DE HAVILLAND "HAWK MOTH"

By BILL NOONAN . . . Rubber-powered free flight scale is where all of our diverse interests in model aircraft began. Here is an exceptionally fine sample of that original art form. Placed 5th at the 1977 AMA Nationals.

• If you had to pick a name as being synonymous with the development of British aviation, de Havilland would likely be the first choice.

Geoff de Havilland the man, fit perfectly the image of the innovative and resourceful pilot/designer of the Golden Years of flight. Born in 1883, his influence on aircraft design was felt for more than half a century. The last aircraft bearing his distinguished name was the D.H. 121 Trident. The company was absorbed into Hawker-Siddeley in 1961.

Not all of de Havilland's designs enjoyed the spot in history which characterized the D.H. 4, the Gipsy Moth, or the Mosquito. Archives contain many interesting designs relegated to obscurity, the Hawk Moth, designated model 75, being one of them.

We blew the dust off a February, 1929 copy of the highly-regarded British publication "Flight", and revealed an interesting and comprehensive analysis of our subject. It provided good three-view drawings and sufficient structural details for proof-of-scale documentation.

The Hawk Moth is a straightforward design, nicely proportioned and simple, but with enough distinctive, character to set it apart from its contemporaries. The wide (10 foot) landing gear tread is unique for a plane of the Hawk Moth's size, the wingspan being 44 feet.

Our model, which incorporates folding wings, deviates from scale only in landing gear length and slight enlargement of the stabilizer.

It is virtually vice-free when it comes to flying. Originally powered with 8 strands of 3/16 rubber, which gave ho-hum performance, the motor was increased to 10 strands for the 1977 Nationals at March AFB. It took fifth place in outdoor rubber scale.

FUSELAGE CONSTRUCTION

Fuselage construction follows conventional practice. Lay 3/32 square hard balsa longerons over plans which have been covered with wax paper or Saran wrap to prevent surplus cement from adhering. All upright and diagonal members are 1/16 square. Cement these in their respective places, noting the 1/32 difference from the longeron thickness. This "detent" accommodates the sheet balsa which surrounds the cabin, and the two 1/32 square basswood stringers. Repeat the same procedure for the right side, taking care to reverse the "detent", otherwise you will have two left sides.

When the two sides are thoroughly dry, cement them together, starting at the rear of the fuselage, which has an unusual boat-tail shape. Hold fuselage sides together with clamp or clothespin. Check for alignment. Add widest (cabin) cross pieces, and work aft, checking to be sure cross-section is square. Finish this operation by pinching nose longerons together and inserting cross pieces. This can be a little scary, so take care. You may find it necessary to wedge the nose between two heavy, vertical objects like books, while the cement dries.

When this basic frame is dry, add the four plywood ribs (R1) which form the cabin roof/wing root. The bottom of these ribs parallel the bottom of the top longerons. Fill in between these with 3/32 sheet balsa, between the front and back spar stations. Carefully cut and fit 1/32 medium sheet balsa sides and bottom (cabin floor). Cement in place. These should be flush with longeron sides, having been "let in" the 1/32 detent. Note that 1/16 square door frames are on starboard (right) side only. After the sheet siding is dry, carefully cut between door and fuselage frames. Remove doors and add hinges, which may be made of fine silk. Take care not to allow surplus cement to enter doorjamb, or the pilot won't be able to get in. Door latches may be made of small diameter wire and installed after covering.

Add the 1/32 basswood stringers. Their bearing surfaces should be on the same plane as longeron sides. Add 1/32 plywood gussets for rubber anchor tube, which is 3/16 O.D. aluminum. It should fit snug in holes drilled in position in gussets shown on plans.

The nose is formed from block balsa, hollowed out to about 1/4 inch wall thickness. The balsa should be carefully contoured to make the transition from the flat fuselage sides and bottom to the oval 1/32 plywood bulkhead (A). There are two of these, one being cemented to the back of the removable prop assembly. The one cemented to the fuselage has a square aperture which receives the 1/4 inch thick indexing plug cemented to the back of the prop assembly.

