De HAVILLAND D.H. 91 ALBATROSS

By Laddie Mikulasko

The mention of the name De Havilland is certain to evoke fond sentiments from most scale aircraft enthusiasts. This innovative and prolific company strongly influenced aircraft design from just prior to the First World War until after the second World War. The De Havilland Company became involved in almost every facet of aircraft design. Their creations included military fighters, sport planes, transports, and several highly successful racing aircraft.

De Havilland's most successful racer (arguably the most beautiful twin ever constructed) was the famous D.H. 88 Comet that won the 1934 Melbourne Air Race by covering 11,000 miles in 77 hours. Three weeks after this race, De Havilland submitted a proposal to the Air Ministry for a high-speed airliner based on the Comet design. Initially, their proposal was rejected, but persistence by De Havilland resulted in the signing of a contract in January of 1936. To achieve the performance specified in the contract, it was necessary to design a very aerodynamically clean aircraft of minimal weight. This design was of all wooden construction and had a projected payload of 22 passengers. The monocoque fuselage shell was built over a collapsible jig. The inner plywood skin was 1.5mm thick while the outer skin was 2mm thick. Between these skins was a 22mm thick balsa core. This "sandwich" technique produced an exceptionally strong and lightweight fuselage that was certainly a precursor of contemporary composite construction. On a later branch of the family tree, this same technique was used extensively on De Havilland's famous Mosquito fighter (of course, all wooden aircraft come from good family trees!) The engines were created by mating two Gypsy six cylinder blocks to a newly designed crankcase. The engines were air cooled by means of inlets in the leading edge of the wing on either side of the nacelles. The maiden flight of the prototype was successfully completed in May of 1937.

A total of seven planes were built and flown on domestic and international routes. It is my view that, with the exception of present-day jet airliners, there are few airliners designed that achieved the aerodynamic efficiency of the D.H. 99 Albatross. These "wooden wonders" were environmental friendly, but unfortunately they were also termite and dry rot friendly; consequently, none of the original aircraft exist in flying condition.

I decided to build an electric-powered model of the Albatross after I had successfully flown my three-engined Ballanca Trimotor (RCM. January '97). Added encouragement came from reading excellent articles in *Electric Model Magazine* which is a periodical published in England. Many photos in this publication indicate the rising popularity of electric-powered multi-engine scale models that use Graupner Speed 400 motors.

I recalled seeing 3-view drawings of the

The author with his beautiful D.H. 91 Albatross.

Albatross somewhere in my archives, and shortly after locating them, a set of construction drawings was completed. Many multi-engined aircraft featured in European model magazines show a growing trend towards using Styrofoam as the primary building material, or sometimes Styrofoam combined with balsa. As a side note, when I was living in Czechoslovakia, in the early 60's, I had no balsa with which to build models, and even Styrofoam was not readily accessible. By chance, one day I came across a sheet of white Styrofoam. After picking this sheet up and finding it so light, I was immediately dreaming of ways to use it as building material. I recall sanding it to approximately 1/4" thickness and, of course, there was foam dust everywhere! I constructed a small R/C model by using this sheet for the fuselage sides and tail surfaces. These components were then covered with Japanese tissue using white glue to bond it to the foam. To my delight, this model actually flew quite well. Subsequently, I was able to purchase balsa, and this has been my primary building material up to the present. Returning full circle, I have recently begun to construct some of my models using Styrofoam and paper. On the Albatross, I decided to build the wing and tail surfaces in the conventional manner, using balsa and spruce. The fuselage, however, is a combination of balsa stick frames with formers on the outside acting as guides to achieve the desired fuselage shape. Blue Styrofoam occupies the spaces between these formers. The nacelles are constructed using only formers and Styrofoam. Brown wrapping paper was used to cover all of the foam. On my next project, I intend to use foam exclusively. Since I have access to a paved runway, I installed a fixed main undercarriage, a steerable tail wheel, and working rudders. This model could be built to be hand-launched, and, in this case, the undercarriage and working rudders are not necessary. In addition, the stabilizer and elevators could be constructed as flat surfaces using 1/4" sq. balsa sticks, with the fin and rudder cut out from 1/8" balsa sheeting in a single piece.

