45mm from the leading edge of the shroud.

☐ Insert the fan into the forward fuselage section. Use an extra fine Sharpie marker to draw a line around the fan shroud where F7 contacts it. Remove the fan.

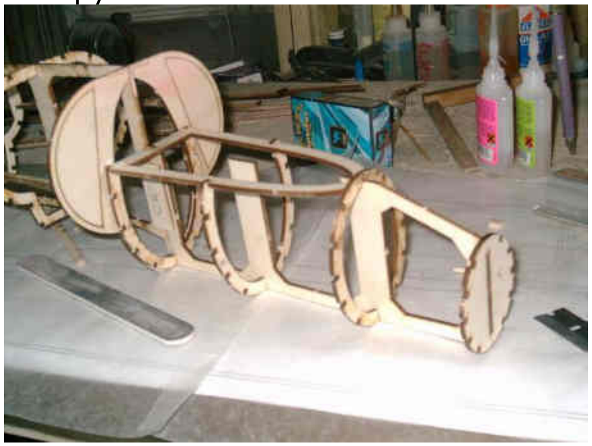
☐ Cut accurate 1/8" wide cross-grain strips of 1/64" ply from the scrap. You need enough to wrap four layers around the shroud. Using thin CA, wrap and glue these strips to the shroud at the rear edge of the line drawn. Each layer should complete a single wrap.

☐ Insert shroud into the F7 assemblies and use the line for reference and alignment. Tack the shroud in place with thick CA. Note that the inside edge of F9 and side keels may have to be relieved to allow clearance for the fan shroud and exhaust tube.

☐ CA the four fan retainers FR to the rear of F7A, equally spaced around the fan shroud. These fan retainers will capture the strips on the fan and retain the fan from moving rearward.

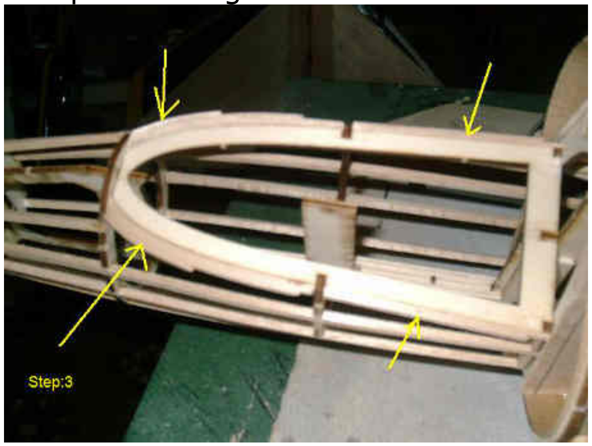
☐ Glue canopy base C6A in place. View from the front and make sure it is level.

☐ Glue FO to front of C1. The glue F2 and F3 in place. Note that F2 will protrude slightly away from the canopy base.



☐ Add 1/8" sq medium balsa stringers along the sides of the canopy base C6A. The stringers should angle downward in the front.

☐ Using scrap layers of 1/6" x 1/8" balsa, blend the cockpit coaming as shown.



Steve says: When adding stringers to any "stick type" frame work, always work two stringers from the exact opposite side position at the same time. This will avoid inducing a warp into the frame. Always try to match stringer stiffness on opposite sides of the frame. Applying these precautions will produce a straight framework.

☐ Add two top stringers between F4 and F10 in the first notches next to C3 and C4. All stringers butt to the inside of F4. Trim the rear of the stringers to butt against the inside edge of F10. DON'T glue any stringers to F10 at this time. This will be done when all stringers are in place.

☐ Glue two bottom stringers between F7 assembly and F10, in the first notches next to C4.

The Intakes

Steve says: After much consideration, I elected to keep the intakes as a wood build. The problems of angles and twists require the use of a simple jig to keep the angles correct. Steve's initial thoughts were for a glass outer curved section. This would still require the use of the jig. For simplicity and to keep the kit cost down, Steve used 1/64 ply for the curved section. The only alternative would have been to make two molds and fabricate complete glass ducting. This would have driven the kit cost up an additional $60 to $70, and is completely unnecessary. You will find that making these ducts will give insight to making future ducting for your other projects. Plus these ducts are every bit as functional as the fancy glass ducting.

Forming the Intake Ducts and Installation

☐ Cut two 18" lengths of 3/16" aluminum tubing. Fine sand each end for gluing. Tack glue two duct forms D2 to front of the fan shroud. It is important to get the adjoining flat side vertical, in relation to top and bottom keel. The fan shroud must also be set in square to the F7 bulkheads to accomplish this.

☐ Insert the lengths of 3/16" aluminum tubing between the holes in D1 and D2. Permanently glue the tubing in place. The parts D2 can now be released from the shroud. Cut the inlet filler pieces free from F4.

☐ Build one duct framing over the full-sized drawing. Remove pins, cover with wax paper and frame the second one, on top of the first. After the glue cures, remove both and block sand lightly with fine paper on a flat surface.

☐ Lay out 1/32" balsa flat duct pieces D3 on wax paper. You need to make both a left and a right side duct. Pin 1/8 square balsa duct framing to D3. Note that the frames are flush with the fan side, leaving excess of slightly over 1/8" on the intake side. Glue the duct framing to D3 with thin CA.

☐ Use the pattern on the plan to make two D4 parts from 1/64” ply.