If you intend to incorporate folding wings on your model, it will be necessary to cement 1/32 I.D. aluminum tubes in place inside fuselage uprights immediately below spar stations. These act as hinge bases, and receive hinge pin saddle (W1). The front one is withdrawn to fold wings, the back one remaining in place unless you want to completely remove the wing panels. Folded wings are kept from swinging by a short piece of wire that bridges the gap between the two trailing edges and plugs into tubing set in trailing edges immediately aft of aileron control horns.

Wing struts are made of plastic soda straws, slightly flattened to streamline shape, and plugged at each end with hard balsa. A 1/32 dia. wire is epoxied in the balsa. The wire engages tubing in the wing to effect attachment. At the base of the front strut, a hook-shape wire engages an "eye" soldered at the apex of the landing gear strutting. The bottom of the rear strut utilizes an aluminum "tongue" with a hole drilled in it to receive the pin which locks it to the aluminum anchor set in the fuselage. This allows strut to swing when wing folds.

The easiest way to set dihedral is to attach wings to fuselage with wire pins, prop up wings, attach struts at bottom and establish dihedral with temporary support, slip tubing over upper wire ends and carefully apply epoxy to tubing. Press tubing to spar underside in correct position. When epoxy is set, the entire assembly may be taken apart. Note that the tubing in the wing has a balsa "surround" to allow tissue to be cemented.

The cabin is glazed with .005 clear acetate. The top "skylight" has structural support under the glazing. Four strips of 1/32 silver tape are applied on the plastic (running fore and aft) to simulate separations.

The cylinder covers on the real Hawk Moth had the appearance of being bent by hand. This may be the case, as there was only one prototype made. On our model, these are bent from thin aluminum. A 3/4 inch diameter dowel serves as a form. The rear part of these is teardrop shaped, made of soft balsa. The Ghost engine was a V8, but only the front cylinders are visible through the scoop-like cowling front. Make these from Williams Brothers 3/4 inch scale universal cylinders, on which are added four cooling fins and simulated rocker arms. Cement these in place before attaching cowling covers. Note that

cowling covers have four circular cut-outs on the sides which allow passage of simulated exhaust collectors to main pipe.

The exhaust pipes are made from (yep) soda straws. Bent portions are from balsa or reed. The pipe on the starboard side bends behind the engine, across what would be the firewall, and into the main pipe. Note that diameter of the main pipe is reduced about halfway back. An authentic appearance can be had by spraying all pipes with silver enamel, and while still wet, spraying lightly with black. The two colors become mottled. You can further enhance the worn metal look of both exhaust pipes and engine cylinders by rubbing with powdered graphite. Attach exhaust pipe with three wire brackets cemented to fuselage side after covering and doping.

Bend landing gear components from 1/32 diameter music wire. Bind joints with fine brass wire and solder. All struts except oleo have (yep, again) soda straw "sleeves" pressed to streamlined shape, to bring them to more nearly correct scale appearance. Balsa may be substituted if you don't drink soda.

Wheels on the DH 75 had rather distinct appearance, having a somewhat exaggerated angle to the outer spokes. The main wheels are turned from laminated balsa discs. A recess on the outer side receives the spoke assembly, fabricated separately. It is made of a 1/32 balsa disc on which spokes are glued.

Cement two pieces of medium-hard 1/4 inch thick balsa together. Grain should run at right angles. It is well to cut wheels to a rough 2-3/4 inch diameter. Cement a 2 inch length of 1/4 inch diameter birch dowel in center, letting about a 1/4 inch protrude. Chuck the long end of the dowel into a drill motor or lathe chuck. Turn down the wheel to correct diameter (2-1/2 inch) and contour with progressively fine sandpaper. Cut off portion of dowel that served as handle. Fabricate spoke assembly. When complete, slip this over the 1/4 inch remaining dowel to form outer part of wheel. The spoke assembly has a thin card stock rim to act as a rim to which the tissue covering is cemented. It is easier and neater to cover this before slipping it onto main wheel.

