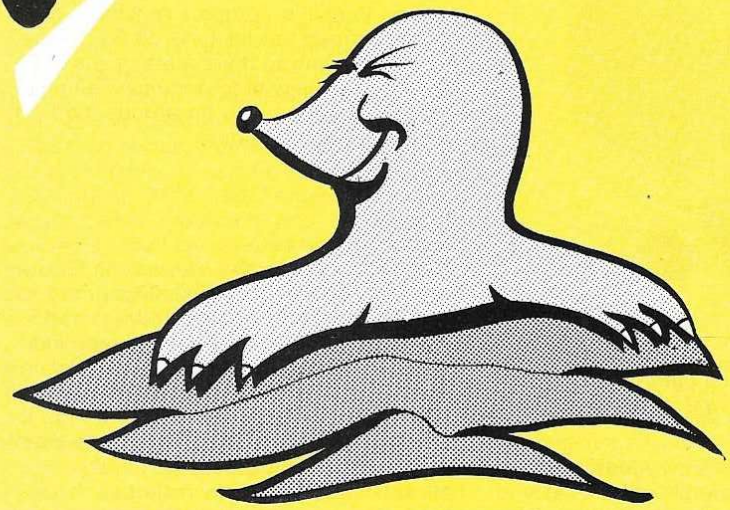
the Mole



DAVE RICHARDSON's design for .25 two strokes and four to five function radio.

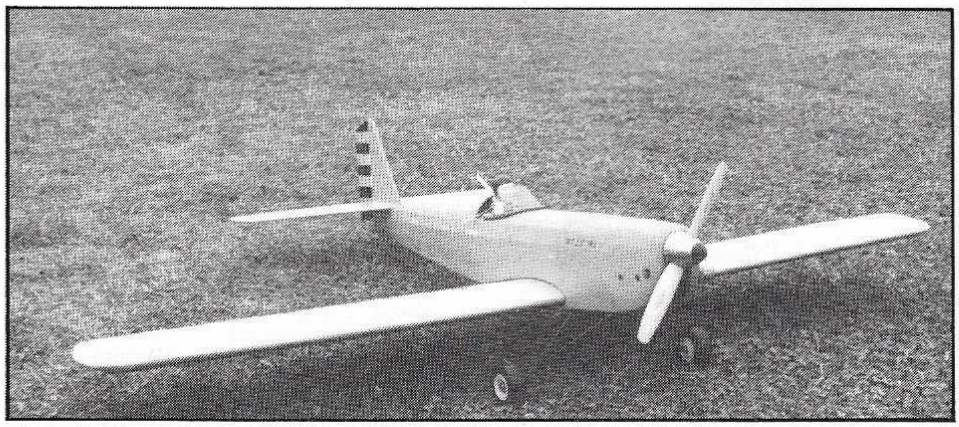
Above, designer Dave Richardson with one of the two prototype Moles. The two views below show the uncomplicated lines of this simple sportster.

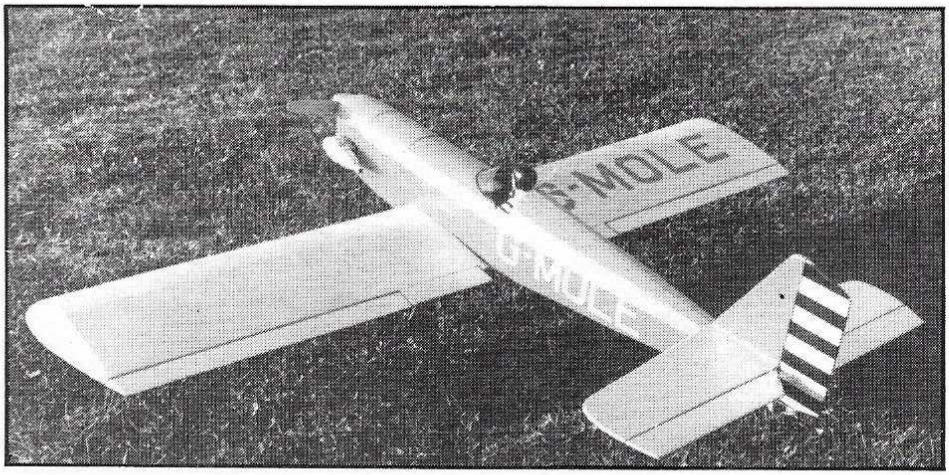
Many years ago "they sat down in their seats and strapped themselves in with tight belts. Bobby pressed the button that started the engine. The propeller spun round. Whrr! The little plane raced down the field. Then ... s-s-s ... z-z-z ... it sprang into the air!