☐ Pin duct jig pieces DJ-1 and DJ-2 to top view, noting that the jig forms a high point at the fan end. REMEMBER: Left and right! Pin framed duct portions to the jigs, frame side down.

☐ Apply candle wax the curved portions of D1 and D2.

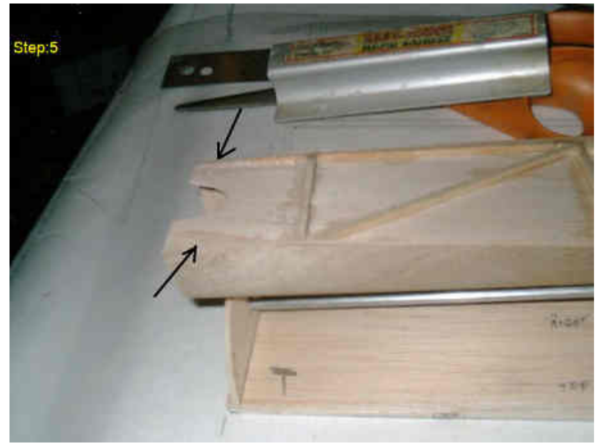
☐ Tack glue D1 and D2 to D3.

☐ Spray several light coats of Krylon satin clear acrylic spray paint on the inside surfaces of D3 and D4. Then sand the parts lightly to remove fuzz.

☐ Trial fit D4 to the assembly. When satisfied, glue one side of D4 to the flat framed section. Then bend D4 over and glue it to other side.

☐ Remove the duct assemblies from building surface. Cut D1 and D2 free from D3. Gently push the duct jig towards the inlet, just enough to cut the aluminum tubing on the D1 inlet end. Now remove the D2 fan end.

☐ Taper the 1/8" square framing near the fan end so that they will clear each other when assembled to the fuselage. Also bevel the vertical 1/8" square framing at the inlet end so that it will clear bulkhead F-4.



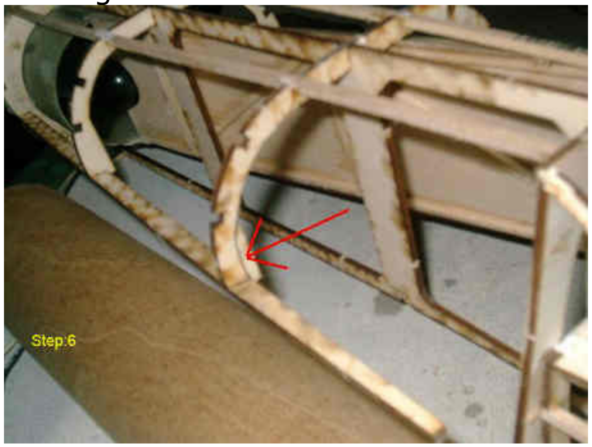
Intake Duct installation.

Prepare the bulkheads to receive the ducts as follows:

☐ Cut free the bottom portions of F5 and F6 between the side crutches and bottom crutch to allow insertion of the ducting.

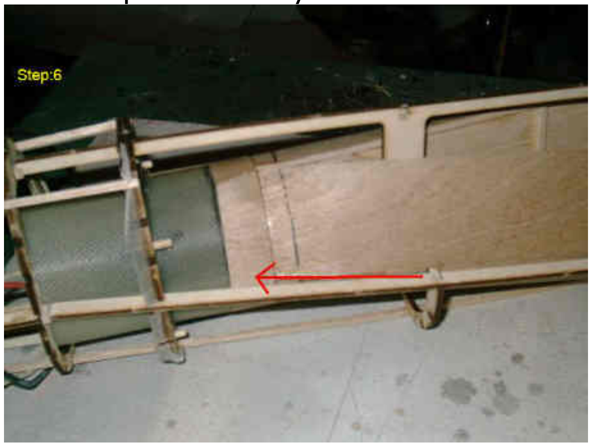
☐ Crack the curved portion of F4 and lay it down.

☐ Relieve bulkhead F5 above the side keel to clear the ducting. Remove a little at a time, for a snug fit to ducting.



☐ Install the ducts into their proper sides. Temporarily tape the ducting to the fan shroud. Replace curved section of F4 in proper position, and attach ducting to F4.

☐ Remove the tape from fan end of ducting, and attach duct retainer D5 to the duct ONLY. The part will overlap. Place the overlap towards the bottom of the ducting. Use thick adhesive here, or the ducting may be held permanently to the fan shroud.



☐ Reattach the bottoms of bulkheads F5 and F6. Note that they will have to be relieved to clear the ducting. Do this a little bit at a time so as to achieve a snug fit. Use thick adhesive to attach ducting to the keels and bulkheads contacting the ducting.

☐ Roll up the exhaust duct, using the template provided, from thin Mylar and trial fit. Use tape to hold the seam. Folding the duct will allow insertion through F10 later.

Stringers and sheeting preparation

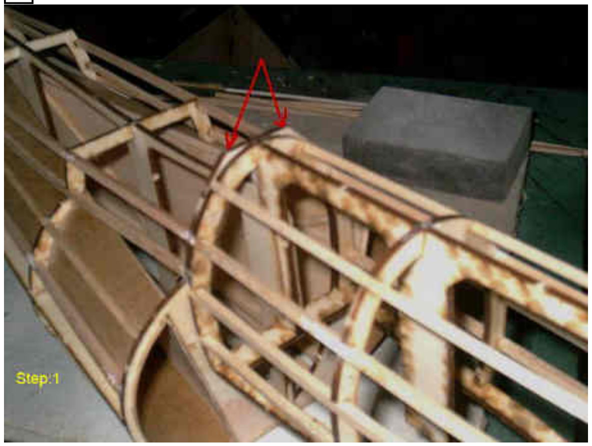
☐ Attach stringers alternately, left side and right.

