

## Electric-powered British fighter



DeHavilland

# HORNET



### S P E C I F I C A T I O N S

**Type:** Sport-scale twin electric  
**Wingspan:** 58 inches  
**Length:** 48 inches  
**Wing area:** 600 square inches  
**Wing loading:** 24 ounces/square foot  
**Power:** 2 Astro geared 05 cobalt motors; 15 to 18 Ni-Cd cells  
**No. of channels req'd:** 4 (elevator, rudder, aileron, throttle)

**Features:** easy battery-pack installation/removal from the assembled airplane (through the nose); positive battery-pack restraint designed into the fuselage structure; balsa/ply sandwich construction for high strength-to-weight ratio; molded papier-maché for light nacelle fairings.

**Comments:** this is a good-looking sport-scale model of the twin-engine Hornet fighter; variation in power and flight duration available with unique battery installation; good takeoff, flight and landing characteristics.

by ROY DAY

**T**HE OPERATIONAL success of the Mosquito Bomber was the basis for the development of the deHavilland 103 Hornet. The Hornet was conceived as a long-range, high-speed fighter that would be capable of combating the Japanese in the South Pacific during World War II. To satisfy the requirements for long range and high speed, the Hornet combined the ultimate in streamlining with twin 2,000hp Merlin engines. While the Hornet reminds one of the Mosquito and did benefit from that successful airplane, it was, in fact, a completely new design.

The first prototype flew in July 1944, only 13 months after detail design had begun. The prototype's climb and speed were exceptional. It reached 485mph—a

record for prop-driven airplanes.

Production and delivery of Hornets to the RAF did not begin until February 1945, so the war in the Pacific ended before Hornets could participate. They did, however, see considerable action as ground-attack fighters against the Malayan terrorists in 1951 to '54.

The Hornet was the last piston-engine airplane of the deHavilland line. Considered by many to be the ultimate in fighter design, it is unfortunate that not a single one has been preserved.

### WHY A TWIN?

As a number of designers and builders have said, the electric-powered model is ideally suited to twins because there's no danger of "one engine out." The arrange-

ment of the two motors in series ensures that both are always powered.

Once it has been decided to model a twin, there are countless possibilities, from civil transports to bombers to long-range fighters. Few are modeled with gas engines because of the dreaded "engine-out" syndrome. For those who are interested in building electric twins, I strongly recommend Keith Shaw's article in the December '91 issue of *Model Airplane News*. Keith is a superb scale modeler and has been designing and building electrics—many of them twins—for years.

I selected the Hornet because it's aerodynamically clean and has very pleasing lines. It's well-proportioned for scaling as a model. The long engine nacelles and the sharply tapered wings give it a distinctive appearance in flight. The tapered wings are, however, a little more trouble to build, and washout is essential to avoid tip-stalling. The sleek configuration with adequate power provides a stand-off-scale model that performs well.

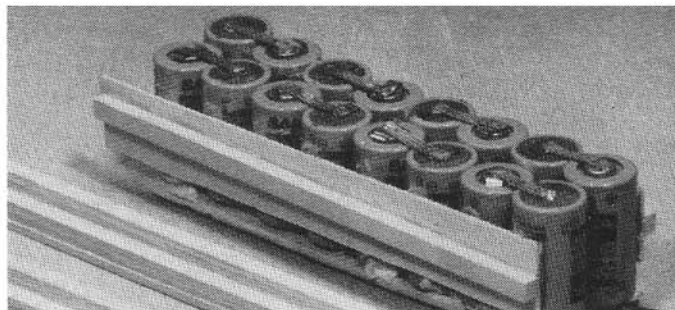
**DESIGN FEATURES**

- Easy battery-pack installation/removal from the assembled airplane (through the nose).
- Positive battery-pack restraint designed into the fuselage structure.
- Balsa/ply sandwich construction for high strength-to-weight ratio.
- Molded papier-maché for light nacelle fairings.

**SIZING THE MODEL**

**Power system.** The Hornet uses two of the popular size of electric motors—the AstroFlight\* geared 05 cobalts. Following discussions with Bill Young, Scale Electric editor of *R/C Scale Modeler*, it was decided to use iron stator rings on the motors. The stator rings increase efficiency by completely containing the magnetic field. The rings are very thin and weigh less than 0.5 ounce each. They are inexpensive and can be bought from Hobby Lobby\*.

On a test stand, using nine cells, I tested a single geared 05 with and without the iron rings. I



*The battery-pack cells are glued together with silicone and held in the fuselage with a rail-and-channel system.*

measured current draw and rpm. With the stator rings, the motor showed about a 15 percent reduction in current draw with hardly a measurable drop in rpm. This current reduction translates into longer flight times.

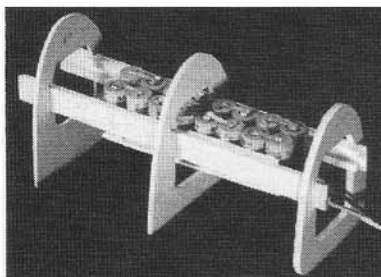
As long as the current is kept below 30 amps (the limit of the brushes), nine, or even 10, cells are acceptable with the 05 cobalt motors.

Based on these considerations, the power system is designed for 18 cells, and there's room for more if needed.