They were off!"

"Bobby and His Airplanes" was my favourite story as a child, and the little open-cockpit taildragger in the extract above became lodged in my subconscious as the archetypal "airplane", a memory reinforced a couple of years later when my father came back from New York with an ARTF "U-control airplane" just like it.

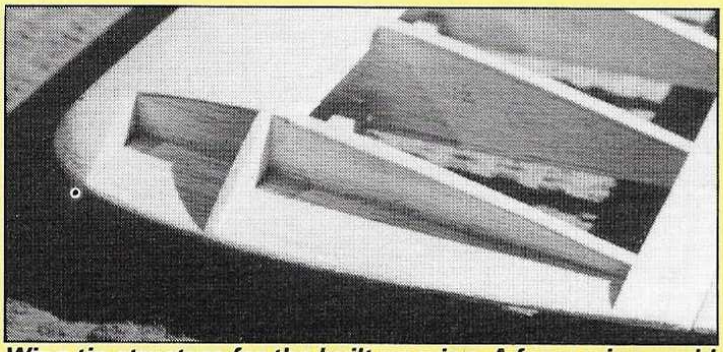
Several decades later whilst on holiday with the children in Devon, one of my compulsive aeroplane doodles began to look very much like Bobby's "little airplane" and many months later became transmogrified into the three-dimensional balsa and glue creation on offer here — the Mole!



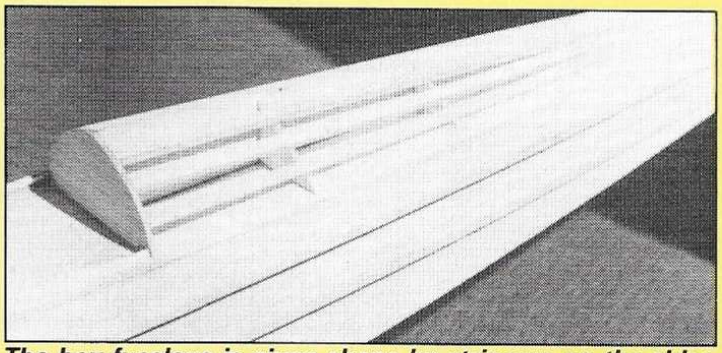


The Mole is a sturdy, scalish aeroplane designed around a 25-size engine, well within the building and flying capabilities of a low-time solo R/C pilot and fully aerobatic in the right hands. It features a foam or built-up wing with optional flaps, which add considerably to the fun of flying. Certainly not a first or second model, but third to umpteenth, yes indeed!

Experienced R/C modellers will now skip forward to the "Flying" section, whilst the converted will already be reaching for the cheque-book, checking stocks of balsa and



Wing tip structure for the built up wing. A foam wing could be chopped off at 45°.



The box fuselage is given shape by stringers on the sides and supported by deck formers.

glue and telling the wife or girlfriend they'll see her in a few weeks!

Construction

Seasoned builders never read construction notes, so this bit is just for you — an adult dot-to-dot guide, to keep your language out of the blue zone and ensure your loved ones don't miss you for too long!

Wood selection is tedious but fundamental to successful building. All balsa should be "medium" or "hard", not too heavy (dense), warp-free, and, most importantly, evenly matched for handed components such as fuselage sides and wing parts. I use an old letter scales to match left and right bits (I'm sure a new one would work just as well).

Organised builders make a "kit" when building from plans, apparently. Building takes me long enough as it is without the distraction of organisation (I would probably lose the bits anyway), so I just get on with it.