Use care around the F7 bulkheads to avoid gluing the bulkheads to each other.

Some side stringers have a curve to them near the F6 bulkheads. Use milder stressed stringers in those positions. Note that stringers butt up against the inside edges of F4 and F10. DO NOT glue the stringers to F10 yet. Two of side stringers butt against F6 and F7 as shown in the photo below.

☐ After all stringers are in place, glue them to F10, alternating left and right, top and bottom, spacing them evenly.

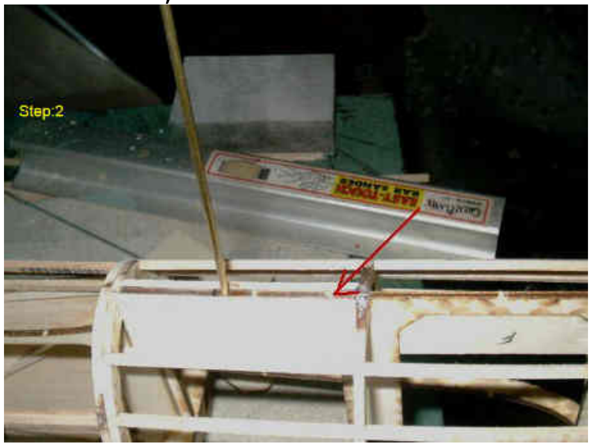
☐ Trim bulkhead F4 to conform to F3.



Battery support and catapult hook

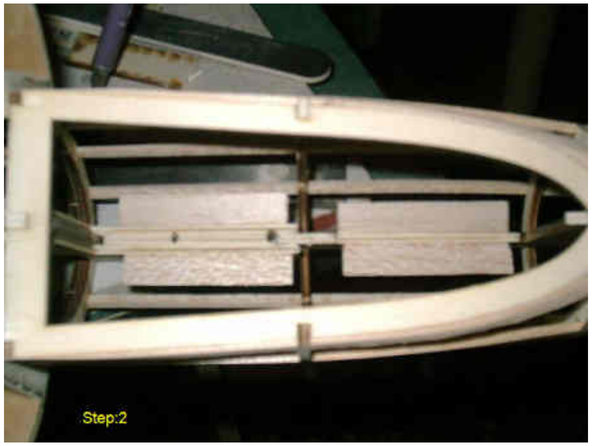
☐ Trim the section shown in the pictures from the scrap laser sheet.

☐ Using scrap ply, make two scabs that will fit between F2 and F3. Attach one scab and insert the laser cut section from the opposite side. Attach last scab, sandwiching the section. Attach the forward laser cut section, in front of F2.



☐ Cut 4 sections of 1/2" triangle stock and attach to top surface of laser cut sections.

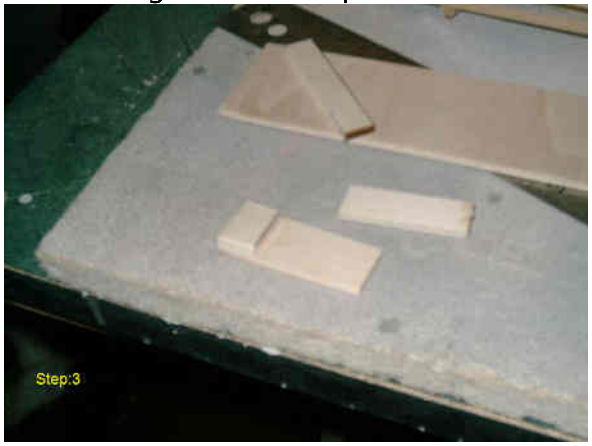
☐ Remove vertical section of keel between F3 bulkheads.



☐ Using a 4-40 threaded pushrod, bend as shown in the picture. The threaded end is the longest. Make the bend away from the threaded area. Or it will be weak. The threaded portion is anchored in fuselage.

☐ Drill hole for hook in bottom keel, 1/2" behind F2. Be sure to be 90 deg. Trial fit hook, and put aside.

☐ Using scrap lite ply, mark off sections as shown, for 4 inserts. These are for fuselage retainer anchors. There is a small square of 1/8 ply attached to one end. This is to give more depth for the sheet metal screws.



☐ Fit and glue 1/8" scrap balsa inserts between the stringers on both sides of the F7 bulkheads. The mid sections of these inserts should be flush with the bulkheads, and the edges will be raised above the stringers. The small dots are for orientation of placement. Try for a snug but not tight fit. Too tight and you may warp the frame. Use caution with adhesive around F7 bulkheads.

☐ Mark the bulkheads where the laminate ply inserts are, and transfer these marks to the fuselage outside surface (yellow arrows).

☐ Finally sand the entire framework. Blend the insert pieces around F6 and where stringers meet bulkheads.
[Tip:] Use a nail file board.
[Note:] The final quality of the sheeting process will only be as good as the under-lying surface. Steps taken here to either fill or remove will guarantee a superior sheeting job. Don't be in a hurry.