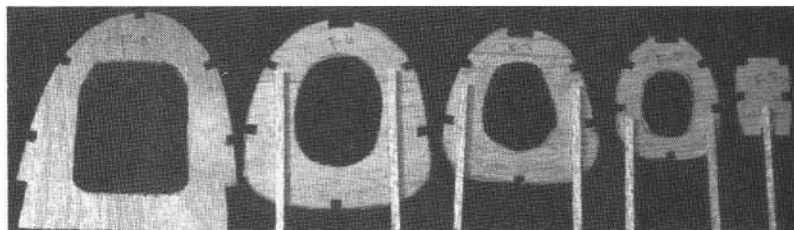
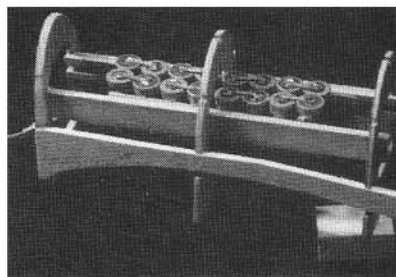
**Weight and wing area considerations.** The general rule in electric-airplane design is to aim for an all-up flying weight of not more than twice the weight of the power

system, i.e., the batteries and motors.

Working from three-views, the design was scaled to this wing area and the detailed construction plan drawn.



*Left: The rail-and-channel battery-support system is the "keel" of the fuselage, and this is where the construction begins. Right: The strong, light, fuselage center section has formers made of cross-laminated balsa with 1/64 ply doublers.*



*Temporary jigs of 1/8-inch-square balsa are glued to the aft fuselage formers to raise each one to the correct height for assembling the fuselage.*

**HORNET WEIGHT AND WING AREA**

**FLYING WEIGHT** = 2 x weight of power system

**POWER SYSTEM WEIGHT:** Two geared 05 cobalt motors = 16 oz  
 Eighteen 1200mAh cells = 36 oz\*\*  
 Total = 52 oz

Therefore, The maximum all-up flying weight should be:  
 2x52 = 104 ounces or 6.5 pounds.

For the Hornet, a wing loading of 24 oz/sq. ft. was chosen.

$$\begin{aligned} \text{Wing area} &= \frac{\text{weight}}{\text{wing loading}} = \frac{(104 \text{ oz})}{(24 \text{ oz/sq.ft.})} \\ &= 4.33 \text{ sq.ft.} = 624 \text{ sq. in.} \end{aligned}$$

For the design, the wing area was rounded to 600 sq.in.

\*\*A weight of 2 ounces for each 1200mAh cell was used for the design. An actual cell weighs closer to 1.8 ounces, but the rounded-up number allows for wiring, connectors, etc.

**CONSTRUCTION**

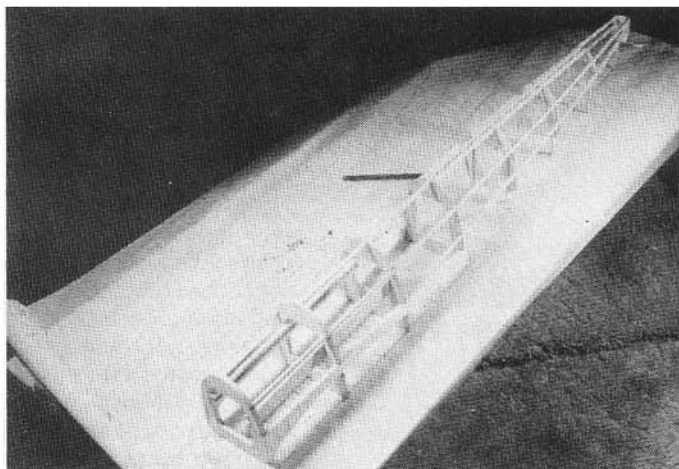
Attention to weight is crucial in electric-airplane construction. Use 6- to 10-pound/square-foot balsa wherever possible, except where something else is specified. Except for the ply doublers over balsa, use plywood/hardwood only in high-load areas such as the landing gear and the wing mounts. Minimize the use of epoxy; thick and thin CA should do the job with few exceptions. Covering can be any light film. I used Coverite's\* Micafilm because it's light and strong.

You will need a number of templates; SeeTemp\* material is easy to use.

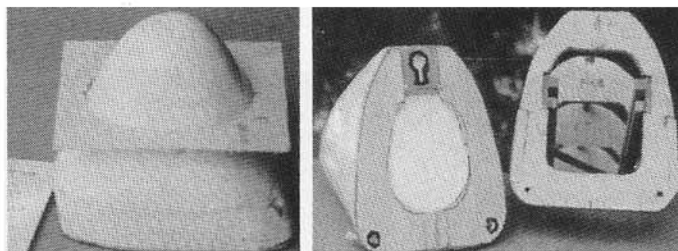
• **Fuselage.** Often, battery-pack

accommodation is the last thing considered in the construction of an electric-powered airplane. For airplanes with a dozen or more cells (1 1/2 pounds of concentrated weight), I am convinced it should be the first consideration. That is how the Hornet design and the fuselage construction begins.