Wings

Wings are sometimes handy for setting up the fuselage, also they are quite boring to build so let's build them first and get on with the interesting bits. It is probably just as well, though not essential, to decide at this point whether you will be fitting flaps. Actually, flaps make wings a lot more interesting. Going for foam wings? Then grab your bow and car battery or do what I did and phone one of the wing cutting services advertised in the back of the mag. The prototype Mole used a foam wing made by a firm which no longer seems to be around. These were cheap (£6) but required the leading and trailing edges to be glued in place. A more realistic price today would be £8-£12, the higher price getting you built-in leading and trailing edges with the veneer wrapped right round — you get what you pay for!

Send off a tracing or photo-copy of the wing-section with your order. If you are fitting the shaped wing-tips as on the built-up wing, each panel should be 23⅛ inches long with 90 degree ends. A simpler alternative is to order the panels exactly half-span, 24½ inches, with the tips cut off at 45 degrees. That's what I used on the original prototype.

When you get your foam wings, join them in the time-honoured fashion with epoxy and a fibre-glass bandage. Chock up one wing tip 1in to give the required dihedral. Check and re-check the alignment of the leading and trailing edges before the epoxy dries — a warp built-in at this stage will ensure the aeroplane never flies properly! Cut out the servo recess to the appropriate size for one or two servos and line it with 1/16 inch balsa using epoxy or PVA (everyone knows cyano dissolves foam, don't they?). With the foam wing the servo box could be slightly further forward to utilise the maximum camber point — not possible with the built up version due to the position of the main spar.

Now for the torque rods. The false trailing edge parts (T1) are made from ⅜in. square hardwood (engine bearer stock). Hard balsa would be OK if you are omitting the flaps. Mark the centre line and file a groove for the aileron torque rod. Then cut away the lower edge completely giving an L-shaped section to permit the fitting of the flap torque rod underneath the aileron rod. File grooves in this component and corresponding grooves in the wing trailing edge for the exit holes. Logic dictates that the lower (flap) torque rods exit through the inner pair of holes. Check-fit dry to ensure it all fits and works. I used two types of Micro-Mold rods — long ones with threaded ends and bearings for the ailerons and short ones with a plastic tube bearing and the horn retained by a brass collet. You could make your own from 12g piano wire. Before gluing lubricate both rods with silicone grease (or Vaseline, cheapskate). Epoxy the L-shaped T1's to the trailing edge. When dry, invert the wing and fit both pairs of lubricated torque rods. Slot the trailing edge to take the aileron rod bearings. Now epoxy on the 1/32in. ply anti-crush plate and clamp in place till dry. Waggle all four torque rods during the drying to ensure they don't seize up. The grease should prevent this, working the rods while the glue is drying makes sure. If you are omitting the flaps, ignore half the above as appropriate!

Apply the fibre-glass bandage as neatly as possible. I used a Micro-Mold 3in. nylon bandage (much neater), "pinned" in place with cyano before applying the resin.

Finally, fit the shaped wing tips or sheet with 3/32in. if you chose the 45 degree cut-off style.

Built-Up Version

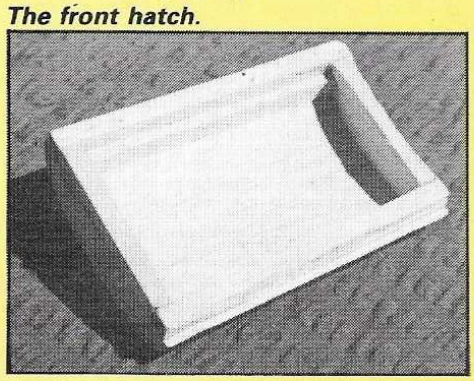
Much more interesting! Make a rib template from ⅛in. or 3/16in. ply and cut 18 W2's from 3/32in. quarter-grain rib stock balsa and four W1's from ⅛in. ditto. Block them all together with ¼in. square spars top and bottom, check for accuracy and sand lightly. Pin the plan to your perfectly flat building board and protect it with clear film (the backing from Solartex is ideal). Slip a sheet of 1/16in. balsa on the plan just aft of the mainspar. Then pin the 1/16 x ¾in. trailing edge over the plan and glue all W2's in place accurately, omitting the most inboard W2 and all W1's. The wing section is flat on its lower part behind the mainspar and the 1/16in. sheet underneath ensures the correct levels. Now glue the top ¼in. square mainspar in place followed by the ⅜in. square leading edge checking all the while for accurate alignment. Make sure the spars and leading edge are about 1in. overlength at the centre section. Now add the ¼in. sheet shaped false trailing edge and upper 1/16th x ¾in. trailing edge. When dry, remove the wing panel and add the lower ¼in. square mainspar. Repeat for the other wing panel — no excuse for building two left wings, both are shown on the plan!