Coat wheels with three coats of sanding sealer. Simulate tires with flat black paint, or for better simulation, use a coating of "Plasti-Grip", a rubber-like vinyl goop available at hardware stores to insulate electrician's tools. This stuff is messy, but it looks like tires when you get done, and it offers resilient protection for the balsa wheels. It can be thinned and cleaned up with naptha.

Drill a 1/32 diameter hole in the center of the birch dowel hub, and slip in the axle. Solder or epoxy washer as retainer.

The unusual fenders which prevented mud from English airfields from being thrown into the revolving prop, are cut from thin aluminum and epoxied to thin wire supports, which are soldered to the main landing gear strut base.

PROPELLER

The 14 inch diameter prop is made by cutting four pieces of 1/64 plywood (2 pieces for each blade), using pattern shown. Lay up each blade by cementing two pieces together and binding to a 5 inch diameter cylinder. Angle blades at about 15 degrees from cylinder centerline. See sketch. A discarded tobacco can or similar container works fine.

Cut 3/8 inch diameter birch dowels for hub. Slot ends to receive finished blades. Taper dowels on slotted ends. Cement blades in slots, being sure blade centerlines parallel dowel sides.

The laminated spinner can be turned in the same manner as described for the wheels, leaving the hardwood dowel core. You should start with an accurate cube which can be placed on the drill press table and drilled with a 3/8 inch bit to provide for insertion of prop hubs.

Insert blades in finished spinner, angling each to 30 degrees at hub for blade pitch. Check for alignment and consistent pitch between blades. Cement in place.

Now cover front of blades and hubs with 1/32 inch medium sheet balsa. This cover should fit neatly where blades enter spinner. Trim and sand to airfoil cross-section. Stain entire prop mahogany color and give three coats of sanding sealer followed by two coats of clear nitrate dope, sanding with 600 grit wet-or-dry between coats. Finish off with brown shoe polish.

The free-wheeling device is made from two thin brass discs which have been slotted from the center out. Bend coinciding tabs in each to form a dog clutch. See drawing. The front disc has balsa spinner cap epoxied on after the 1/16 diameter prop hook has been soldered in place. Assemble prop/nose block parts, being sure to use roller thrust bearing between spinner and nose block. You should wind up with about 2 degrees down thrust when the prop assembly is inserted in fuselage.

WING

Main ribs are made up by laminating top and bottom components around cardboard or balsa forms. Soak 1/32 x 1/16 basswood and balsa strips in hot water for about half-an-hour. The strips should be about 8 inches long. Cement the bass part on top of the balsa and pin against the airfoil form. Make 20 ribs.

When all ribs are complete, position bottom rib components over wing plan, holding in place with plastic "Pin-Downs" which prevent having to pierce balsa with pins. Trim surplus from front and back of ribs to allow accurate contact with leading and trailing edges. Cement these, and front and rear spars, in place. Establish proper chord width for top rib parts, trim these parts and cement in place. Cut the 16 false ribs from hard 1/32 sheet balsa and cement in place.

Wing tips are laminated from two pieces of 1/32 x 3/32 basswood, soaked and wrapped around form. When these are thoroughly dry, cement in place.

The spar stubs protrude from the wing root about 3/8 inch and incorporate 1/32 I.D. aluminum tubing as part of the wing hinge. See detail on drawing. The tubing is reinforced with 1/32 plywood "cheeks" which are cemented to spar sides.

The wing root is filled in on the top with soft 1/4 inch sheet balsa and a small block forward of the front spar. Note rounded appearance in front view. Contouring should coincide with plywood root rib R1 on fuselage.

Simulated fuel tanks may be made of stiff artist's paper cemented inside top ribs as shown.