Fuselage Sheeting

Steve says: All sheeting is 1/16". Grade your sheeting. Use the firmest wood in the nose, and go lighter as you move rearward. On stick type framing, use a "tile" method. As with stringer attachment, alternate left and right. If you prefer to cover large areas with one piece, you are on your own. Watch for warping. The tile method does not require wetting. Tight radiuses can be accomplished by "seasoning" the wood using a half-pound coffee can, and taping the section to the can. Then use a heat gun to "set" the wood. I found this unnecessary if the wood is not hard. Before sheeting aft of F4, you must insert-plank the wing saddle with scrap 1/8" balsa. The wing contour will be sanded in later. Sand the insert planking flush with the stringers and bulkheads.

☐ Begin with the nose at F3 and work forward, sheeting each bulkhead bay individually.

☐ Cut the F7 bulkheads apart before sheeting aft of F4. Use a single edge razor(new) and cut through the stringers using a rocking motion.

☐ Remove the fan (hopefully not glued to the ducts!).

☐ Then from F4 work rearward, sheeting each bulkhead bay individually. Use the softest, lightest wood to sheet the rear section. Aft of F7, start with the top and work evenly down the side of each bay.

Tail Surfaces

Horizontal Tail

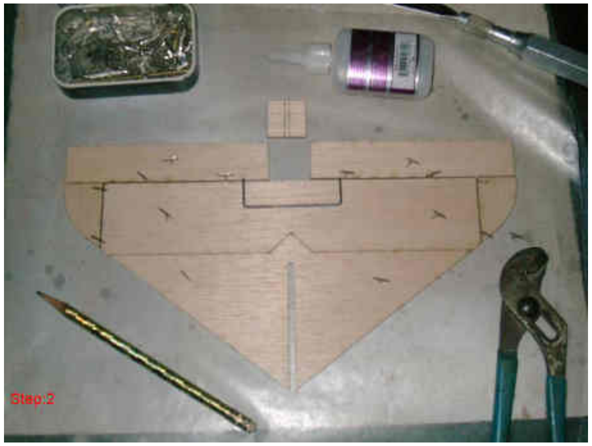
☐ Lay out horizontal tail parts on flat surface. Use pins to gain clearance between stab and elevator parts.

☐ Glue the horizontal tail parts together.

☐ Cut free 1" of the center of the elevator. This will be attached permanently to the vertical fin later and hide the elevator joiner.

☐ Make the elevator joiner by cutting a 4” length of 1/16” music wire.

☐ Use the joiner to find the position of the holes needed for the spurs. Use a short length of music wire to drill holes in the elevators for the joiner wire. Also to dig a trough for the width of the joiner to reside, flush with the LE of the elevator.



☐ Assemble the elevators and joiners, using the stab to insure they are straight. Remove the stab and wick thin CA into the joiners.

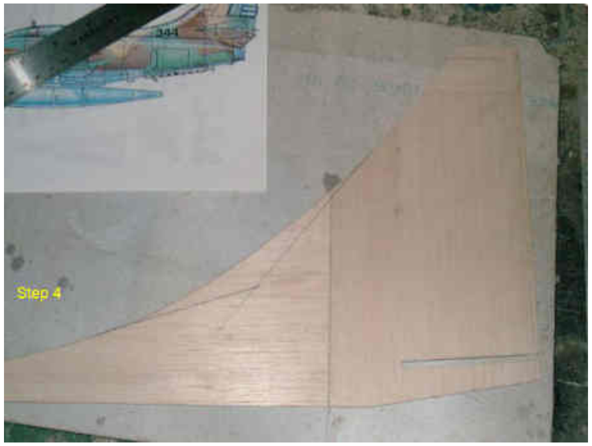
Vertical Tail

Steve says: The plans show 4 pieces for the vertical. Mine consisted of two pieces, plus the two ECM bulges.

The ECM bulges are useful as a stiffener for the vertical tail. If a different version of the SKYHAWK is built, and does not use the ECM bulges, then trim the top of the vertical tail and replace it with firm wood, with the grain going opposite of the main vertical.

☐ Round the bottom edges of the ECM bulges before gluing then to the vertical tail. Verify top and bottom before sanding and gluing.

Steve says: The next few photos show how I modified the vertical to that of a "K" version, as I modeled the second proto to that of an IAD version that uses a taller vertical. Other nations used this version. Some noted as the "L" version. Step 3# shows the addition of a 1/8" sq balsa, to broaden the chord and add stiffness.



☐ The next photo shows the 1/8" soft balsa side doublers that attach to the base of the fin. The standard build would use 1/4" tri stock at the base of the fin for additional support. Steve thinks this option looks better.

☐ Step # 9-10 shows placing the doublers at the edge of a hard true surface and pre-shaping the edges.

☐ Sand the trailing edges of the horizontal and vertical to a thinner edge, and round the leading edges. Note that the horizontal stab must have the slot enlarged 1/8" on either side of the existing slot. This will allow the 3/8" thick vertical base to fit.

Wing

Steve says: The wing has a "reflex airfoil". In other words, the trailing edge angles upward. This is a common airfoil for use in deltas and flying wings. I believe this is why the plane does not have a "snap roll" at the stall. For this reason, the aircraft needs to fly on the "step". Or, it flies nose high in slow flight. So, the wing has a rather unorthodox assembly sequence.

☐ Assemble the wing skins first. Arrows on wing skin drawing denote direction of grain towards wing center.

The kit includes two sets of wing sheeting. Four are required. Cut two more sets of sheeting from 1/16” X 4” balsa. Grade the sheet for stiffness. Use the stiffer sheets on the bottom of the wing.