To build a successful model, you will need to use lightweight balsa sticks and sheets, along with a small amount of 1/8" plywood and four 1/8" x 1/4" x 36" spruce spars. Also required is 1" thick blue or pink Styrofoam, brown wrapping paper (unwaxed), and white or yellow water soluble glue.

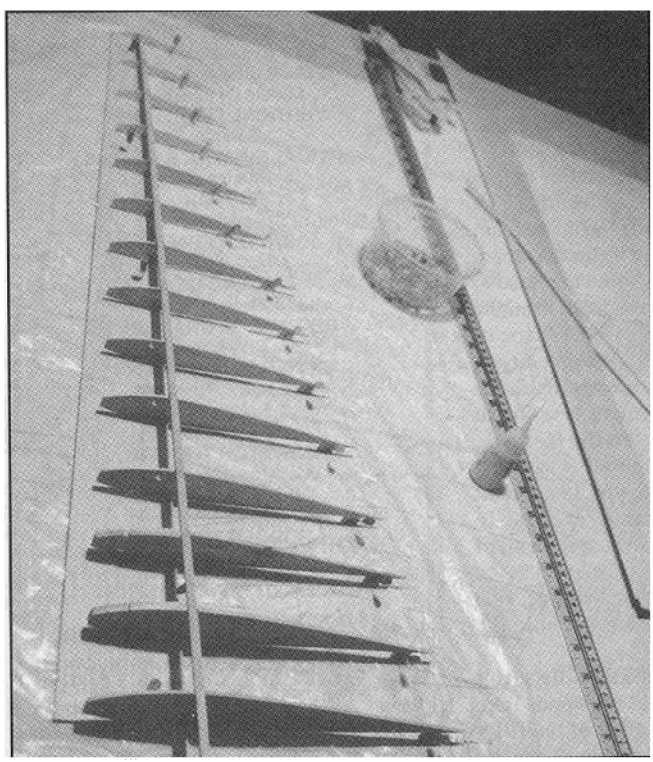
CONSTRUCTION

To start building, cut out all of the parts accurately.

Wing:

The wing should be made first, since it will be needed as the fuselage is being built. The wing is built in two halves which are joined later. Punch out holes in the ribs to route the NyRod cables and motor wires. Pin the bottom leading edge sheeting to the building board directly over the plan and glue the bottom main spar to it. Pin all the ribs to the sheeting and to the main spar. Ribs (W1), (W2), and (W3) should be cut in two halves so there is room for the dihedral brace when joining the two halves of the wing later. To ribs (W3) and (W4) glue the doublers that hold the landing gear blocks. Position the top main spar in place and glue both spars to the ribs. In the rear, glue the bottom trailing edge sheeting to the ribs. In the front, glue on the subleading edge spar. This subleading edge spar should be sanded so that it follows the contour of the ribs. Next, glue the bottom leading edge sheeting to all the ribs and to the subleading edge spar.

At this time, insert the NyRod and the motor wiring into the wing. The motor wires should be long enough so they protrude from the front of the nacelle by 2" and inside the fuselage by 4". Glue on the top leading and trailing edge sheeting. Note on the drawing that the trailing edge sheeting covers the entire aileron. Once both halves are built to this stage, turn the wing over and remove all the tabs on the ribs, except the tabs on (W1) and (W13). Glue on capstrips and the sheeting that supports the nacelles. Separate the ailerons from the wing. Glue on the aileron leading edge and close the opening in the wing by gluing in the hinge spar. Slide both halves of the wing onto the dihedral brace. Pin the root rib (W1) to the building board. Prop up the wingtips using the balsa template indicated on the drawing by the arrow at the wingtip. Place these templates under (W13) ribs. Glue the dihedral



Bottom L.E. sheeting, ribs, and spars glued in place.