The fuselage's narrow cross-section will barely accommodate a 1200mAh battery pack. The most compact way to install it is by using a sliding-rail system. This rail arrangement holds the battery pack securely and allows quick installation through a removable nose. In addition, it



The fuselage is built over the plan with the temporary jigs on the formers. When the longerons have been glued, the jigs are cut off to leave a light, strong structure.



Left: the nose is made of white foam and shaped using templates. Coat it with laminating epoxy resin to give it a hard, slick finish. Right: the "quick-disconnect" nose allows easy access to the battery pack. Two 8-32 nylon bolts hold it at the lower corners, and a third bolt slides into a keyhole slot at top center.

serves as a sort of "keel" for the fuselage and strengthens a high-load area. The batteries are glued together with silicone adhesive. If you can't make a pack at this time, then you should make an accurate mock-up so you can fit-check the rail assembly as you build the fuselage.

Now is the time to make the formers. For maximum strength and low weight, the formers are a sandwich of 1/64-inch-thick plywood and 3/32-inch sheet balsa. Refer to the table on the plan for the make-up of each former. Cross-laminate the sheet balsa at about 45 degrees, and then glue on the plywood. Then cut out the formers with your scroll saw. The composite formers are quite strong, yet light.

The entire fuselage will be built over the datum line at the bottom of the plan. Assemble the three formers and the two battery-pack channels, but don't glue them together. Check that the battery pack will slide freely, and then glue the assembly,

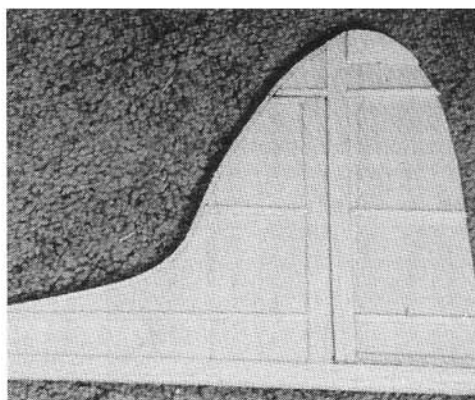
ensuring that the formers are vertical and centered on the datum line. Next, glue in the 1/4-inch sheet-balsa wing saddle.

The Hornet has a so-called "bent fuselage," so the remaining formers must be jugged up to the correct height above the datum line. Use 1/8-inch-square balsa as temporary jigs for each former. Glue in the top and upper

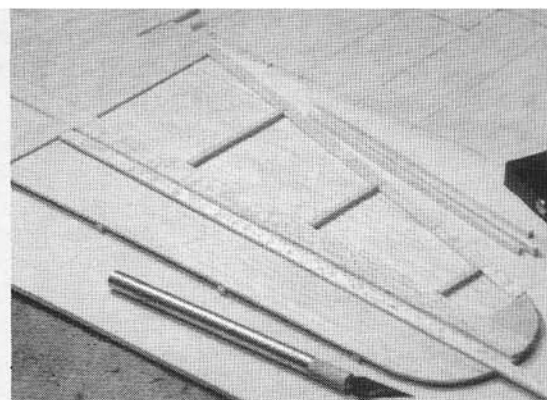
longerons to the first three formers. Then install the remaining formers, being careful to keep them centered on the datum line to ensure a straight fuselage.

Because the entire tail assembly is removable, I chose to make a tail wheel that has an internal tiller arm connected to the rudder servo. Use 1/16-inch-thick music wire inserted into a brass tube

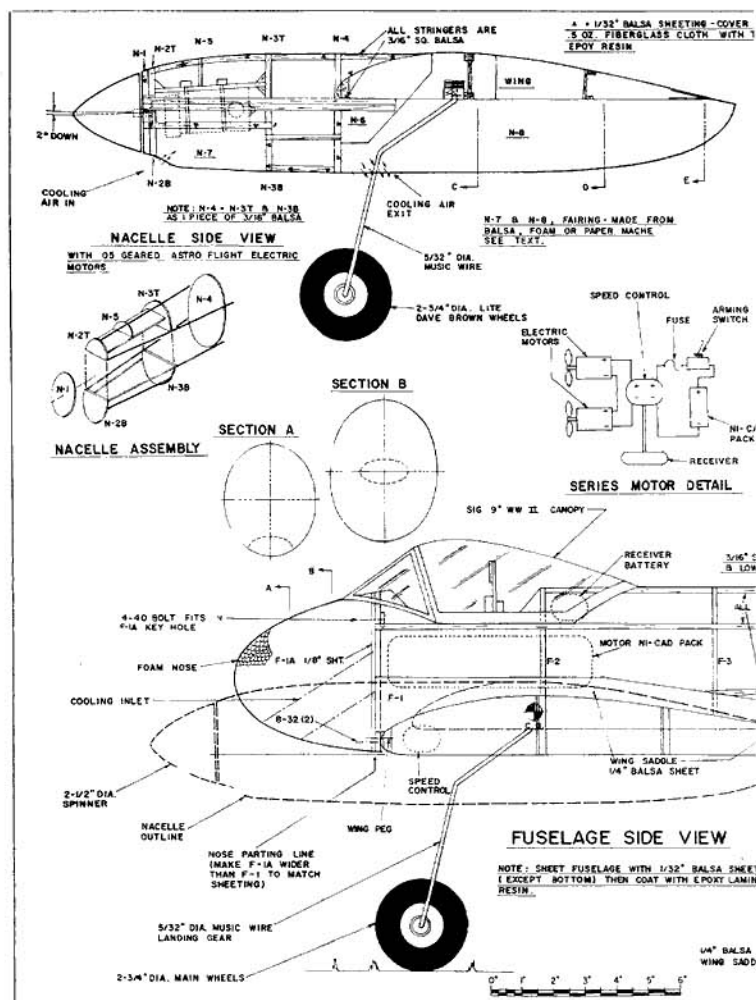
that's held by 1/16-inch-thick plywood supports between the upper and lower longerons. Install your choice of pushrods before sheeting the fuselage with light 1/32-inch balsa sheet. To save weight, the bottom is not sheeted. The 1/32 sheet is easy to mold to the shape of the fuselage, but it is not rigid enough to prevent handling damage. I there-

