

Spruce Goose



PLAN AND CONSTRUCTION BY: **ROBIN ANDREW**

An eight engined scale model that is of simple construction and so easy to fly

Why?

Robin Andrew loves to build and fly something different. Regular readers will have seen in the four and a half years during which this magazine has been published, several scale models of his, often of unusual original subjects. Robin is a quick builder; he uses a very similar construction technique whatever the subject and he does not get bogged down with a lot of intricate scale detail - he

would rather be out there flying. He builds several 'stand-off scale' models each year and for the past two years has been fascinated by multis. He has built fours, sixes and this eight, all powered by Speed 400. Robin saw the report by Martin Lagerstedt in the March/April issue of *Electric Flight International* of the Hughes that he and his father Christer had designed and built and upon learning that there was no plan available, was inspired to design his own.

The Real One

The real Spruce Goose like so many big military projects was not needed by the time it was finished, or in this case, not needed long before it was finished. In 1942, Allied shipping in the North Atlantic was at the mercy of Axis U-boats and shipping magnate Henry Kaiser persuaded the USA government to finance the construction of a fleet of giant flying boats for patrol work and long range transport. In order to not deplete materials the entire construction was required to use no 'strategic materials'. In 1942 this was aluminium and at that date the only alternative was wood.

In 1944 the project was cancelled, the requirement was no longer there, the US government cancelled the fleet but would

Hughes H-4 Hercules Specification

Specifications:

WINGSPAN:	320" (98m)
TAILPLANE:	113" (34m)
LENGTH:	219" (67m)
HEIGHT:	79.3" (24m)
ENGINES:	8 x Pratt & Whitney R4360, 3000HP
PROP	
DIAMETER:	17" (5.2m)
WEIGHT:	200 tonnes

The Model

I designed and built this SPRUCE GOOSE in the spring of 1997 and flew it at several competitions. I drew it from a three view silhouette and only had black and white photographs of the full size on the water so I always felt that it might only be near scale. A big vote of thanks to my friend Dick Comber who supplied accurate drawings allowed me to correct the fin top and tailplane tips and the upward slant of the rear fuselage in order to be nearer scale. As it stands any loss of scale is in the interests of lightening it and reducing the construction time.

Building

I always start on the rear 1/4 sq (6.4mm) longerons and uprights, thus making two sides and placing them upright and joining them at the tail. Using the top view add in the cross pieces and add the plate with a hole in it for the fin LE to go through.

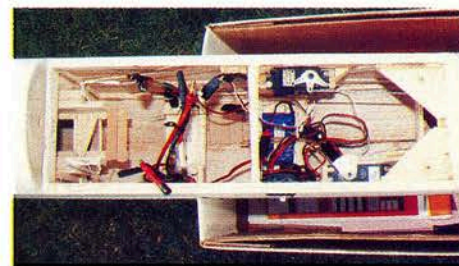
Now cut out the top two sides and then the bottom two sides from 3/32 (2.4mm) hard sheet. Glue them together and add on the 1/2 x 1/8 (13 x 3.2mm) doubler strip making sure it's on the inside. Leave to dry and start cutting strips out 3/4 x 1/8 (19 x 3.2mm) sheet to make formers. Measure each former to get the length and construct them noting that the top formers slot in between the uprights and the bottom cross strips glue across the back of the of the uprights. The keel formers can now be slotted

in like the top ones. When all the front formers are built it is now possible to add the bottom 1/4 sq hull longerons and the top longeron of the rear previously constructed stick fuselage onto the front assembly, not forgetting the 1/4 spruce doubler underneath. When dry add in a few cross strips of 1/4 sq between the top longerons to stiffen the formers and their glue joints. You can now add in the BATTERY 1 inch x 1/8 (25 x 3.2mm) sheet cross strips not forgetting to notch then to strengthen the hardwood rails joints. It is best to make up the 3/8 x 1/4 (10 x 3.2) battery rails next and the front full width 2 x 1/2 (51 x 13mm) front block. When dry add in the 1 x 1/16 (25 x 1.6mm) ply flat plates that support the twin battery packs. Leave the side blocks until later when you have decided which type of batteries you are going to use as they are all different width measurements.