☐ Pin WB, WC and WD to work surface and tape the seams with masking tape. Remove pins, turn over and flex open the joints. Apply white glue sparingly into the seam. Lay the sheeting flat and wipe excess glue away with a damp paper towel. Turn panels over and pin bottom edge. Pin WA in position and tape. Repeat gluing as above.

☐ Repeat above instructions to make a total of four wing panels. Stack the panels on a flat surface, using wax paper between all and on flat surface. Weight down with a heavy flat surface and let the glue cure overnight.

☐ Remove tape from wing sheeting, by pulling tape back over itself. Sand the wing sheeting using 220 on a long sanding tool at a 45 degree angle to the wing centerline. The inside surfaces need only leveling. The outer surfaces should be sanded smooth. Mark all panels for their position (top, bottom, left, right) on the inside surface.

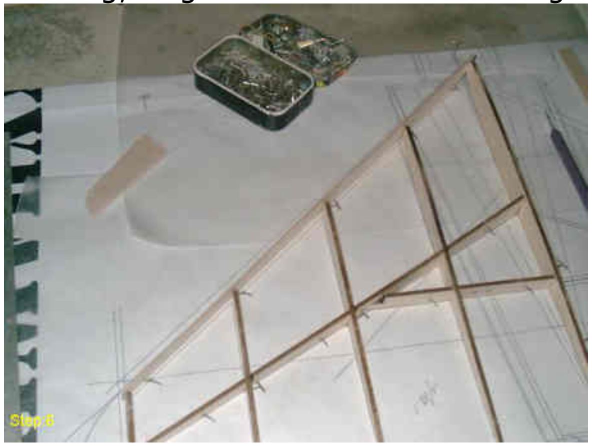
☐ Use a cardboard nail file to angle the rib notches in the spars W6 and W7.

☐ Pin spars W6 and W7 to the plan, with the rib notches pointing up. Glue W6 to W7 where they meet.

☐ Use the Root Rib Jig to position W1 on the spars and glue it in place. The bottom of the rib (facing up) will be further towards the center of the wing. This angling of the rib will make the finished wing flat on top and have dihedral in the bottom surface.

☐ Add remaining ribs W2 thru W5.

☐ Cut two sub-leading edges from firm 1/16" balsa sheet. (Not shown on plan.) Cut them wide enough so that the bottom of the sub-leading edge rests on the board and still fits the ribs. The ribs may need a little sanding, to get the LE to attach straight.



☐ With balsa, fill in the area where the leading edge meets W1. Blocks should be oversized as compared to W-1.

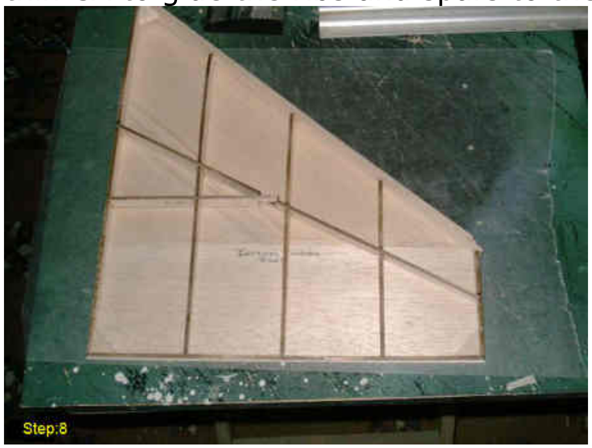
☐ Add the trailing edge parts TE.

☐ Cut a 5/8” wide strip of scrap 1/8" balsa, and cut the strip into right triangles. Glue these to the TE at W1 and W5.

☐ Remove the wing panel from the build surface. Using a flat hard edged surface such as a work bench, shape the TE to match the ribs. Do the same to the sub-leading edge. The wing panel is quite fragile at this point. Be gentle, take your time, and make sure it is not wavy. Then finish shaping the trailing edge and sub-leading edge with the sanding tool. Leave the opposite side (top) alone for now, as it will give rigidness to the LE assembly.

☐ Flip the wing panel over so that the top side is up. Position it on the corresponding bottom sheeting. Use wax paper under the sheeting. Pin the trailing edge down and use thin CA to glue the trailing edge to the sheeting.

☐ Remove the pins. Gradually working forward, use thin CA to glue the ribs and spars to the sheeting.



☐ Trim and sand the sub-leading edge to match the rib tops. Make sure you sand a true and straight line. View from different angles, and check often during the process. It will give a great looking frame and avoid fillers later.

☐ Trim and sand all excess glue from bottom sheeting.

☐ Pin the trailing edge to work surface over wax paper. Place a length of 1/8" square balsa under the front of the wing for support. The tip section will be under the leading edge at W5, and the root end will be about 3/8" in front of W1. Pin this area down. You want the wing stationary, for the sheeting process. You can add some scrap balsa to support the wing at the leading edge and at W1.

Steve says: Get some large sandwich bags and fill with sand. Use these to keep the wing sheeting in contacts with the ribs. They will conform to any curvature.

☐ Apply polyurethane glue (Gorilla glue) on all rib tops and spars. Then apply thick/slow CA to the top of the trailing edge strip.

☐ Position the wing sheeting carefully and pin the sheeting to the trailing edge.