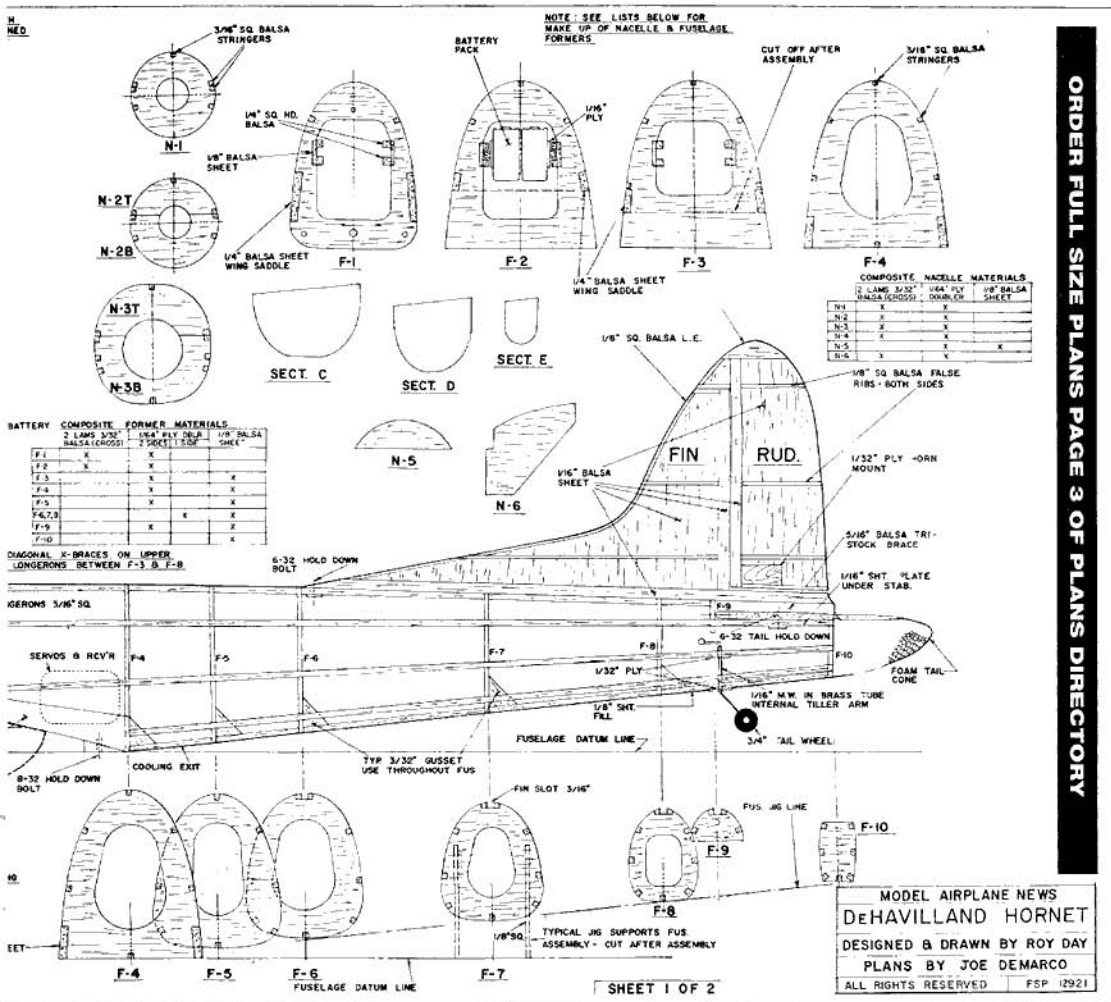


The light, strong, tail surfaces are made with a center core of 1/16 balsa sheet and false ribs on each side.



Build the horizontal tail as one unit. After sanding to the final shape, cut the elevator away from the stabilizer.





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fore applied one coat of thinned laminating epoxy (without cloth) to stiffen it.

Next, finish the cockpit with a pilot figure (I chose a Williams Brothers\* standard pilot), then fit and install the canopy. The canopy must be in place before the removable nose is shaped because the nose slides up into

place under the front of the canopy.

