DE HAVILLAND DH88 COMET
by Ivan Pettigrew
Construction Notes

When built in 1934, the DH Comet was a very advanced aircraft for its day. The wing with a very high taper ratio gave excellent performance at speed. The top speed was 237 mph. But there was a price to pay. At low speed, such as on approach for landing, the plane had very bad stall characteristics, and tip stall was a real problem when it came to slowing up to do a three point landing in the small airports of that era. It was considered to be a plane for professional pilots! Forty years later the Piper Seneca came along, and a comparison is interesting. The Seneca had a similar gross weight, and the same power, but the cruise speed was about 40 mph slower. So much for forty years of progress! But thanks to its "Hershey Bar" wing, the Seneca was safe for any ham fisted pilot to fly. The outstanding thing about the Comet was the maximum range of 2,925 miles. The plane was built to compete in the London to Melbourne MacRoberton air race in 1934, and its long range had a lot to do with its winning performance.

The challenge in building a model of the Comet is to tame the highly tapered wing so that it does not have the same tip stall tendencies as the full scale plane. This is done in various ways in the model. From the aileron break to the wing tip, a NASA leading edge cuff is incorporated. This reduces angle of attack on the outer wing panels and delays the stall. The full scale Comet had old style navigation lights on the leading edge of the wing outboard of the engine nacelles. In the model, these lights are located where the cuff starts, and are used to disguise the "shark tooth" appearance of the leading edge at this point. In addition to the NASA cuff, there is some washout in the tip, this being indicated in the plan. Washout would have tamed the tip stall tendency of the full scale Comet, but it would have drastically reduced the cruising speed. This is not important in a model, but it was not the kind of thing that Macho pilots wanted in a plane that was built to win an air race. Amy Mollison proved to be a very successful pilot in the Comet. Maybe she was not "Macho," but she was probably very professional. More so at least than her alcoholic husband.

When first built in 1995, this model still had some of the bad stall characteristics of the full size Comet, but over the years modifications have been made, and in its present form it is very "user friendly." Three point landings can be made without fear of tip stall. The model is very aerobatic, and looks impressive doing large loops, rolls, Cuban eights etc.

It is expected that the builder of this model will have previous scratch building experience, so these instructions will not dwell on the obvious, but deal with the items of special interest. Likewise, the builder is expected to have experience with electric models, so very little detail is given on that subject.

FUSELAGE
The fuselage is a simple framed up box with bulkheads added to the top. First build the two sides of the fuselage over the plan, and join together. The bulkheads are then added to the top of the framed up “box,” and sheeting applied where shown.

TAIL SURFACES
These are of conventional construction. In making these, it is recommended that the spars for each of the surfaces is made, shaped, and hinged, before starting assembly of the rest of the tail surfaces. There are aerodynamic advantages to having a symmetrical section in the tail surfaces, besides which, the resulting deeper spar gives added strength over a flat tail section. The result is that the tail surfaces can be built very light, and are also less prone to warping. The bare uncovered weight of the fuselage and tail should be just 8 ounces. With radio, servos, pushrods and covering, this will come up to 18 oz.

WING CONSTRUCTION
The wing is built in one piece with a full depth 1/8” sheet balsa spar continuous throughout the wing The ribs are cut where they meet the main spar, and are butted to the front and rear surfaces of the spar. First cut the main spar from sheet balsa and splice the pieces together. The join at the centre is quite critical in order to give the correct dihedral angle as well as the correct amount of sweep back. Now glue the hardwood strips to the top and bottom surfaces of the spar as indicated. These strips should be bass or spruce.

Cut all the ribs in two at the point where they join the spar. Assemble one half of the wing section with the spar of the other half propped up. First attach the rear half of each of the wing ribs, and trailing edge. If retracts are to be used, the front part of ribs #1 to #3A must be threaded on to the long 3/32” wire that operates the retracts from the centrally located retract servo. Notice that the leading edge consists of two strips of 3/16” balsa. Only the first (inner) strip should be applied at this time. Now build the other wing panel over the plan by propping up the already constructed panel to the correct dihedral angle.

