LADYBIRD MK2

For expert pilots, Brian Shaw's fully aerobatic slope soarer.

Introduction:

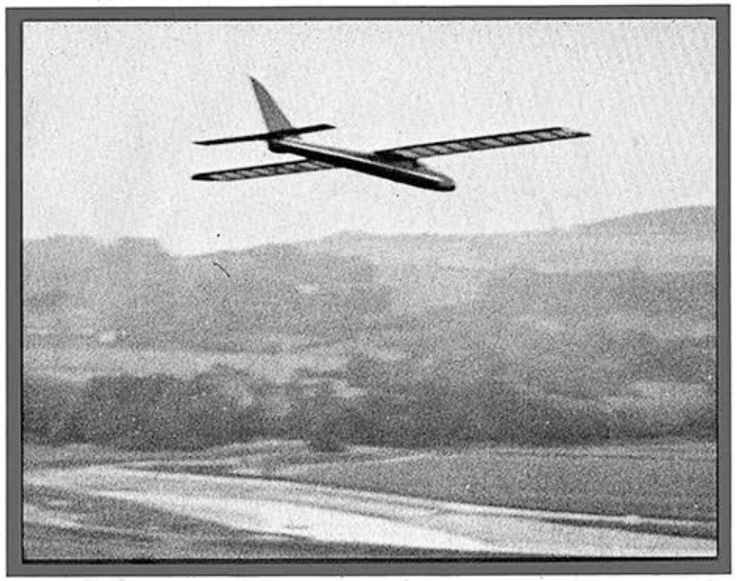
Ladybird Mk 2 is by far the most successful of a series of four fully aerobatic slope soarers built to date. For several years I had flown rudder and elevator models with lifting section wings, using single channel, then reeds and, finally, proportional.

Early in 1970 Ladybird Mk 1 was flown and revealed the great possibilities of a low aspect ratio wing of near symmetrical section equipped with ailerons. Mk 1 was functional with little regard for appearance, but it was easy to fly, being very reluctant to stall, and the ailerons were effective at even the lowest speeds. The span was 53".

Mk 2 presented here is larger at 59" span, the appearance is improved, and the airfoil changed more towards the symmetrical but still retaining a slightly lifting section. Large inset ailerons are used to give a very rapid roll rate, and rudder function is provided. It should be noted that this function may be omitted, the only loss will be in stall turns and spins.

This model has turned out to be very pleasant to fly and it will do any aerobatic maneuver within the ability of the pilot. I believe the Horner tips give smoother penetration in gusty conditions, and the airfoil is quite good in poor lift, but still capable of good inverted performance. Ladybird Mk 2 has been my number one model for over a year, and has probably flown about 2000 miles!

I have experimented with two other designs; a smaller version of 54" span and a larger one of 64" span, but neither of these demonstrated the good performance characteristics of Ladybird Mk 2. The smaller model was faster but would stall and snap roll if too great a 'G' loading was applied. The larger model was less responsive. It seems, therefore, that a span of about 5 ft. and a loading of 11 oz. per square foot is near to the ideal, and this is confirmed by the excellent design 'Phase One' by Chriss Foss, one of our best soarers and fellow member of the Sussex club.



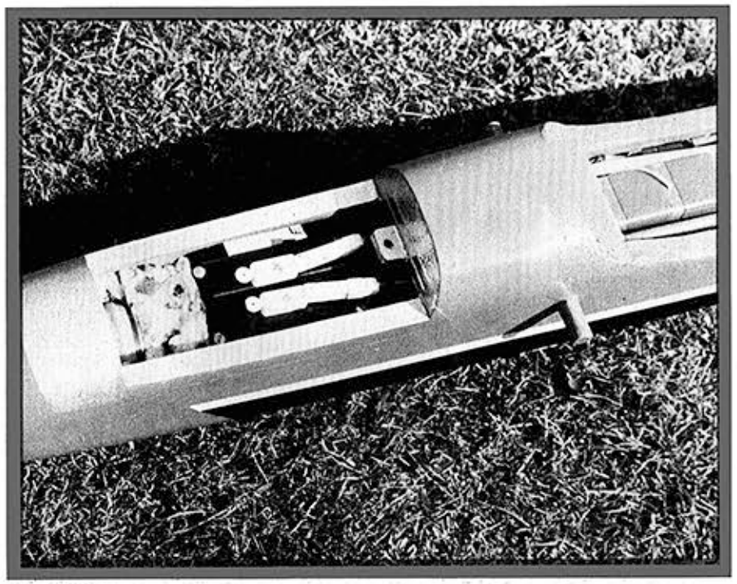
For those who have yet to see this type of model in action, here are some of the possible maneuvers: Consecutive loops and bunts, square loop, consecutive rolls, hesitation roll, vertical climbing roll, inverted flight, stall turn, spins and inverted spins, horizontal and Cuban Eights, and even the double stall turn (if the pilot is sufficiently skilled).

The only change on the plan from the model in the photographs is a slight alteration in the nose shape to permit the inclusion of a transparent canopy as this does greatly improve the appearance.

Fuselage construction:

Cut the two fuselage sides from 1/8" medium sheet, cutting to the chain dotted outline shown on the plan, thus allowing for the top and bottom sheeting. Work as if the cockpit was to be left solid. Glue in position the two spruce longerons, steaming, if necessary, to achieve the curve shown on the plans. The bottom longerons are cut from very hard balsa. Take care to get the two sides identical, and sand the edges as a pair. Use Titebond except where stated otherwise.