Using templates, shape the nose out of white foam. Use a filler like Goldberg's\* Model Magic to fill any rough spots before you do the final finishing. To allow speedy removal, the nose has a three-point attachment. Two 8-32 nylon bolts at

the lower corners hold it on the front former. A third bolt at the top center fits into a keyhole slot in the nose. Cut away about 3/4 inch of the foam at the two bottom corners, and install a short piece of tubing set in epoxy (to which you've added a filler to make a slurry). This will strengthen the corners where the

8-32 bolts hold the nose on the front former. Install threaded 1/8-inch-thick plywood blocks on the back of the front former to take the bolts. Use a 4-40 or a 6-32 bolt for the top nose attachment. This bolt is threaded into the front former (F1), and it protrudes about 1/8 inch to engage the keyhole slot in the nose.

To attach the nose, run the upper bolt through the keyhole slot, slide the nose up under the front edge of the canopy, and insert the two lower 8-32 bolts.

Put the fuselage aside now and move on to building the tail.

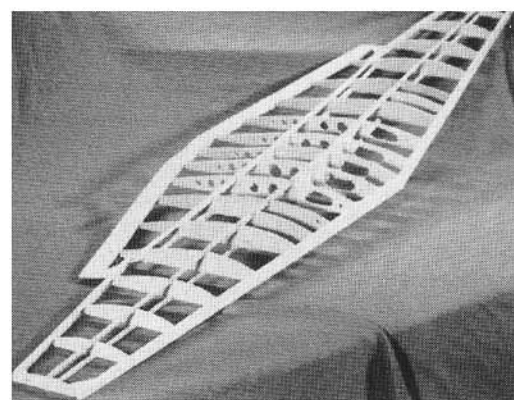
• **Tail.** I prefer removable tail assemblies. They make it easy to adjust the angle of incidence, and they simplify plane repair and transportation. Both the horizontal and vertical tails are built with 1/16 balsa sheet as the core.

Use your SeeTemp to make a template of the entire vertical tail. Cut the core out of 1/16 sheet, and glue on the 1/16 spars, 1/8-inch-square false ribs, tip cross-laminations and the strip along the base. Turn the tail over and repeat the process on the other side. Shape the leading edge and the ribs before you cut the rudder and fin apart. Cut lightening holes if you like (I didn't).

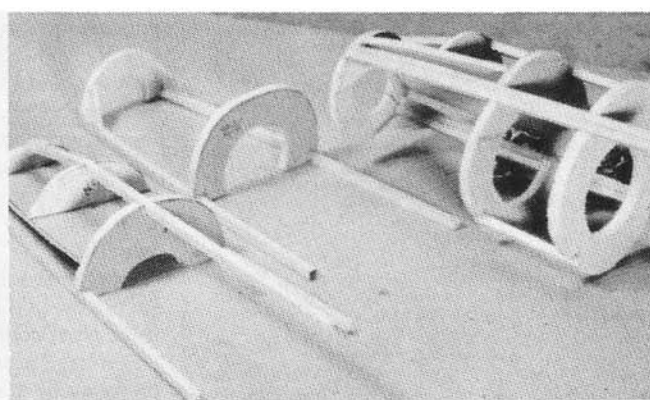
Build the horizontal tail in the same way. Bolt the stabilizer to the fuselage, and align the fin with the stab and then glue them together. Put a piece of triangle stock on each side of the fin where it sits on the stab to strengthen the glue joint. At the forward end of the fin, drill and tap the attachment points for the 6-32 hold-down bolt. The completed tail assembly should weigh 1.5 to 2.0 ounces.

• **The wing** is built over the plan. Before you glue in the ribs, remember to drill holes in them for the plastic-straw wiring conduit and the flexible aileron pushrod.

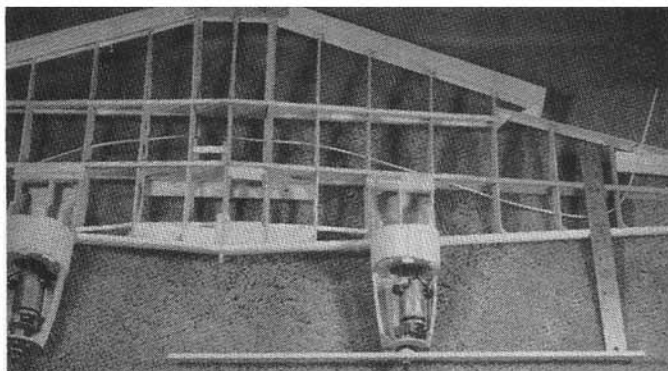
Lightening holes in the ribs reduce weight and also allow access to the wiring from the



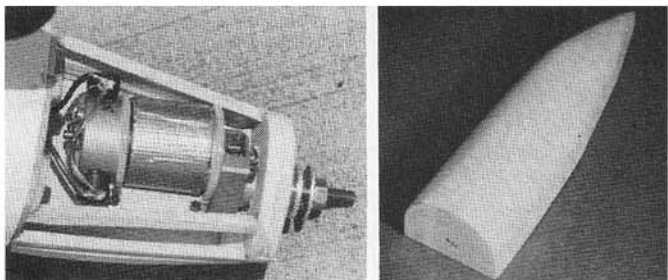
The thickness of the wing at the root, combined with the spruce spars, makes the wing strong enough without sheeting. Without the nacelles, the wing should weigh about 8 or 9 ounces.