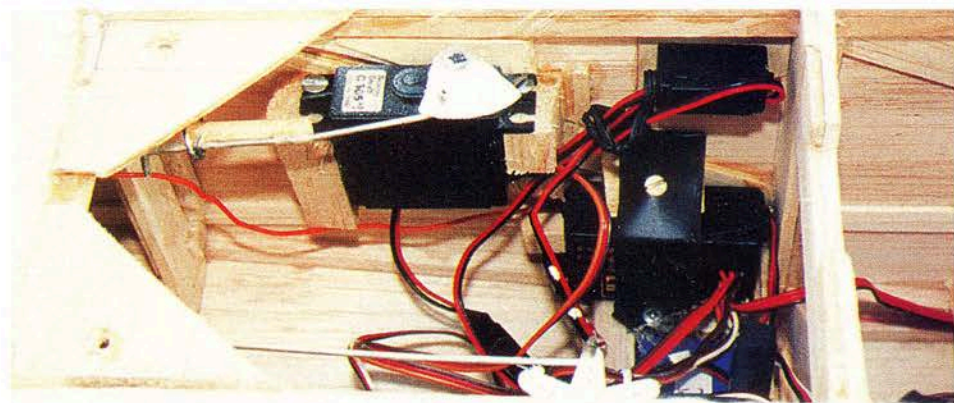
After the keel formers are glued in place it is possible to fit the rear keel and then the front 1/16 plywood keel. After it is dry the rear under formers all the way to the tail can be fitted. Remember the ones directly after the step are V shaped and the flat 3/32 sheet BOAT shaped part can be glue on to these. The rest are rounded and five stringers are fitted along to the tail. Note they are notched into the flat sheet to give strength where the Boat shaped part ends.

Make up a nose block from laminations of medium 1/2 sheet and hollow out a little on the rear in case you need nose weight after the flying boat is built. Fit the front curved 1/4 sq front nose top and bottom longerons from 1/4 sheet. Now it should be possible to fit the front FI former of 1/4 sheet full depth

▼ Below the wing, two speed controllers, Rx battery, two servos and Rx (below switch).



▼ The Rx is securely located below the switch.



▲ The battery packs fit below and forward of the wing seat.

take delivery of the one part built 'HK-1' in 1948. The original \$18 million for three had already been spent so Howard Hughes spent \$7 million of his own to complete the one airplane in 1946. 'Hughes H-4 Hercules' was the official title but its construction of mostly birch and some spruce gained it the nickname "Spruce Goose".

It used eight of the most powerful engines available, 3000HP Pratt & Whitney R4360s, and these were probably not big enough. This aircraft was and is the largest the world had ever seen. The wingspan of 320' (98m) is 50% larger than a Boeing 747. Hughes was determined to prove it could fly and on November 2, 1947, with a small crew and 30 reporters aboard he started the engines in order to conduct some taxi trials around Long Beach Harbor. He later dropped off these reporters, telling them that the first flight was scheduled for 1948 and he needed to conduct one more taxi trial. No-one will ever know what Howard Hughes' true intentions were but with himself at the controls during this next 'taxi trial' Hughes instructed co-pilot Dave Grant to lower the flaps and the H-4 became airborne, lifted 70 feet above the water, flew over one mile, achieved a top speed of 80MPH and made a perfect landing after less than one minute. It must have been an absolutely incredible sight! Hughes had proved that it could fly.

The H-4 was then parked in its climate controlled hanger for more than forty years. Starting in 1992 it was disassembled into 38 sections for removal to its present location at the Evergreen Air Venture Museum, McMinnville, Oregon, USA. This magnificent flying boat is typical of the courage and determination of Howard Hughes, of the conventional establishment opposition to achievement of any novel idea and a super example of what dedication can achieve.

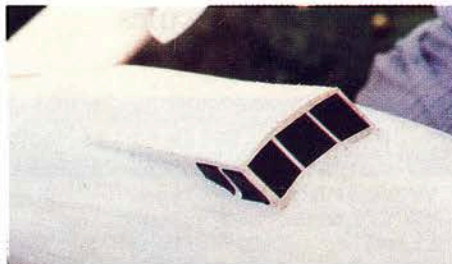
onto these longerons. Later the nose block can be added. Notice that the side sheets do not reach the nose block so leave one side open in case of weight being needed but glue in the other 1/4 sheet panel.

The rear top formers and the top 1/4 sq rail can now be fitted.

In order to work more easily on the fuselage it is possible to make a saddle from a cardboard box about 14 inches long by 8 x 10 (350 x 200 x 250mm). Cut out the ends to fit the hull tightly and place the fuselage into it, whilst construction advances. This is the time to fit the LE plywood doubler so don't forget it.

The top 1/16 sheeting can now be done from four inch (102mm) wide stock. Wet the outside and leave for 15 mins and then start gluing the edge over the top longeron on one side at a time before pulling it over to the top centre line where the top rail sits. This is the method for the front sheeting from the LE and also the back of the TE but with the curved top at the rear, the sheet comes over the side of the top longerons for a good gluing area. Instant glue and accelerator is useful here. The only remaining thing is to plank in the top nose sheet to the nose block and then add the cockpit from scrap 3/32 sheet note the curves. The top of the cabin should be blended in to be level with the top sheeting. Don't forget to add the 3/32 x 1/4 capping strips over the rear fuselage side uprights and bottom longeron as these allow the covering to change from the front sides which are sheet to the rear sticks without a step.