Finish off entire wing with progressively finer sandpaper. Check for any lumps of cement that will cause a less-than-perfect covering job later on. Give wing root three coats of sanding sealer.

TAIL ASSEMBLY

The vertical fin and horizontal stabilizer outlines are of two pieces of 1/32 x 1/16 basswood in the same manner as wing tips. The bones of the vertical fin are 1/16 x 3/32 balsa. Sand ribs to streamline section. Spar is long enough at bottom to penetrate fuselage and cement to cross-piece in fuselage bottom. When covering fin, note that a portion at the bottom is left uncovered so as to be able to adjust stab incidence. The sheet balsa tab in the rudder provides a method of adjusting for turn.

The horizontal stabilizer utilizes "sister" ribs in its construction. The idea of this is to bury the spar in the ribs, which results in a neater covering job. Cut ribs as shown. As cut, they will have one flat side. When joined side by side on spar, they result in a symmetrical airfoil section. The 1/16 square top spar was added after stab was completed. You may want to follow the more conventional method of cutting single ribs and notching for spar.

Using either method, arrange ribs on spar and cement in place. Cement basswood laminated outline in place. When cement is dry, sand to correct airfoil. Note that balsa filler pieces have to be added where elevator turns into fuselage/fin junction, to bring thickness to right cross-section. See drawing.

Master West Coast scale modeler, Bill Warner, advanced a theory some time ago in an article in the Flightmaster's newsletter, regarding superior efficiency of thick symmetrical stabilizer airfoils. The idea is to minimize the need to enlarge the stab plan excessively from scale. Our model tests this theory, as the stab is only about 10% over scale, but thicker in scale than the real one. The end result has been quite satisfactory.

Alteration of incidence in the stabilizer is made possible with the incorporation of a tube-and-wire hinge immediately behind the leading edge. The tube cements to the stab, the wire to fuselage longerons. Stabilizer is held in weak compression to top of fuselage by rubber band attached to hook cemented to stabilizer underside. The hook/rubber band assembly is entirely inside the fuselage. This arrangement allows about 3 degrees negative incidence. Merely slip balsa shim between fuse and stab during testing, cementing stab in place after trim has been established.

COVERING

The Hawk Moth color scheme follows information provided by noted English aviation author, A.J. Jackson. The fuselage and wheels are maroon or dark crimson, the wings and tail surfaces, silver.

White Japanese tissue from Peck-Polymers was used on our model. White glue, diluted 50-50 with water, was used as adhesive. Some modelers prefer using dope. Use whatever seems to work best.

There are no difficult areas that require special explanation. Water-shrink all covering. When thoroughly dry, apply three coats of clear nitrate dope, diluted to a 50-50 solution with manufacturer's thinner. Add plasticizer to minimize warping.

The maroon fuselage on our model was colored with Magic Marker "SprayMark", an aerosol propelled dye (transparent) available at better stocked commercial art supply stores. It has one drawback in that it is water soluble after drying, and has to be "fixed" by spraying, not brushing, with at least one coat of clear dope.

Wings and tail surfaces had a final coat of sprayed dope, made silver by introducing fine silver powder (called brill) into diluted clear dope. About half a teaspoon to two ounces is a reasonable ratio. This last coat barely alters the translucent quality of the white tissue, just enough to give kind of a "mother-of-pearl" look.

Cut wing registration letters from black tissue and cement in place with diluted white glue. The white letters on fuselage sides are made by using a 3M photographic transfer product, I.N.T., available at graphic arts supply houses. A cheaper method is to carefully paint the registration or cut from thin bond paper.

MISCELLANEOUS

Cabin interior is painted flat medium gray before covering is applied. The 1/32 sheet cabin sides and bottom should be given several coats of sanding sealer first. Window frames are painted silver, as well as door edges.

All struts are painted a warm silver-gray, to simulate anodizing.