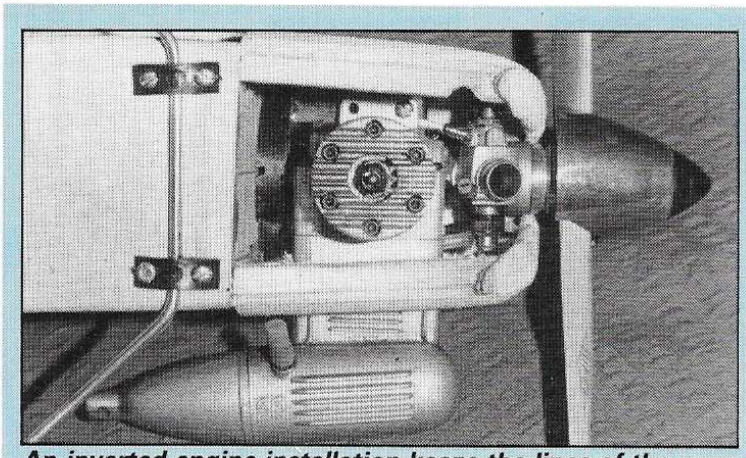
Now for joining the wing panels. Pin one back on the plan flat and offer up the second with the tip blocked up the requisite 1 inch dihedral. Mark the centre lines on both spars, leading edge and trailing edge cut carefully with a razor saw and epoxy accurately in place. Now epoxy in the two 1/16in. ply dihedral braces, not forgetting to drill two ¼in. dowel holes in the front brace only (I did). The next step is to fit the remaining ribs. This involves marking a line 1/16in. either side of the mainspar and cutting out the centre sections. Two of the W2's are glued together for the centre rib. Glue all rib parts in place and add 1/16in. D-box sheeting top and bottom. Don't forget to fill in the trailing edge centre section to take wing-bolt drilling. Now add the centre section sheeting with appropriate cut-outs for the servos. Next comes the 1/16in. vertical grain webbing omitting the last two outboard bays. Almost there, build up the wing tips and drill through the leading edge for the locating dowels. I recommend not gluing the dowels — just make sure they are a tight fit — much better if you ever break one and have to replace it! Fitting the torque rods is exactly as for the foam wing above. Fit the ply servo bearers spaced to fit your servos. I use JR radio, the spacing on the plan is for NES 505's (I actually used an NES102 on the flaps). Last items on the wing are the 1/16 x 3/16in cap strips on all exposed ribs, top and bottom.

Cut the ailerons and flaps from ¼ x 5/16in. trailing edge stock. The ailerons are chamfered for conventional centre hingeing, whereas the flaps are bottom-hinged with Solartex and require rebating along the centre line to ensure a correct fit.

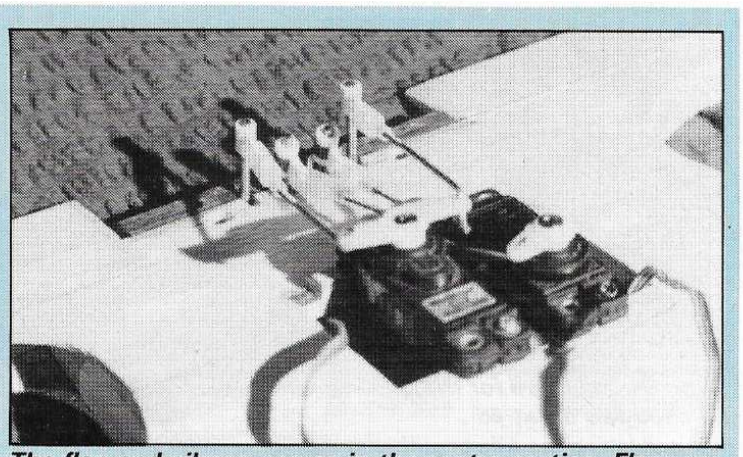
Razor-plane the sharpe edge off the leading edge and sand to section. Finally sand the whole wing lightly.