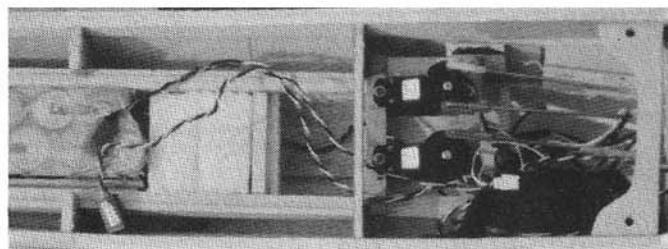
Build the nacelles in halves; join the halves; glue them to the wing. The nacelles have to be strong because they hit the ground in a nose-over.



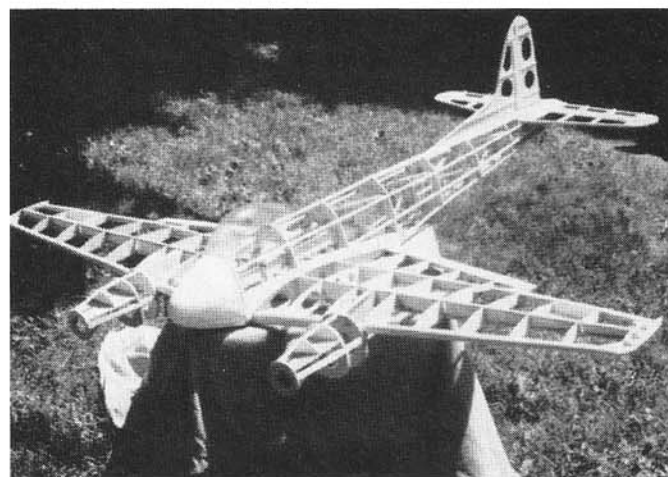
Using the spar as a guide, align the motors so they point straight ahead. There's no need to skew the motors, because there's no danger of an "engine out." The motor-mounting plate in the nacelle gives a 2-degree downthrust.



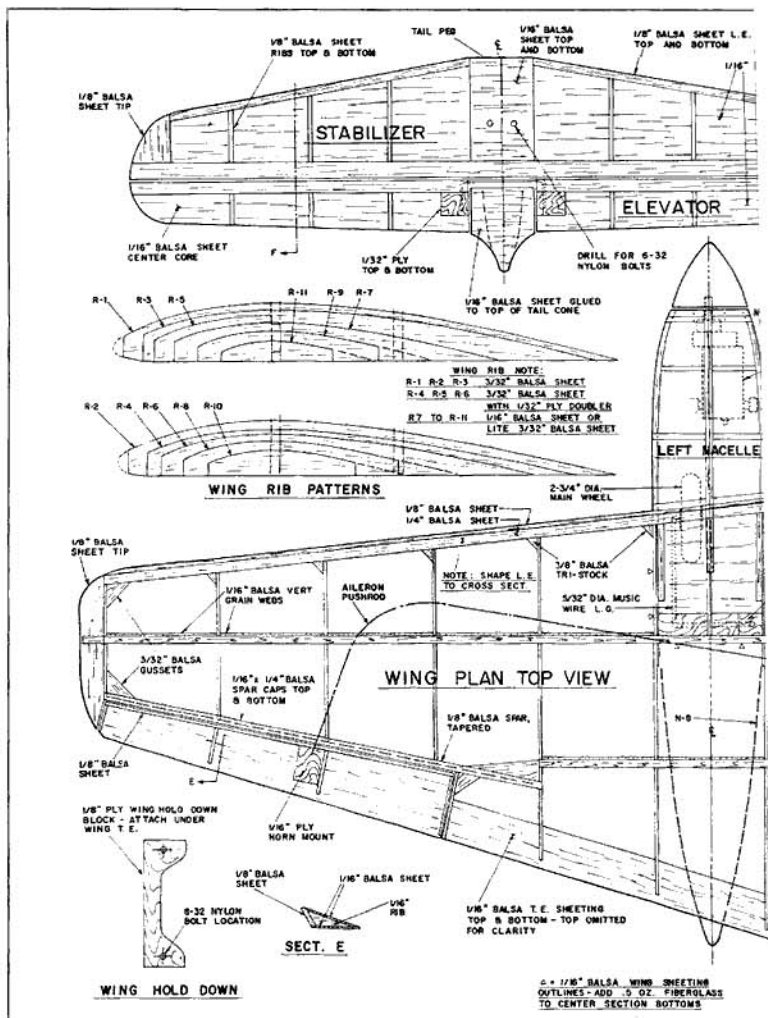
Left: the motors are reached through the bottom of the nacelle. They're firmly held in a vee-block mount with inner Nyrod straps. Right: the mold for the aft nacelle fairing is made of shaped blue foam. The papier-mâché fairing is made with three layers of paper strips that are soaked in a water/glue mixture and then put on the mold to dry.



To minimize interference from the power system, radio equipment is installed as far aft as is practical. Note the battery pack installed in the sliding-rail system.



The Hornet's built-up structure is light (only 19 ounces) and strong.



arming switch and the speed controller.