The two halves of the wing partially done. Note the wires for the motors, and the tube for the aileron pushrod wire.

brace to the wing spars. Next, all top capstrips and root balsa sheeting can be glued in. Again, turn the wing over and glue in the plywood brace to ribs (W1) and (W2) which support the wing bolts. Glue the landing gear blocks to the leading edge area. Glue on the wingtip sheets and foam blocks to the top of them. Glue a hardwood dowel into the front of the wing at the root rib. Sand the whole wing to your satisfaction and put it aside for now.

Tail Surfaces:

The stabilizer and elevator can be built two ways. If you choose to build flat stabilizer and elevator surfaces, use 1/4" x 1/4" sq. balsa for the leading and trailing edges. Where the ribs are located, glue in cross members of same size. The fin can be constructed from 1/8" sheet. Alternatively, when building the stabilizer according to the plan, before the sheeting is glued on, you must install the NyRod tubes for rudder control. Notice that the hinge spar has part of it cut off at the tip so the rudder horn has clearance when the rudder is deflected inward. The two halves of the stabilizer are then glued together at the proper dihedral angle. Build each fin in two halves and then glue them together to achieve their symmetrical shape. Once they are built, put them aside and do not glue the fins to the stabilizer yet.

Fuselage:

Build two identical sides by gluing uprights to the longerons and the wing saddle sheet. In the rear, glue in the stabilizer's support sheet. At this time, draw the fuselage's centerline on each upright. On the inside wing saddle area, glue in the plywood doubler. Remove the fuselage sides from the building board and position them vertically, by pinning each side to the building board at the wing saddle. Place appropriate sized blocks or sheets under the bottom longerons so the centerline of the fuselage is parallel to the building board. Support the sides in the upright position with the aid of squares placed on the outside and pinned down. Glue in all cross members between the two sides. Be certain that the fuselage is square to the building board and with the centerline on the drawing. In the rear, glue in the plywood formers with the 1/16" i.d. aluminum tube attached that holds the tail wheel.

Before the foam blocks are glued to the fuselage, take each former and paint the outside edges with black ink or a marker. This will assist you when you are sanding and shaping the foam. Begin by gluing the quarter formers (F8) to the top, right, and left sides of the fuselage. Using a handsaw, cut the foam blocks that go from this former all the way to the rear. Smear white glue onto the longerons, cross members, and the formers. Place the foam onto the fuselage and pin or wrap tape around to hold these three blocks to the fuselage. Next, cut out and glue the next set of foam blocks that go between former (F8) and former (F7). Once these blocks are held to the fuselage and former (F8), glue on former (F7) to it and to the fuselage. Continue cutting and gluing foam blocks until the fuselage is covered up to former (F3) on top and the sides. The foam blocks between formers (F3) and (F7) have their bottom sides sanded to shape that follows the contour of the fuselage. Remove the fuselage from the building board. Next, inside the fuselage between formers (F3) and (F5) glue a 3/16" x 3" wide balsa strip to create a floor which supports the motor battery. Glue Velcro to this strip. Next, glue on all bottom formers and foam blocks.

Build the nose section separately before it is glued to the fuselage. To former (F3), glue remaining balsa formers with the foam blocks between them. Trim the excess foam using a sharp knife. Now, glue the nose to the fuselage. Trim the excess foam from the rest of the blocks and sand to the shape of the formers. Begin sanding by using 40 grit paper first. Sand until you are approximately 1/16" away from the formers. Use 80 grit paper to sand all the way to the formers. Last, sand entire fuselage with 120 grit sandpaper. Go slowly, since you do not want to take too much off and create low spots. To achieve the proper fuselage shape, do all of the sanding at a 45° angle in relation to the fuselage centerline. Inside the fuselage, glue in the two hardwood blocks that hold the wing bolts.

The next step is to make the fillets. Cut the fillet base out of 1/32" plywood. Take the wing and draw the outline of the fillet base onto the top balsa sheeting. Wrap the middle section of the wing with wax paper

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Designed by:
Laddie Mikulasko

TYPE AIRCRAFT
Sport Scale Electric

WINGSPAN
68 Inches

WING CHORD
7-3/8 Inches (Avg.)