☐ Apply thick CA to the top of the sub-leading edge and start laying the sand bags on the wing beginning at the trailing edge. Stop just shy of the high point of the wing, and using your long sanding tool, press the sheeting down on the sub-leading edge. Hold the sheeting in place until the CA sets, then place another sand bag over the leading edge.

☐ Repeat these steps to build the opposite side wing panel.

☐ Use a long sanding tool to true-up the sheeting and sub-leading edge.

☐ Glue the 1/4" balsa leading edge to the sub-leading edge. Sand the ends of the leading edge flush with W1 and W5.

☐ Laminate 3 WT parts to form each wing tip. Glue the wing tip to W5 with the bottom surface matching the bottom rear portion of the wing. Rough sand the leading edge and wing tips to shape, using the wing itself as a guide.

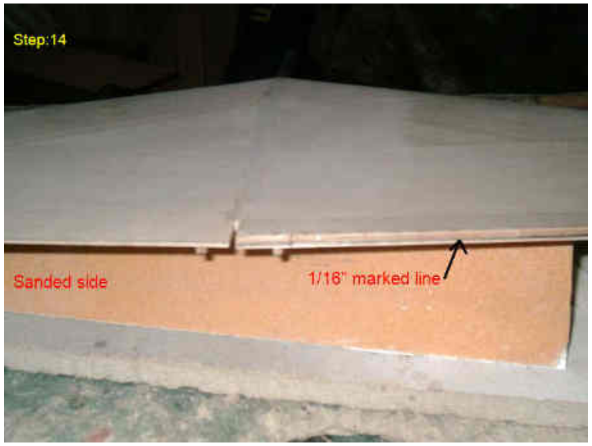
Joining the Wing Panels

☐ 1/8" square balsa is used as dihedral braces. These are placed 5-1/2" from the wing center. Mark the TE where they will go. Temporarily pin the TE, at the center, to the board. This will raise the front part of the wing. Place the 1/8"sq in place at the marks and pin to board. Check that everything aligns properly, then remove one panel. I used Gorilla polyurethane to join panels, slightly dampening one panel. DO NOT USE TO MUCH GLUE! It will foam and expand. Only a thin layer is required. Join panels and pin securely. Place a piece of wax paper on wing top and place a sand bag at the rear of the wing. Pin the leading edges together, to keep everything secure. You will notice that the TE has dihedral, and the center section has none, or very little. But the bottom wing surface has the most dihedral.

☐ After the cure, clean excess glue from the joint.

☐ Step 14 Tack the aileron to the wing. A solid glue joint should be used at the wing tip block joint. Sand the wing tip blocks to conform to the wing top surface. Round sanding tools help. Then with a sanding block, taper the aileron down to the 1/16" sheet bottoms. Match the wing tips to the ailerons. This leaves a 1/16" TE.

Tip: Using an extra fine marker on the edge of the 1/16" bottom ail sheet and the 1/8" sheet, will help in the visual.



☐ Mark the ailerons 1-1/2" from the wing center. I had a small gap between the ailerons at the center. This will be filled later. And mark the wing tip counter balances. Cut the wing blocks free on this line and remove the ailerons by cutting free the tacks. Remove the 1/8" square alignment guides. Cut the center section aileron blocks free. Be sure to mark the parts right and left.

☐ Cut two 1/16" ID aluminum tube bearings 1-3/4" long, using a single edge blade and rolling the tube under the blade. Bend a 1/2" end of 1/16" MW at 90 deg. Slide alum bearing on MW, leaving 1/4" clearance from bend. And bend the vertical spur 1/4" from bearing. Cut MW 1/2" from bend. Check all bends. Place linkage on board. Vertical spur should be straight up. Form opposite linkage the same way. BE SURE TO MAKE A LEFT AND RIGHT.

☐ Roll cut two 1/16" ID brass tubing, 3/4" long. Flatten one end and drill to accept nylon mini clevis pin. Scour the end of each vertical spur, with sandpaper and solder the brass horns to the spurs. Be sure to get a hot-flow joint with the solder. Mark the linkage spurs on the wing and aileron. Drill 1/16" hole in aileron to accept spur. Using a length of sharpened brass tubing, gouge a recess in the leading edge of the linkage blocks, so they fit against the wing and retain the bearings. A recess will be required on the ailerons, also. Small grooves will be required in the wing and linkage blocks to allow the linkage free movement.

When satisfied, tape the aileron in proper position and attach linkage and blocks into position. Be careful not to get adhesive into the bearings. Remove ailerons and sand the linkage block/wing joint smooth.

☐ Apply a double layer of masking tape to the top and bottom of the wing surface as shown. Steve used ¾ ounce fiberglass cloth to strengthen the center section. As Steve planned to glass the wing, this will provide a double layer. If another type of covering is used, use 2 ounce cloth. Steve thins my epoxy finishing resin 25% with denatured alcohol. After curing, use a tool such as a nail sander to sand the fiberglass and resin at the edge of the tape. Then remove the tape. This raised, straight hard edge is easy to feather using the same sanding tool.

Finishing/Assembly

At this time, prepare the assemblies for the desired covering. Fill all voids with light weight spackle. Surface preparation will go a long way to achieving a superior finish. Though an iron on such as Doculam can be used, Steve strongly suggests an epoxy glass finish. When properly done, it is both light weight and extremely durable, which is a benefit with the faster flying and landing speeds.

Assuming that you are glassing and this step is completed, do not attempt to final sand the glass just yet.