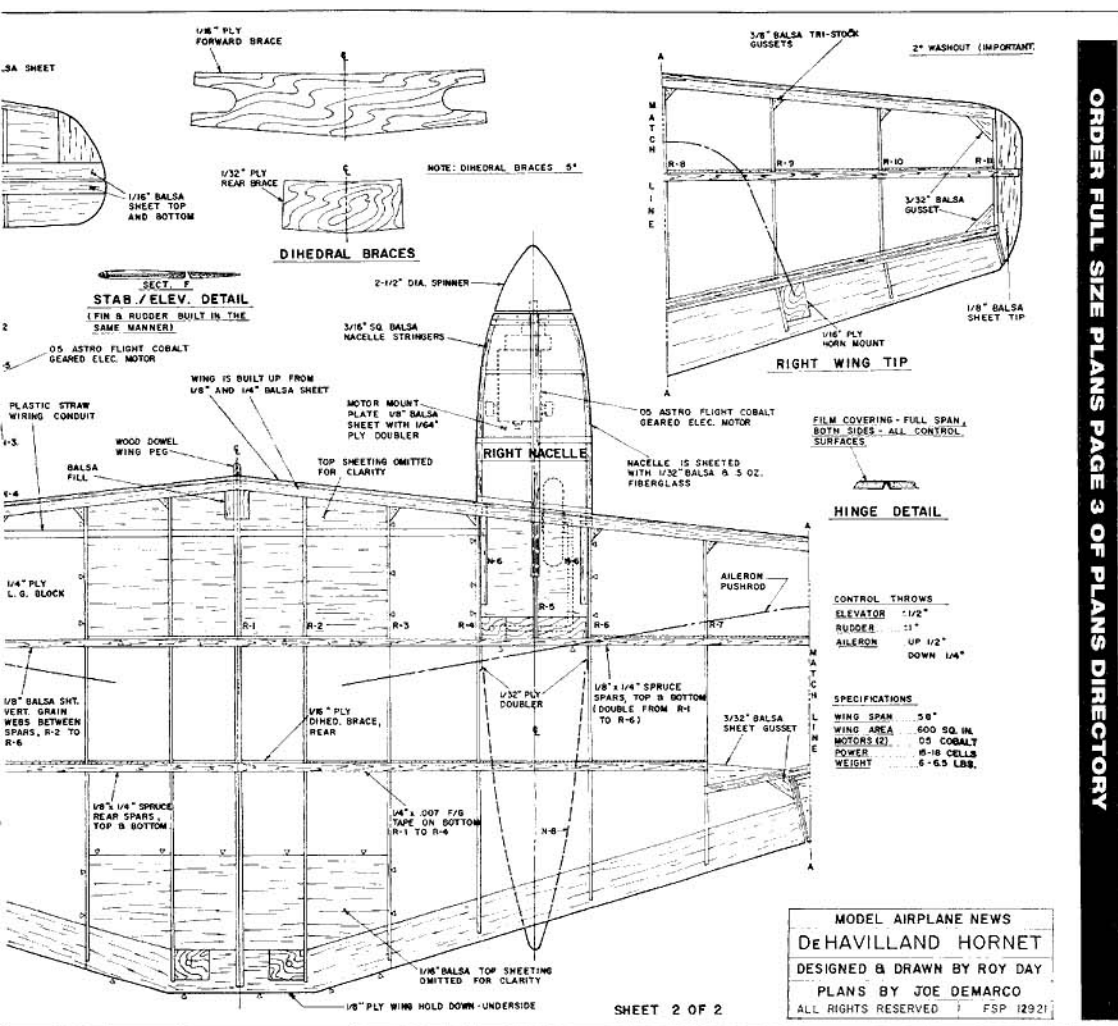
Join the two wing panels with the dihedral braces to give 5 degrees dihedral. Using thin CA, put 1/4x0.007-inch fiberglass tape on the bottom of both spars. (I use Future Flight\* tape.) The completed wing should weigh about 8 or 9 ounces.

This wing is thick at the root, and the spruce spars provide enough strength without any sheeting. When the nacelles are in place and the motors have been installed, however, the wing is very nose-heavy. To prevent handling damage, therefore, a section of the center of the wing is sheeted on the bottom, fore and aft.

• **The nacelles** on the Hornet are the first things that hit the ground if the plane noses-over. There is no fuselage nose to protect the props, so the nacelles are built stronger than would be necessary for a more conventional twin.

Build the nacelles over the plan using the horizontal-crutch method. The upper and lower sections are built separately and then joined. The material for the composite formers is given on the plan. The motor-mounting plate is angled to give 2 degrees of downthrust. Align the nacelles on the wing with 0 degrees of side thrust and 0 degrees downthrust so they're level and pointing straight ahead. Because we are not concerned about the loss of one motor, there is no reason to skew the thrust lines outward.

Install the motor and check the thrust alignment. The motors are secured with inner flexible-pushrod material and short sections of threaded rod. Solder small tabs to the end of each threaded rod, and use 4-40 bolts threaded into blocks on top of the motor-mounting plate. This will allow the motor to be installed or removed through the opening in the bottom of the nacelle. Sheet



the nacelle with 1/32-inch sheet balsa, and cover it with thinned laminating epoxy resin and 0.5-ounce/square yard fiberglass cloth.

All that remains now is the building of the chin cowl (N7) that covers the motor access and the long fairing (N-8) that

extends back to the wing trailing edge. These are fairings only; they carry no loads, and should be made as light as possible of balsa, foam, formed plastic or papier-maché (my choice). Here's how they're made.