TOTAL WING AREA
495 Sq. In.

WING LOCATION
Low Wing

AIRFOIL
Clark Y (Modified)

WING PLANFORM
Taper

DIHEDRAL, EACH TIP
3 Inches

OVERALL FUSELAGE LENGTH
47 Inches

RADIO COMPARTMENT SIZE
(L) 10" (W) 4" (H) 4"

STABILIZER SPAN
18-1/2 Inches

STABILIZER CHORD (inc. elev.)
5 Inches (Avg.)

STABILIZER AREA
92-1/2 Sq. In.

STAB AIRFOIL SECTION
Symmetrical

STABILIZER LOCATION
Middle Of Fuselage

VERTICAL FIN HEIGHT
6-1/8 Inches (X2)

VERTICAL FIN WIDTH (inc. rud.)
4-1/4 Inches (X2)

MOTOR
Speed 400 (X4)

BATTERY PACK
8-9 Cells/1700 mA (SCR)

LANDING GEAR
Conventional

REC. NO. OF CHANNELS
4

CONTROL FUNCTIONS
Rud., Elev., Throt., Ail.

C.G. (from L.E.)
2-3/4 Inches

ELEVATOR THROWS
3/4" Up — 3/4" Down

AILERON THROWS
3/8" Up — 1/4" Down

RUDDER THROWS
3/4" Left — 3/4" Right

SIDETHRUST
0

DOWNTHRUST/UPTHRUST
0

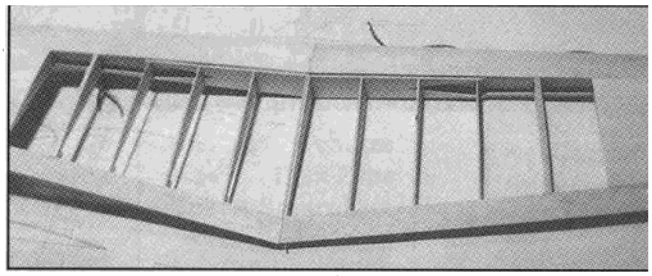
BASIC MATERIALS USED IN CONSTRUCTION

Fuselage ..... Balsa, Foam & Ply
Wing ..... Balsa, Foam, Ply & Spruce
Empennage ..... Balsa
Wt. Ready To Fly .... 74 Oz. (4 Lbs. 10 Oz.)
Wing Loading ..... 21.5 Oz./Sq. Ft.

or clear plastic. Place the fillets onto the wing and hold them in place with the masking tape. Smear glue on the bottom edge of the wing saddle and bolt the wing to the fuselage. Now cut the foam into small blocks to fit in the space between the fuselage and the fillet's plywood base using white glue to bond them in place. After the glue is dry, roll up a sheet of the sandpaper into a tube and sand the fillets to achieve an equal radius on both sides. Once the sanding of the fuselage is completed, it may be necessary to fill some dents or low spots. On these areas, brush on white glue diluted 50-50 with the water. Let it dry so that surface area hardens. Sand the fuselage lightly. You should use a lightweight type of filler like those sold by Sig or CG Models. (I purchased mine from a hardware store.) Once the filler is dry, sand it carefully.

Covering of the fuselage with brown paper is the next task. Cut the paper into strips so one strip covers 1/4 of the fuselage. The rear of the fuselage past former (F7) is covered first. Take a strip of paper and soak it in water. Wipe the excess water off the paper so that it remains damp only. Brush a 50-50 glue mixture onto the fuselage and place a strip on one side. Brush a 50-50 glue mixture on top of paper as well. Using a squeegee, beginning at the middle of the strip and working outwards, force most of the glue out. Use just enough pressure so that the paper sticks to the foam without wrinkles. Put one layer of paper on the rear section of the fuselage and let it dry. Sand lightly. Next, start covering the front of the fuselage. Since the front section of the fuselage has a compound curvature, the covering technique is slightly different. Take one strip of paper and soak it well. In the palm of your hand, crunch this sheet into a ball and squeeze most of the water out. Gently unfold the strip. Again brush the glue onto the foam and place this strip on top. Brush on the glue on the outside of this strip as well. Using your fingers, gently work the sheet around the curvatures. When the strip stops conforming to curves, and creases begin to appear, cut the excess off. In a similar fashion, attach additional strips until the entire fuselage is covered. Let it dry again and then sand lightly. Repeat this process to add a second layer of paper to the fuselage. When the paper is dry, sand it until the surface is smooth. Cut out the side windows. This is easier to do accurately if you make a cardboard template with the windows cut out. Pin this template to the fuselage sides and use a sharp knife to cut out all of the windows. Note: the windows will remain open to assist with cooling of the batteries.