The tail wheel on the real aircraft was light gray, the fork black. The shock strut appeared to have a rubber boot wrapped around it. Simulate this by using coarse black thread.

Aileron, rudder and elevator separations are simulated with 1/32 chart tape or black tissue. Control wires running from horns and the two short lengths immediately behind the cabin, were made from 2-pound test fishing leader, painted black.

Geoff de Havilland's likeness, which is enscounced in the driver's seat, was cut from soft block balsa, dipped repeatedly in sanding sealer and painted with artist's acrylic tube paints. Geoff eschewed helmet and goggles when flying the 75, and seemed to prefer a fedora, which gave him a man-in-the-street look.

Framework photos show thread cross-bracing throughout the length of the fuselage and portions of the wing, between spars. These were incorporated to duplicate original structure as faithfully as possible. The thread is dental floss (unwaxed) which is strong, light and very fine silk. Use Hot Stuff or similar Cyanacrolate glue to adhere.

FLYING

Some models have a "correct" look that suggest testing will be trauma-free. The Hawk Moth is one of them.

The only adjustments made during about a dozen and a half pre-Nats test flights were in the amount of rubber power used, otherwise the model behaved perfectly, without any thrust or rudder correction.

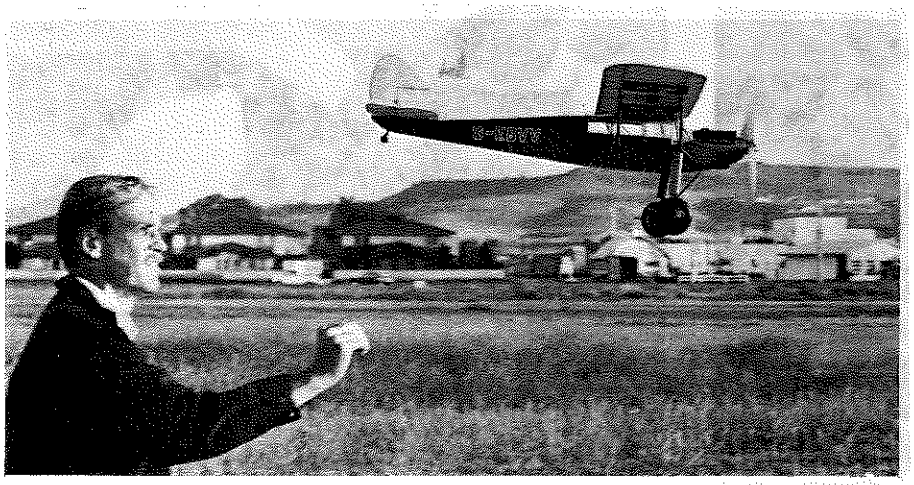
Eight strands of FAI 3/16 brown rubber, 30 inches long, gives marginal performance, so the number was increased to ten, which boosted the duration and altitude considerably.

Using a protective winding tube, the most turns we have tried is 900, before breaking out in a sweat. This gives an average flight of 48 to 50 seconds, consistently.

We modified a rechargeable cordless Black & Decker drill into a field winder, adding a counter. This has some advantages over a conventional manual winder, and some drawbacks. You can keep absolute track of turns, even if someone engages you in a conversation about the lift coefficient of the Eiffel 400. Also, if called upon, you can wind with one hand, leaving the other free to check rubber tension, drink beer, or congratulate the competition. You have to remember to charge the unit before the contest, otherwise you run out of electricity.

Also, you can't pack 2000 turns into 14 strands of 1/2 inch Pirelli, because when you release the trigger, the rubber torque turns the drill so fast in reverse, you end up holding a generator!

The Hawk Moth is a rugged and reliable modeling subject that incorporates most of the attributes sought for flying scale. It will provide you with many pleasurable building and flying hours. Good luck! •



Bill does some test-gliding. We agree with his philosophy . . a model that looks "right" will fly "right". The Hawk Moth is no exception to this . It placed 5th at the 1977 Nats.