Sheeting is now applied to the lower surface of the wing from the leading edge to the main spar. At this point the wiring should be installed for the motors. It will be noted that the wing is still not torsionally strong, meaning that it can easily be twisted. After the sheeting is applied to the upper surface of the same area as already sheeted, the wing will be very rigid and difficult to twist. Hence it is very important, when applying the sheeting to the upper surface, to weight that section of the wing down on a surface that is perfectly flat. This should be done in two stages, first the inboard panel from the root to the aileron break, then the outer panel. There should be no washout from the wing root to the start of the aileron, but from that point to the tip there should be 3/16” washout. The remaining strip of 3/16” sheet balsa that forms the leading edge is now glued to the one in place and contoured to shape. This strip can be tapered to 1/8” at the tips. Keeping the leading edge on the blunt side (with a larger radius) towards the tips is a big help in reducing tip stall. Finally sheeting is added to the centre section, and 3/16" x 1/16" cap strips to the sections of the ribs to the rear of the spar. The ailerons are built and fitted, and controls installed.

MOTOR MOUNT AND LANDING GEAR PEDESTAL

The two ¼" square hardwood strips that form the motor mount are securely attached to the leading edge and bottom of the main spar. Notice that these are marked #1 on the plan. The sequence for building the pedestal is shown in sequence, with #2, #3 and #4 coming next. Details of the retracts are given in separate instructions. If fixed gear operation is desired, the same pedestal can be used and the same "torsion bar" shock absorption method retained by mounting the gear legs in a similar fashion with the two nylon landing gear straps. But where the wire on the retract gear is bent 180 degrees to form a "U" at the upper end, just continue it straight for a further two or three inches. This straight portion is bound with cotton and glued to the #2 support near its upper end.

The engine nacelles are started by building a bulkhead at the position of M1. Note that small hardwood blocks are glued to this to accept the wood screws that hold the cowlings in place. A balsa doubler is glued to the side of the rear face of M1. When sheeting the nacelle, the forward edge of the 1/16" sheet should just come to the join line of the M1 and balsa doubler. This allows for flush fitting of the cowling which firs over M1 and is screwed to the hardwood blocks.

COWLINGS

These are made with the motors in place. First the nose block is made, but the hole for the propeller shaft should, at this point, be made just large enough for the nose block to be a snug fit over the propeller adaptor back plate. This will hold the nose block in place while the cowling is built. Later the hole for the propeller shaft can be enlarged. With the MEC type of gearbox, it is best to slide the motor a little to the rear of its final position so that the propeller adaptor is in the middle of the nose block, thus supporting it while the cowling is assembled. Start making the cowls by cutting out the side panels. These are attached at the rear to the hardwood blocks, using #2 screws. To reinforce the balsa where these screws are located, a small square (washer) of 1/64" ply should be placed under the heads of the screws. The front edges of the side panels are glued to the sides of the nose block. Next apply the top and bottom parts of the cowling, gluing these to the nose block and adjacent side panel sections, but not of course to the bulkhead M1. When the glue is dry, take out the screws, and remove the cowling. Now the hole in the nose block for the propeller shaft can be enlarged to give adequate clearance, and the motor moved forward to its correct location.

CONTROL THROWS

The control throws are shown on the plan. Aileron differential will really help with flight at slower speeds, especially as on approach to landing. In order to provide for this, the servo arm should be made so that it is a 60 degree "V" as shown in the plan. This can be cut from the circular disk that comes with most servos. Take care not to move the aileron horn further forward than the position shown on the plan. This would decrease the amount of differential. If there is insufficient aileron differential, it can be increased by moving the aileron horn slightly rearward to a position slightly behind the hinge line.