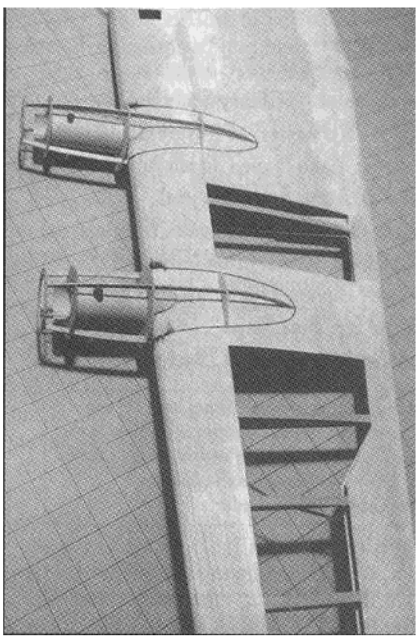
Next, use a sharp knife to separate the section of the foam beneath the stabilizer. This will be a hatch, providing access to the elevator, rudder, and steerable tail wheel control arms. At the rear of the fuselage, cut out the holes that accept the stabilizer. Slide the stabilizer in and glue it in place. Install the elevator and rudder controls. Check the surface of the fuselage and fill any imperfections, if necessary. Sand again with fine sandpaper to prepare the fuselage for the finish of your choice. Glue the fins onto the tips of the stabilizer.



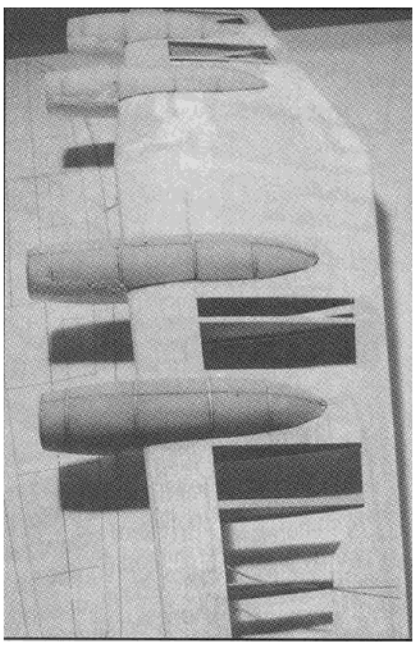
The two wing panels are now joined together with the plywood dihedral brace.

Nacelles:

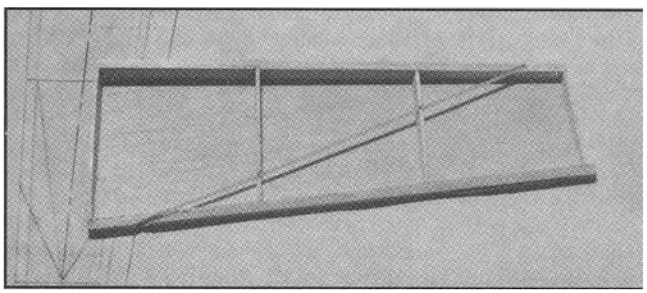
Begin by constructing the paper tubes that hold the motors in place. Wrap a Speed 400 motor with clear plastic. Take a sheet of typing paper and make one tight wrap around the motor. Now run a bead of thick CA glue in the seam and begin rolling the paper around the motor to achieve additional layers. As soon as you see no more glue is being squeezed out, add another bead. Continue this process until the entire sheet is rolled into a tube. Make four tubes in a similar fashion and cut these tubes to the length shown on the drawing. On both sides of the tubes, cut out cooling holes that line up with the holes on the motor. This is necessary so that hot air can escape from the motor. To prevent the motors from spinning inside the tubes, insert the motor in the tube and line up with cooling holes. Between the cooling holes where the brush cavity is, carefully drill a 3/64" dia. hole right through the motor's case. Be certain that the drill does not