The front hatch.





An inverted engine installation keeps the lines of the nose clean.



The flap and aileron servos in the centre section. Flaps are an optional feature.

Tail Surfaces

The tailplane is simply cut from medium/hard 3/16in. and the fin and rudder from 1/4in. Anti-warp tips are not used on the prototype. Don't omit the shaped "peg" on the fin and the corresponding slot in the tailplane. Sand the leading edge and tips to a round section, and give the elevators and rudder a gentle taper leaving the trailing edge square and not too thin. Chamfer the front of the rudder and elevators for centre hingeing.

Fuselage

Apparently this is the interesting bit! Cut the two sides from 3/32 x 3in sheet — this involves butt joining small bits fore and aft of the wing cutout, but 4 inch sheet would be a waste. Attach the 1/32in. ply doublers using a contact adhesive such as Thixofix. Mark the positions of F1, F2 and F3 on the inside of each side, and mark a centre line on the top of F1. Now glue F2 and F3 onto one fuselage side checking for absolute squareness. When dry glue on the other side using the marks. In theory you now have a perfectly square fuselage though in practise Murphy's Law states that it will in fact resemble a banana. Therefore use a square continuously before the glue dries. It is your only protection against Murphy.

The next operation is performed upside down (good practise for flying later!). Pin D2 onto the plan. Then glue your perfectly square box onto it. The section between F2 and F3 has parallel sides, aft of F3 is a gentle curve hopefully following the natural curve of the wood. The tail end is simply pulled together and glued with a slight chamfer on the inside. The front end is now pulled together and F1 epoxied in according to the marks on the sides and the centre line on the former and plan. Glue on D3 and the wing seating doublers. Omit the lower rear decking at this point, it helps installing the controls.

Now turn the banana, sorry, fuselage the right way up, add F4, the spine, and F5, 6 and 7 (the last three each in two halves), F8 (3/16in. square) and the two 1/8in. square stringers each side. Glue on F2B and the curved upper decking D1, which is easier done in two halves as suggested. Wetting the outer surface assists the curving process. Add the soft block (3/4 or 3 x 1/4in sheet laminated) top cowl roughly shaped. Next glue on the 3/16 square external stringers and the 3/16in. sheet cheeks at the nose and infill at the rear (getting medical, this!). Then glue on F1B followed by the 1/4in. balsa facing. Shape the whole nose section with a razor plane and sanding. The prototype used an OS 25 FSR mounted on a SLEC plastic mount — the top cowl block will need rebating to accommodate. You will need to cut a slot for the silencer and drill various holes for the needle valve, mid-range adjustment, exhaust pressure tube, and silencer retaining screws depending on your choice of engine. A manifold extension is necessary unless you want to hack away half the cowl! Glue on the ply tailwheel plate. Press 2BA captive nuts (or to suit your choice of nylon wing retaining bolts) into the ply shear plate and glue this in place.

Construct the hatch and catch, ensuring that the hatch matches the decking. You will need to glue cross-grain 3/32in. sheet on top of F1 to achieve a match at the front.

Finally epoxy on the tailplane and fin checking all is true and square, and temporarily hinge all control surfaces for a trial radio fit. I use Mylar hinges, I always glue the other type solid.

The undercarriage is formed to the shape shown, then bind and solder the joints. I find this impossible with a soldering iron, a cinch with a Ronson blowtorch and flux. I used PB 2 1/2 balloon wheels retained with brass collets. Make sure the wheels have a bit of toe-in and negative camber. The steerable tailwheel is based on a Micro-Mold unit hooked to the rudder with rubber bands — saves your servo and rudder hinges!

R/C Installation

My JR servos were mounted on the standard three-servo tray in 2+1 configuration. Check the height of your equipment dry to avoid gluing the servo bearers in the wrong position. Have the servos almost touching the top deck, there isn't much room in there! The prototype used an internal switch with a bent spoke to the exterior.

The elevator is operated by a pushrod with closed loop for the rudder (you could use a pushrod here too) and Bowden cable for the throttle. The aerial is run internally to the tail and exits through a small hole just to the right of the rudder.