BATTERY LOCATION

The motors are wired in series from eighteen cells passing through an electronic speed control that can handle this many cells, and at least 35 or 40 amps. A BEC is not recommended for this many cells. The battery packs that are shown in the plan are two nine-cell packs of standard RC 1700 nicads. Each pack is made from a flat seven cell pack , with two additional cells added on top of each pack. This is a matter of convenience for this builder, since these packs are used in several other single motor models. Another way of arranging the batteries is to use three “six cell” packs taped together sitting on edge. There is ample length available for the battery pack, so this provides plenty of space for moving the packs forward or backwards to achieve the correct C of G location. If using lighter cells such as Sanyo CP-1700 SCR, the battery packs will likely have to be a little forward of the location shown on the plans. The packs are secured to the platform with Velcro strips, but a back stop should be made so that they do not move backward under acceleration on a rough strip.

ELECTRICAL INTERFERENCE

In multi motor electric models, there is an increased risk of problems with radio interference from motor brush noise and also the increased length of wiring used for the motors. Schotky diodes should be placed across the terminals of each motor when they are wired in series such as in this model. This is in addition to the normal capacitors, which should of course be used across the motor terminals. The wires carrying current to the motor should be kept touching each other, and twisted at least one turn to the inch. The motor wires should be no thinner than #13. The radio and servos should be kept as far as possible from the motor wiring and the servo leads kept short. Do not use outboard servos for the ailerons. These would require long leads running along the wing, and they would be very prone to picking up interference from the parallel wiring that carries power to the motors. At the low airspeed of this model, one standard servo is ample to operate the ailerons. Weight can be saved by using micro servos for the rudder and elevator, but it is recommended that a standard servo be used for the aileron. The ailerons require more force than the elevator and rudder, and apart from being stronger, a standard servo draws less current under high load conditions.

COVERING AND FINISHING

The prototype is covered mostly with low temperature film. It is slightly lighter than high temp film, and less likely to warp the lightweight framework. In the prototype, mica film was used for the lower surface of the wing and horizontal tail surfaces. It is lighter (especially the transparent) and stronger than film. Its appearance is not as good, but that is not so important underneath. The flat panels of the windows of the prototype are covered with clear monokote. For the curved section of the windscreen, clear mylar as used for overhead transparencies is very good. This should be applied before the regular film covering.

FLYING

There is nothing unusual about flying this model. It is a delight to fly. But there is one word of warning regarding the take off. With those large propellers, there is enormous thrust and a certain amount of torque. High speed taxiing prior to the first test flight is NOT recommended. The model is likely to take off unexpectedly at low speed and catch the pilot unawares. Previous builders have warned about this. By all means practice some taxiing, but keep it slow. On take off, apply power VERY slowly. If the grass is long, keep back pressure on the stick until the model is rolling. Otherwise a small amount of back pressure is all that is needed throughout the take off. Just apply about 25% power at first until the model is rolling straight, and rudder control is positive. Then slowly apply more power. The model is usually in the air by the time the throttle is little more than half open. Once airborne, full power can be applied and the gear retracted. Landings can be done with no power, but are more realistic, and safer under windy conditions, if a little power is carried. A powered approach should be somewhat flatter, and power kept on through the flare. All landings should be three point at minimum speed. There is no fear of tip stall if the wing has the correct washout. If there is any indication of tip stall just prior to a full stall landing, a little more washout should be added to the wing that stalled.

Good luck with your Comet.
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De Havilland Comet, D.H. 88. (1995) Scale 1/6.6 Span 80 ins. Wing area 750 sq. ins. Length 54 ins. Weight with eighteen 1700 mAH nicads is 108 ounces giving a wing loading of 20.7 oz/sq.ft. Airfoil is Eppler 374 with NACA leading edge cuff on outboard sections. Two Trinity Ruby 16 turn motors, with MEC or home made 4.3:1 superboxes, in series from 18 cells driving 12x8 APC-E props. Static load is 30 amps with props turning 7,000 RPM, giving static thrust of 74 ounces.

Flight time with average aerobatics is in the order of seven or eight minutes using 1700 mAH nicads. The uses of heavier cells is not recommended with retracts unless the flying field being flown from is quite smooth. Overall performance is best with Sanyo CP-1700 SCR cells which are considerably lighter than the older 1700 nicads. The newer 1950 FAUP NiMH cells are even lighter, and like the CP-1700 SCR cells, they have very low internal resistance, and keep up their voltage very well under load.