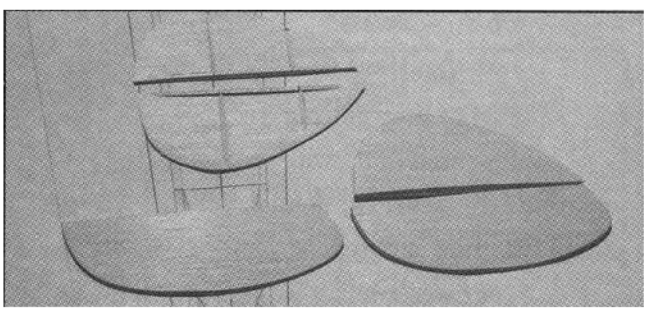
The nacelle formers and motor tubes are glued in place, ready to add foam blocks.



The nacelles have been sanded to match the shape of the formers.

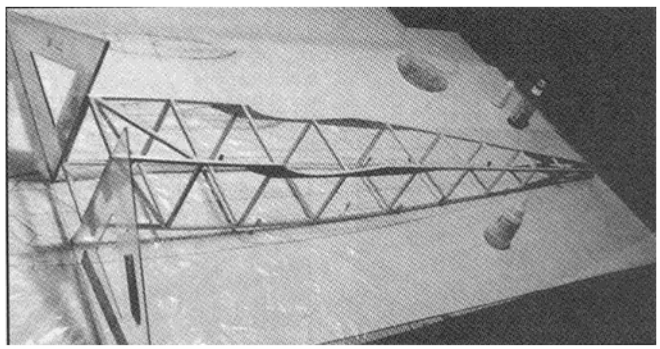


One half of the stabilizer is shown with a small diameter NyRod glued in place. 1/32" piano wire will go inside for the rudder control. The top sheeting will be glued on next.

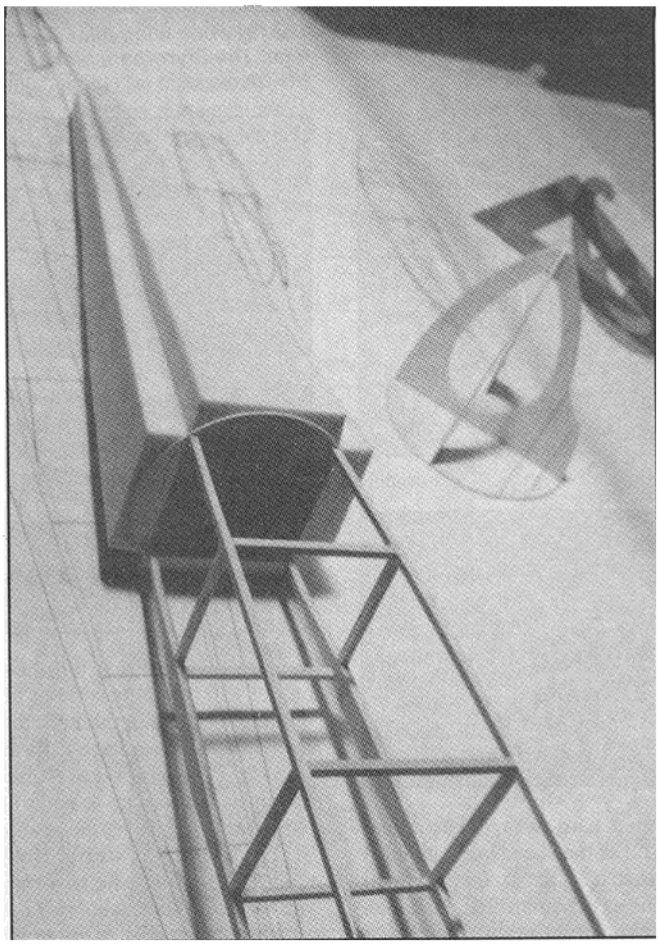


Built-up sheet balsa fins and rudders were used on the original, but 1/8" balsa sheet can be used.