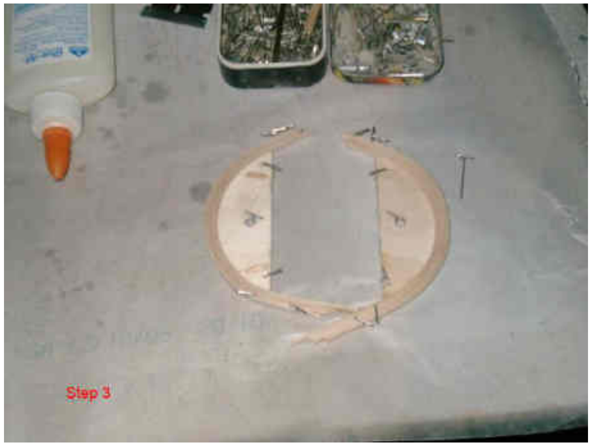
Splitting the Fuselage

☐ Shown are two heavy duty nylon landing gear straps. Assemble the fuselage and hold w/masking tape. Using the landing gear straps as templates, mark their outlines and drill the 1/32" holes for the strap mounting screws. Disassemble the fuselage and remove the sheeting, where marked, so that the LG straps will sit recessed. Reassemble the fuselage with tape and install the LG straps with #2 sheet metal screws. Once these are painted, they are hardly noticeable.

Steve says take this time to do a "mock" assembly, of the Skyhawk. Now sit back and admire your handiwork!

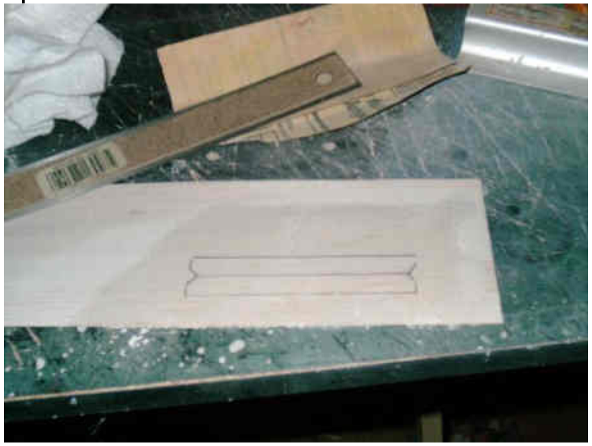
Final Assembly

☐ **Intakes**. Remember the D1 intake forms used to make the intake ducting? Using a candle, wax these forms on the round edge. Strip scrap 1/16" balsa, 1/8" wide. Dampen with ammoniated water (Steve uses a spray bottle with the mixture.) Using regular Elmer's white glue, assemble four layers of balsa and wrap them around the waxed forms, pinned to a flat surface. Make two – one for each side of the aircraft. Let the glue dry completely. Block sand if the layers are not even..



Place on the intake area as shown and trim for a good fit. Radius the edges and sand flush with the inside of the duct and outer fuselage. The reason for using a laminate piece for this assembly is a constant grain direction. This allows uniform shaping.

☐ Take a piece of 1/32" balsa and glass both sides with ½-ounce fiberglass cloth scrap and thin CA. Prime the fiberglass and sand it smooth. Make a template of the splitter and marked the primed piece. (2) required. Install these after priming the glass. It may be necessary to trim the radiused lips, to keep the splitters flush with the inside of the ducting.



☐ **Cockpit and Canopy.** Build up the sides of the canopy base C6B with strip wood to match the contours of the cockpit area. Then attach to 1/8" balsa. Tack to cockpit area and blend with cockpit. Attach rear lite ply cockpit former C9. The cockpit canopy and base are held in place with four pairs of rare earth magnets. These can be had at Radio Shack part#64-1895. Remove the cockpit and cut scrap pieces of balsa and place under these holes in the canopy base C6A.

☐ Dab some 15 minute epoxy into the magnet holes in the canopy base and place a magnet in each hole. Cover the area with wax paper and tape the cockpit in place securely. Insert the remaining magnet halves in the holes and fill with epoxy. Let cure. Remove tape and cockpit/wax paper and.

☐ Temporarily attach the canopy with tape, and make the rear canopy fairing from layers of scrap balsa. Temporarily fit the ECM hump if you plan to use it on the model.

☐ **Fitting the Wing.** Remove the frame work in the fuselage center. Fit and install rear wing hold down blocks using double layers of 1/8 lite ply scrap. Do not install the front block yet. The wing is held fore and aft with two 8-32 nylon screws from hardware store. Test fit wing in saddle and trim the saddle for a close fit. Caution should be used not to change the incidence. The rear of the wing will sit below the rear fuselage section. Be sure wing is level when viewed from front.

☐ View the leading edge of the wing directly overhead. Where the leading edge intersects the fuselage side, draw a line and cut this section free.

Apply a scrap scab of 1/64 ply and shape it to the wing.

Install forward wing hold block. Remove area on top of wing to clear block.

The wing should fit with a slight gap between block and wing. Add 1/64 scrap to recessed area.

Wing should now be tight against saddle and block. Drill and tap holes for wing bolts. Cover wing with plastic wrap. Apply a thin layer of spackling to the wing saddle and mount wing. Excess spackle will push out. Use excess to form a small fillet between wing and fuselage.

☐ Fill area in front of wing with scrap block balsa, shaped to fuselage cross section and glue to fuselage.

Using scrap balsa, fair in front of wing to fuselage joint and fill with spackle. Let cure overnight. While this was curing, I added cooling holes to bottom of fuselage, where nose block ends. I used a 3/16" round file. Then saturated w/thin CA.