Now you can fit out the hull with the plywood wing TE plate that goes under the top



▲ Cockpit windows are tape or paint.



▲ Engine cowling is a 35mm plastic film can.

longerons for the two wing bolts and the hand grip block low down in the hull in front of the step. It's time to fit the two rearmost tailplane formers in order to glue the rib shaped platform on top of them. When this has been done it is the best time to fit the push-rods as you can see in at the moment. Make up the elevator bellcrank from 1/16 ply and drill it for the 1/8 dowel. Securely glue in

the assembly and fit the pushrods and wires and solder them.

Leave the servo ends of the push-rods with just the wire bent ready so that a better fit can be obtained later. Lastly when fitting the rudder and elevator servos their actual position can be varied so as to get the best operation.

Wings

Start by gluing the fixed 1 1/2 (38mm) TE section root piece to the outer 1/2 x 3/8 aileron spar.

Pin down the bottom spars and also the LE and prepared TE. Make two sets of ribs by the sandwich method and notch them for the spars. Glue them in place and when dry add in the top spars and wing tips.

The 1/16 x 4 sheet LE can now be wetted on the outer side and glued down onto the ribs. Glue in all the centre braces on the first wing and when dry the other wing half can be constructed. When dry it can be offered up to the other half and glued together with EPOXY. When turned over it is possible to add in the 1/2 sq infills for the sponsons at rib 11. They have to have 1/8 inside dia Al or brass tubes inserted for fixings. Whilst upside down I used a piece of wire heated in a gas flame, to burn holes along each rib just behind the LE in order to feed the motor wiring through.

Purchase 3 metres of flat copper loud-speaker wire from TANDYS and start feeding it along. Remember each motor has to have a feed of its own pair of wires and the help is that this wire is coded on one side by a black stripe which I called +. Make small



holes in the LE sheeting and poke a wire through, one on each side of the motor position.

Next make all of the motor 1/4 hard balsa motor vertical formers and glue them in place over the LE between the pairs of wires poking out. The motors are fitted after the wing is covered in light weight nylon and doped with two coats of shrinking dope.

At the centre section construct the aileron servo seat and bearers and try it in for position. The outer aileron bellcranks can now be fitted on 1/16 ply plates next and link them up by a 16SWG run of wire close past the centre servo output disc, remembering there is a little dihedral so an upward bend is needed in the wire at the centre. The servo is removed and a short link of bent wire is soldered in place in order to catch in the output arm. Refit the servo and try it working. The centre section top sheeting can now be fitted.

The next thing to do is covering and doping and remember to dope one wing half at a time (top and bottom) at the same time to avoid warping.

Fitting Motors

Start testing each one on a low voltage to see if they are as speedy as each other. If all is well find some cardboard tubes of a similar dia to the motors (kitchen foil roll tubes) and cut them to fit the LE contour. A slit along the bottom is needed to allow soldering. Use white glue and fit them to the motor positions by glue along the top former. Purchase 8 x 0.1 ufd capacitors (disc) and solder them across the motor terminals. Offer one motor at a time up to its wires through the slit card bottom and solder them in. This leaves each motor dangling out but it is now time to see if all the motors are going round the same way. Don't fit the props as it's a job to get them off again. Use a blob of white typewriter BLOOP to see the rotation direction. Don't use a 7 cell battery for this test as it will flash and spark. Use a lower voltage, about 4V, or two cells. When all is tested insert each motor and secure in place with 3 spots of epoxy. The cardboard tube must now be covered with a nylon patch around it and spreading over onto the LE wing sheeting. This is important as when the model's nose bumps the ground during a landing it causes a bob up and down on the motors and they need this bandage for strength. Even if you don't use nylon for a covering use a nylon bandage soaked with white glue. Finally make up the ailerons and cover them in tissue or SOLAR film and centre hinge them to the wing. Fit the aileron horns and try out the system by powering up the aileron servo. Lastly gather up all the wires and pair them off at the centre section in order to make two output sets of tails. The reason for two batteries is to get a longer run but it needs two separate speed controllers. Remember that it's safer to fit the female 4mm socket onto the speed controller wires and the plugs on the wing tails. The last thing to do is to make a wing covering hatch at the centre section from curved over 1/16 sheet and a couple of formers.

Double up the inside edge along this cover with a strip of 1/16 for strength.