contact the armature. Blow out the filings. Use a small 1/4" long self-tapping screw to hold the motor in the tube. Slowly spin the armature to make certain that the screw does not hit the armature. Mark the location of the formers on the tubes. Glue in formers (N1) and (N2), but make sure that the screw holding the motor to the tube is positioned on the bottom. To these two formers, glue the nacelle's outline formers. Glue two nacelles to one half of the wing at a time. Cut out the two chines that go under the wing and two that go under the nacelles. Pin the chines to the building board directly over the plan and place the wing on them. Place shims under each nacelle as well. These chines will keep the wing and the nacelles at the desired 0° angle of attack. Place weights on top of the wing so it does not move while the nacelles are being glued to it. Check that the paper tubes are positioned straight, with neither right nor left thrust and glue them to the wing. At this time, start gluing the top Styrofoam blocks between the nacelle formers. The foam blocks between (N1) and (N2) should be trimmed on the inside to leave approximately 1/8" clearance between the foam and the paper tube. Again, this is to facilitate proper cooling. Remove the wing, and glue in the bottom foam blocks. Once the first two nacelles are glued to one side of the wing, glue the second pair to the other half of the wing. Sand the foam to the contour of the formers and cover the nacelles with the brown paper. At the bottom of each nacelle, make a hole to access the screws that hold the motor. To make this hole, use thin wall brass tubing that has been sharpened on one end. Directly in front of former (N2) at the bottom, make a 1/2" hole, so that hot air can escape from the nacelle. Do all final filling and sanding.



The basic fuselage "box" is built-up from 3/16" sq. balsa, with 3/16" sheet used for the wing saddle and tail section.



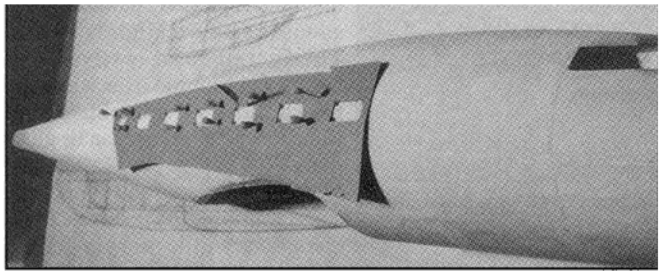
The Styrofoam blocks are being glued to the fuselage starting at the rear. Note the nose section formers to the right.

The model is now ready to be either painted or covered with an iron-on material. The iron-on covering must be a low temperature material. A properly painted model should come out slightly lighter. The overall color is silver with black or dark blue trim while the registration letters are black. The front cockpit windows can be glued in now.

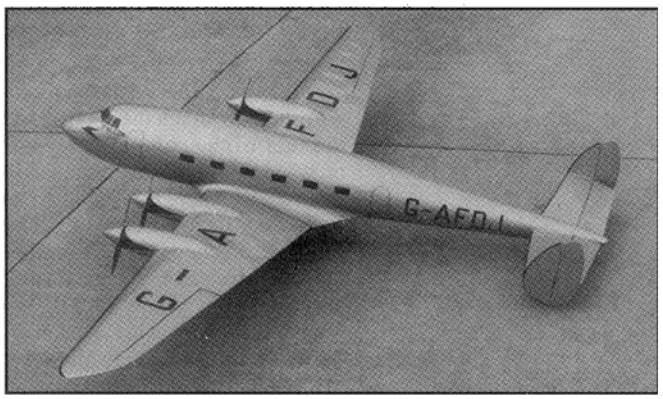
Install the radio and connect all control surfaces to the servos. Since there is very little room in the tail, and I wanted to hide the controls inside the fuselage, it was necessary to fabricate "homemade" elevator horns by bending 1/16" piano wire to the desired shape. I then used thin brass strips wrapped around and soldered to the piano wire arms to attach the clevises. At the rear of the common elevator pushrod, two wires are attached to make a "V" where each end is connected to the split elevator. The pushrod attached between each of the rudders, and the bellcrank wheel is 1/32" piano wire inside NyRod tubing. To achieve differential throw on the rudders, the holes in the wheel transferring movement from the servo are offset as shown on the drawing.