☐ Remove the tape that holds the plastic wrap, fold out of way, remove wing and gently remove wrap. Using thin CA, saturate spackling. This will make the spackle non brittle and strong. Shape the fillet and fairing. And apply a layer of med CA. Sand smooth.

☐ Prime and surface the fiberglass work, and install the intake splitter.

☐ **Final assembly.** Steve used three 1/8" dowels to help secure the horizontal and vertical stabs in place. Also, he used 3/16" wide CA hinges to hinge all surfaces.

☐ Remember to install the small square fill piece between the elevators. Tack the tail surfaces into place with the wing attached. Check the top view to ensure the long dorsal is in the fuselage center. When satisfied that everything is straight and square, permanently glue the tail surfaces.

☐ Permanently attach the ECM hump. Steve used odorless med CA without kicker to give a smooth, small fillet. Using a fine tooth razor saw, cut through the dorsal. Make cockpit details to suit tastes. Paint, then install canopy. Mask canopy framing. Make fuel dump fairing and install on rear fuselage bottom.

☐ Using template, make the "sugar scoop" fairing from 1/64 ply and install between vertical fin and fuselage. It helps to seal with med CA and sand smooth before installing. Make the wing-to-fuselage fairing at rear wing mount bolt

☐ **Install fan.** Motor wires exit through fan shroud and fan is positioned so wires are on bottom. Cut exhaust ducting from thin Mylar using template provided. Mount to fan loosely with tape. Attach rear fuselage to line up exhaust duct, and securely tape in proper position. Duct should exit fuselage approx 1/4". Tack fan unit to F7.

☐ Elevator pushrod is .032 cable and yellow sheath from Sullivan. Steve notched the rear bulkheads to keep it away from the exhaust. Attach the pushrod sheath to the rear fuselage only. Use an EZ connector on the servo to allow removal of the rear fuselage for fan maintenance.

☐ Aileron is basic strip type, using an HS-55 servo installed to one side of the center ribs opposite the elevator servo. Pushrods are .032 music wire and .032 threaded ends soldered, with nylon mini clevises.

☐ Install the catapult hook using epoxy. A nylon or metal washer or a scab of plastic sheet can be used where the hook enters the fuselage. This will keep the bungee ring from denting the fuselage in that area.

Steve installed wing tanks on his Skyhawk. Vacuum-formed tanks are available from Keith Sparks at Park Flyer Plastics, 7755 Noreast Dr, North Richland Hills, Texas, 76180-6805 Web site: http://parkflyerplastics.com/. The tanks are item 1025-7, 14.5" x2" . These are held in place with the same type of magnets as the canopy. Should you decide to make them droppable, remember to install the system before sheeting the top of the wing.

Finishing. Steve finished his second prototype with his favorite paint: Tamiya thinned 50% with denatured alcohol. Paints were custom blended for a close match to the full size. A Paashe VL airbrush was used. The plane was first given a light coat of flat aluminum. This allows natural colors to show without heavy build-up. Then after decals are applied, panel lines are added with a dark artist’s pencil. Many lines were etched with a sharpened piece of 1/8" MW. This shows the underlying aluminum. A charcoal pencil is ground down w/sandpaper to form a grime that was applied with the finger to heavy dirty areas, and with a soft ladies make-up brush (1/4") to lighter areas. Then a light coat of Testors lacquer dull-coat was sprayed from the can to protect everything.

Preparation for Flight

Center of gravity is 8-1/8", measured forward from the trailing edge of the wing near the fuselage. This CG proved correct for the first prototype, and is a good starting point. Using a standard length motor, such as the Mega 16/15/3 or HET 3W, the plane balances with a 4S-2200 LiPo in the cockpit area. Balance the plane upside-down. Inserting shortened common pins at the CG point in the wings, will allow you to "feel" the correct CG point without looking.

The ESC used is a Castle Creations Phoenix 35 with a separate Castle Creations BEC. The BEC is located just behind F5 and secured with Velcro to one intake duct. The ESC is located between the ducting immediately in front of the fan. The design of the ducting forms a low pressure in the fuselage and the ESC is in front of this vent where it receives good airflow.

The receiver is Velcroed to the ducting opposite of the BEC just behind F4. The antenna is routed through the fairing behind the canopy and to top of rudder.

Initial Control Throws:
* Elevator: 1/4" up and down
* Ailerons: 1/4" up and down.

Steve says the Blue Angel prototype required 50% exponential on the ailerons. This most likely due to the lack of dihedral that I did not use. It was sensitive around neutral. 30% expo would be a good choice. Once used to the plane I increased throws to 1/2" on the ail and 3/8" on elev. The plane is capable of a very fast roll rate, but it stops immediately upon releasing the stick.

Hold a quarter stick up elevator on launch. I used 10 pounds of pull on the bungee. Gain altitude in a shallow climb and trim. Try a stall at altitude. If all is correct, it will not snap. Consistent with a delta configuration, she just mushes and loses altitude. Apply power, push the nose down, and she will get on step and scoot. (They did call her the Scooter) If you're flying too slow, she will rock the wings and mush to the ground. With power on and nose up, she is controllable right down to landing.

With the above power system, expect 30A draw at 420 watts. That's 210 watts per pound. Flight speeds are around 80 mph.

Good Luck, Happy/Safe flying
Steve St.Martin, Build-aholic