Tailplane

Construction is just like a normal size wing! Make up the ribs from a sandwich method, note that they are a lifting section. Insert the centre braces and cut the three centre ribs low over the top surface to allow 1/16 sheet to be laid in place. This allows a place to attach the covering nylon. After construction the tailplane can be glued in place back up against the fin post position and the post can also be put in place as well. Now it's possible to put in place the fin LE and add in the top block. Lastly add in the fin ribs. Now that the tailplane is in place it's easy to finish off the vertical fin 1/16 side sheeting under the tailplane which is contoured to meet the top covered 1/16 sheet of the fuselage, but first make sure that the push rods work freely.

The rudder is made from two 1/16 sheets in a V formation with the trailing edge glued together. A few ribs of 3/32 are used inside to give strength. The rudder LE is made from 1/2 square with a chamfer at the front to allow it to move after it has been hinged.

Specifications:

WINGSPAN: 84" (2135mm)
MOTORS: 8 x Speed 400 7.2V
PROPS: Paul Günther 5 x 4.3
WEIGHT: 7 lb (3.2 kg)
ENERGY: 2 x 7 x 1700mAh
CONTROL: Rudder, elevator, aileron and 2 x 4 motors

This is covered in tissue and doped for lightness. The solid elevators are made from 1/2 TE stock with a small added piece of 3/8 sheet glued on the front to make a tapered LE. This also has to be chamfered to be ready for hinging. It is also covered in tissue and doped.

Weights

Fuselage 34ozs (964g) inc radio but not flight batteries
 Wings 56 oz (1590g)
 2 x 1700 battery packs 24 oz (680g)
 Total weight about 7 lb (3.2kg)

Flying

It's a hand launch model of 7 lb weight but with a lot of wing area it seems easy. If the motor and wiring specification are adhered to then 7 x 1700 cells is all you need.

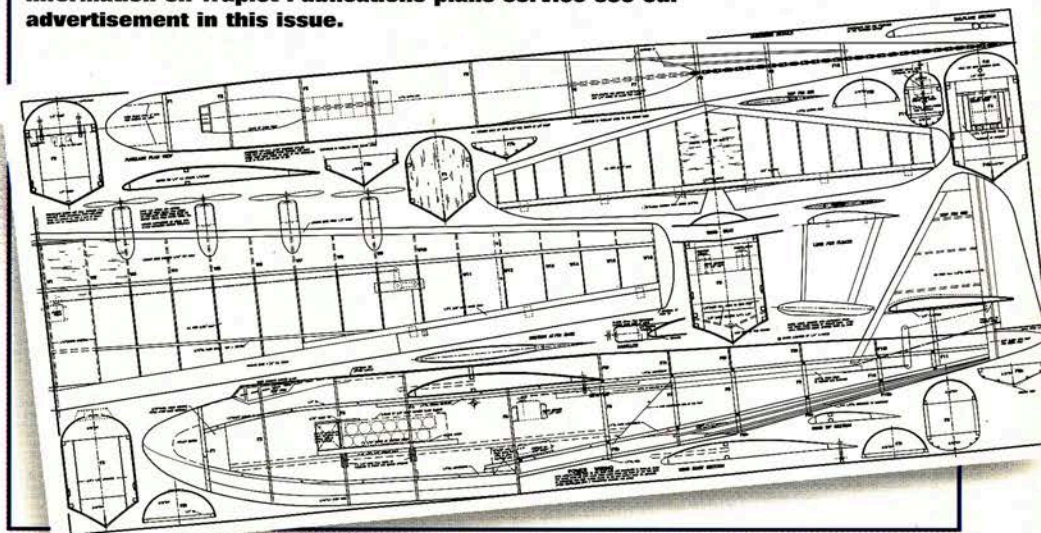
There is room for 3000 but they weren't available when I built it; you can get 7 to 8 mins by throttling back one bank of four motors and it cruises on four without losing height.

There is certainly no doubt about the amount of power available as even on a weak throw it just pulls away from launching. I used coupled aileron and rudder (CAR) because of the dihedral and this gives landings so accurate that it would fly through goal posts on a playing field but I don't! As a precaution I varnished the front hull bottom as sometimes you land in mud.

It's a very stable model, easy to fly, so the best of luck if you build one. Remember - no fuel, no individual starting of IC motors, no twiddling of needle valves, just open the throttles and all 8 engines go! **EFI**

MW2739 - 'SPRUCE GOOSE - HUGHES H4'

Copies of plan number MW2739 'Spruce Goose - Hughes H4' are available from Electric Flight International (Plans Service), Traplet House, Severn Drive, Upton-upon-Severn, Worcestershire, WR8 0JL. Tel: +44 (0) 1684 594 505. Fax: +44 (0) 1684 594 586. E-mail: general@traplet.co.uk
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Water Flying - The Good Ol' Days



Howard Hughes test flying a scale test model of the Hughes H-4 Hercules (better known as the Spruce Goose, a name that Hughes hated).