I vacuum-formed my own spinners as they are lighter; however, you may elect to use readily available commercial spinners, if you prefer. The electric motors are connected in parallel. Use eight or nine 1700 mA SCR cells to construct a battery pack. The motor battery should be positioned to achieve the C.G. location shown on the plan. Check all controls. The deflection on the elevator should be 3/4" up and down. If you are using rudders, the deflection is 1/4" in and 3/4" out. The deflections on the ailerons are 3/8" up and 1/4" down. Run the motors to determine if all is well.

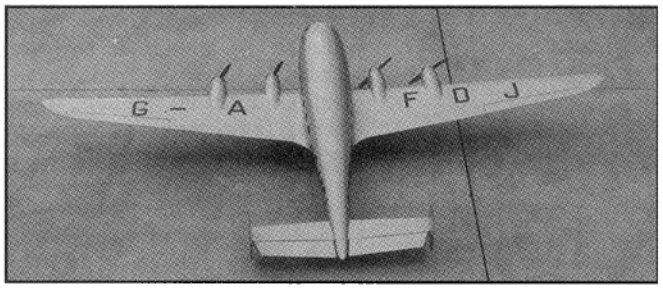
Flying:



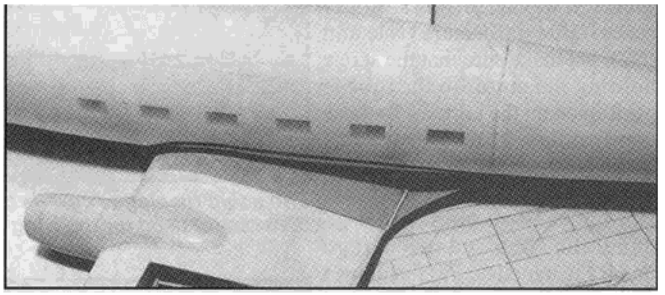
The cardboard templates are cut out and pinned in place to cut out the windows.



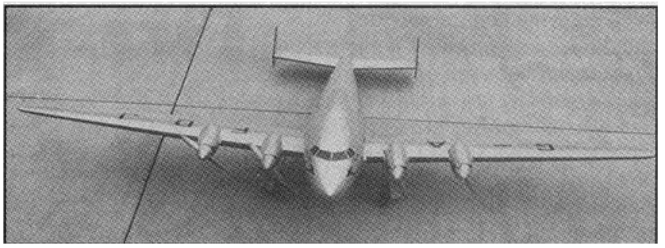
The finished model, ready for flight.



The first flight should be made from a hard surface. The model should track straight during taking off. Let the speed build up until the model lifts off. Do not attempt to force it off the ground. You will find that the Albatross is very docile and easily controlled. If stalled, the model will just drop the nose and resume flying. This is the model of the airliner, so even though some aerobatics are possible, they are not recommended since they would not be scale-like



The plywood wing fillet is glued to the wing saddle of the fuselage. The Styrofoam blocks will be glued to the plywood and to the fuselage.



maneuvers. However, I did perform an inside loop with it. The model will probably roll but I have not tried it. I did do half of an outside loop when the undercarriage hit high-voltage wire. The model sustained damage to the nose of the fuselage only.

This accident showed to me how forgiving this material is. The damaged section, up to end of the cockpit, was replaced and new paper skin put on over the new nose.

The landing is straightforward. Being an electric-powered model, you do not have to worry that one or two engines will quit on you when throttle back.

I hope you will enjoy building and flying this model of the Albatross.