Out of blue foam, make male molds in the shape of the chin

cowl and the long fairing. Fill the foam as required with Goldberg filler, and then finish it with a coat of laminating epoxy resin to give it a hard, slick surface.

Now cut some brown grocery bags into 3/4x8-inch strips, and then soak the strips for a few minutes in a solution made of

one part water to three parts aliphatic-resin glue.

While the strips are soaking, apply a couple of coats of paste wax to the foam molds. Then lay the paper strips diagonally over the mold, alternating the direction of each layer. Three layers will be enough.

Allow the paper to thoroughly dry (about 24 hours). While the fairings are still on the molds, finish with filler and sand the surface smooth. The papier-maché has the qualities of molded plywood; it can be cut and painted as you'd cut and paint any wooden part.

Cut cooling air holes in the chin cowl, and cut an opening for the landing gear in the long fairing. (This will also serve as an outlet for the cooling air.) After the model has been covered, attach the fairings with plastic tape. (See the July '92 issue of *Model Aviation* for an article by Day and Mecklenburg on how to make papier-maché cowls, fairings, etc.)

### FINAL ASSEMBLY

All that remains is the installation of the radio and the wiring. A Jomar\* SM-4 speed controller is mounted in the wing with its heat sink on the bottom surface. The arming switch is installed on the top surface of the wing near the cockpit so that it can be reached from behind—out of danger of the props.

With the arming switch and the speed controller in the wing, only the two battery connections and the controller and aileron

(Continued on page 94)



All that's left to do is the sheeting of the tops of the nacelles and the application of covering.



The electric Hornet has the same sleek lines as the full-scale deHavilland fighter.

servo leads that go to the receiver have to be connected before the wing is attached to the fuselage. With the airplane assembled, install the battery by removing the nose and making the two battery connections through the nose opening. No charge connections are provided because the battery pack should be removed after each flight to allow it to cool before it's recharged.

The plane should now be covered and the other details added. After covering, check to be sure that you have 2 degrees of washout at the wing tips.

### PREPARING FOR THE TEST FLIGHT

Make three important checks before you go to the flying field:

- **Check the CG.** Adjust the position of the battery pack until the plane balances as shown on the plans. Hold the pack in position with foam blocks.

- **Range-check for interference.** Either have someone hold your plane on the ground or secure it with a bungee cord while you check the radio system with the transmitter antenna collapsed. Operate the throttle while you walk around the plane 30 to 40 feet away, and look and listen for signs of interference. I had interference. I resolved it by replacing the receiver with an RCD\* receiver, and by supporting the last 15 inches of the receiver antenna in a plastic tube in a nearly vertical position on the fin.

- **Choose the right prop.** The prop and the number of cells you have will determine the plane's maximum power. To ensure a good performance, you must have 50 to 60 watts of power for each pound of airplane. Use an ammeter to measure the current from the battery for several possible props. Calculate the power as follows:

- Power in watts = voltage x current

- Voltage = number of cells (approximately 1 volt/cell)

- Current = amps, measured at full throttle

For minimum weight on the initial test flights, I used 15, 900mAh cells and 10x8 two-blade wooden props. I measured 25 amps at full throttle, therefore:

Power in watts = 15 volts x 25 amps = 375 watts

At the measured flying weight of 6 pounds, this gives a power-to-weight ratio of:

$$\frac{375}{6}$$

6 = 63 watts/pound

This is more than adequate but, of course, I knew I could throttle back once airborne.

### FLIGHT PERFORMANCE

It was a calm October morning when I decided to make the first test flight. With its excellent power-to-weight ratio and wide landing gear, the Hornet tracked straight down our grass runway and lifted off in about 75 feet. Climb-out was very spirited, and only small trim changes were required. The plane has a very solid feeling, and it looks striking—just like the full-scale airplane.

I was a little concerned about stalling, because sharply tapered wings have a tendency to tip-stall. Apparently, the 2-degree washout does the job, because the Hornet stalled straight ahead with no tendency to fall off on one wing or the other.

Though the Hornet wasn't designed for pattern-type aerobatics, it is capable of aerobatics appropriate for this type of aircraft. On the second test flight, I managed a roll and a stall turn. As I accumulate more flight time, I will expand the envelope.

Landing was straightforward on both powered and dead-stick approaches.

The Hornet twin electric has both the sleek lines of the original deHavilland aircraft and its excellent flight characteristics.

*\*Here are the addresses of the companies mentioned in the article:*

*Astro Flight, 13311 Beach Ave., Marina del Rey, CA 90292.*

*Hobby Lobby, 5614 Franklin Pike Circle, Brentwood, TN 37027.*

*Coverite, 420 Babylon Rd., Horsham, PA 19044.*

*SeeTemp, P.O. Box 105, Sussex, WI 53089.*

*Williams Bros., 181 Pawnee St., San Marcos, CA 92069.*

*Carl Goldberg Models, 4732 W. Chicago Ave., Chicago IL 60651.*

*Future Flight, 1256 Prescott Ave., Sunnyvale, CA 94089.*

*Jomar, 2028 Knightsbridge Dr., Cincinnati, OH 45244.*

*Control Development), 9419 Abraham Way, Santee, CA 92071.* ■