Servo installation in the wing is straightforward but requires care to ensure that the flap and aileron pushrods don't foul each other. The flap pushrod is a "Y" arrangement made by soldering two spokes together.

I believe in going for a complete "dry run" on radio installation to make sure everything works without snags — there is nothing worse than having to start hacking at that concours paint job because something doesn't fit. In particular ensure the wing servos don't foul the ones in the fuselage.

Fit the engine ensuring the prop. driver clears the cowl and get the throttle servo operation set up. Trial fit the tank — SLEC 6oz square (red end!) — and tubing.

Now take it all out (safe in the knowledge that it will slip straight back in with no snags!), finish the lower rear fuselage cross-grain sheeting, give it all a final sanding and you're ready for covering!

Covering and Finishing

Solartex and cellulose spray paint were used to finish the prototype. Red Solartex was used for the fuselage and fin, and white for the wing and tail surfaces, the latter then being sprayed with grey undercoat and several topcoats of metallic silver. A Fablon mask was made for the registration letters — this worked fine on the fuselage but pulled the silver paint off the wings! The correct material is a low-tack film called Frisk, available from art shops. Colours used were BM117 Silver Leaf and Ford Monaco Red (good match for red Solartex). Other lettering was done with dry rub transfers.

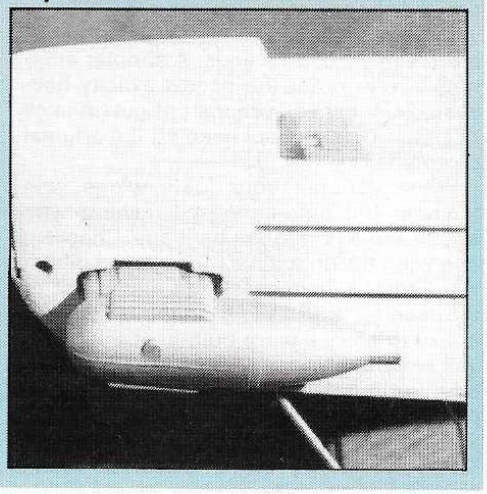
I sprayed the engine bay black and fuelproofed with glass fibre resin, the remainder of the airframe being fuelproofed with automotive aerosol clear lacquer. The instrument panel was cut down from a SLEC stick-on panel mounted on card and cyanoed in place. The coaming around the cockpit and canopy is the black plastic insulation from mains power cable slit lengthways and Zap-a-Gapped in place.

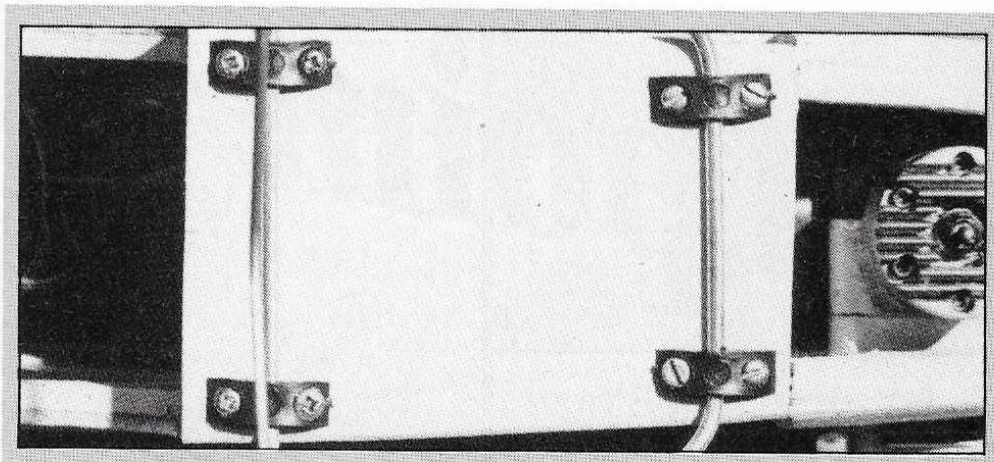
The pilot was supplied by fellow BMAC club member Sam Pilgrim. His miserable look was doutless in anticipation of the impending test flight (the pilot's, not Sam's!).

Flying

At last! Gear back in, check all hinges, nothing snagging, controls all working in correct sense.

Silencer installation is kept as unfussy as possible.





Undercarriage wires are retained by simple saddle clamps.

Control movements were as follows:-
Ailerons — ½in. up, ⅜in. to ½in. down.
Elevators — ½in. up ⅜in. down
Rudder — 1¼in. each way
Flaps — ⅞in. to 1in. down

If you have rate switches, about 70% of the above throws would aid your nerves for test-flying.

Now the centre of gravity. The prototype balanced exactly on the mainspar, 2½in. back from the leading edge. I would not recomment going further back than this, up to ¼in. further forward should be ok.

Down to the flying field, check it all again, fill tank, start engine. The .25FSR was not so easy to start inverted, so I would invert the plane or stand it on a wingtip. Running now, go for max. lean, then richen up two or three clicks, check run at full throttle with nose up vertically. Back on the deck, check throttle response and reliable idle. Adjust mid-range needle if necessary.

No more excuses, check controls at full throttle, back to idle, line up into wind, stick back to keep the tail down, open throttle fully, touch of right rudder to keep it straight, ease off the elevator, then gently back again as flying speed is reached.

The flapless foam-wing prototype lifted off without drama, requiring a touch of right trim on the aileron and down on the elevator. Climb out to a safe height, throttle back to ⅔ and set the trims for straight and level. Gentle turn to the right, nothing unusual happening, bring it back downwind and turn to the left. Once the "it flies" novelty had worn off I tried a few simple manoeuvres.

It soon became clear that the Mole was far more aerobatic than yours truly. Aileron rolls were quick, and loops as tight as you like. Stall turns require a good application of rudder before all speed is lots and work better left than right. Check out the stall. Safe height, throttle back, feed in the elevator. It finally drops a wing, could be either, stick forward, throttle open, pick up the nose as soon as you have flying speed.

Spins? Entry is not instantaneous, but the rotation builds up quickly. Neutralise the sticks and it stops at once (even quicker with a bit of opposite lock!), ease open the throttle and pick up the nose as soon as you know which way it's going. Inverted? The plane was fine with a touch of forward pressure, the pilot less so. Quick, half roll back to upright. Now for a landing. Throttle back downwind, turn gently onto base leg, finals at about 50 feet, bit of throttle to control rate of descent, getting closer, ease back just above the deck, throttle right back, bounce, bounce, bounce, that's a three-pointer isn't it?

I favour the OS .25 FSR for its power and reliability — the way it hauls the Mole around I'm sure any other 20-25 two-stroke or four-stroke even would be fine.

Some months later, "Take Two" with the flapped built-up wing version, same fuselage with Mole MkII markings. Initially flown 'clean', it was indistinguishable from the foam wing version. After a couple of familiarisation flights, let's try those flaps! Safe height, throttle back, half flap — Wow! big nose pitch up! Hold the nose down, rest of flap — no more pitch up, speed comes right down (who said the flaps were too small?), ease throttle back to ⅓. Waggle wings, fly it round — no problem! Still completely controllable, just slow. Now ease flaps off, nose drops, watch it! Technique is, open throttle as you raise flaps and you can fly off without losing height. The stall? Clean, it will still drop a wing. Half flap, it just mushes and is reluctant to drop a wing. Full flap, it nearly stops and 'nods', dead straight.

Take off run is considerably reduced with about 20 degrees of flap. Landing techniques is, throttle back downwind, apply half flap, catch pitch-up with slight forward pressure on the stick (you could retrim, but then you are forever retrimming), turn onto base leg, apply rest of flap, adjust throttle control rate of descent, turn finals and push the nose down to aim for the spot. If it is your first flapped model (it was mine), the steeper descent with slower airspeed takes a bit of getting used to. As you approach the flare be prepared to tickle the throttle to control the descent. Hold off, throttle right back, as soon as she touches down, a quick blip of the throttle to keep the tail down, and get the flaps up as quick as possible or you'll be airborne again!

Well that's it fellow R/C pilots, have fun with your Mole and keep it above the ground!

A final thanks to fellow club member Nigel White who took the airborne photos and some of those on the ground.