Add the ¼" square vertical stiffeners to the sides. When the sides are dry, insert a dummy former at the widest point of the fuselage and bring the nose together and glue to F1. Pin the tail together with scrap as a spacer. Take the 1/8" sheet medium balsa bottom and glue in position the ¼" square stiffeners. The latter define the width and curvature of the sides. Glue the bottom in place, keeping the assembly square with pins and scrap wood. Add the ¼" soft sheet fuselage top in the same fashion, noting that this extends forward to approximately mid-chord of the wing, and is later cut away to form the wing seating. Add soft block to complete the top of the forward section of the fuselage. Add the external doubler to the bottom of the nose section, using 1/8" hard balsa. When all is dry, roughly shape the fuselage with a razor plane. I use laminations of chipboard for the nose block, hollowing by cutting out the inner laminations. (I have found hardwood to shrink after assembly, giving a line under the finished paint work). Shape the nose block roughly before gluing in place. Now shape the fuselage to the well rounded section as shown on the plan. If you are going for the clear canopy (which greatly enhances the appearance of the model) the time has come to mold it. Cut out the block from the fuselage to use as a mold tool and mold the canopy. Face the front and rear of the cockpit cutout with 1/16" ply. The canopy has a floor, front and back of 3/32" sheet. This can now be assembled to be a snug fit in the fuselage cutout. It is not glued in position as it serves as the hatch. Bring the interior of the cockpit to a good finish and spray a matt grey. Add the instrument fairing – a small section of 1" x ¼" T.E. stock. Paint or stain this and then glue the canopy in position, including a pilot's head, if desired. Paint over the glued area with your trim color. Glue two ¼" square cross members across the bottom of the cockpit to locate it in the fuselage. Although I did not bother with a cockpit on my original Ladybird Mk 2, I did build one as described for the larger version, and the improved appearance was worth the extra work. Leave the fuselage now and start on the wing.



Wing construction:

I use a wing jig of simple construction, and having 3/16" steel rods tensioned across a strong steel frame. The wing can, of course, be built on a

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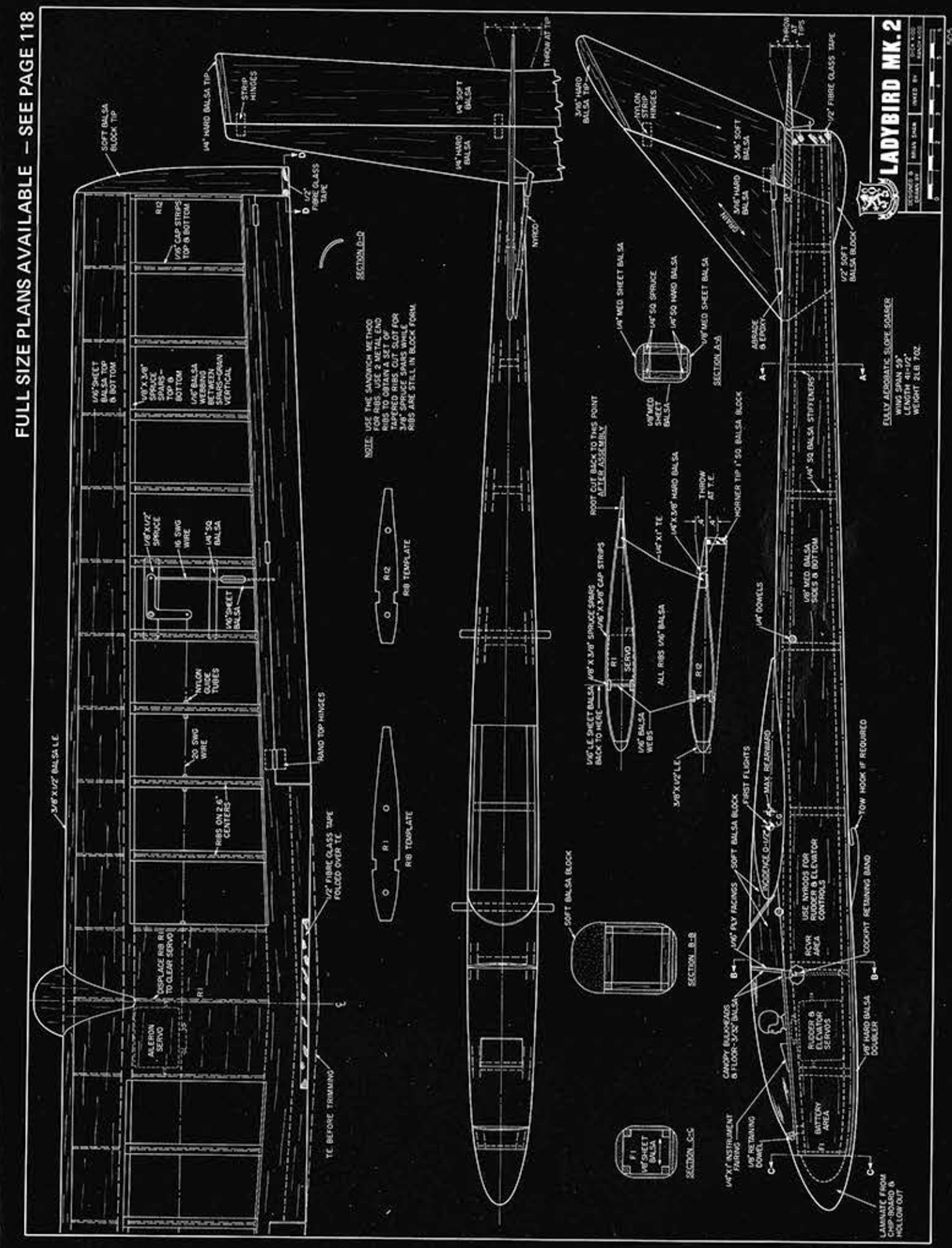
FULL SIZE PLANS AVAILABLE – SEE PAGE 118



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flat board by packing up the leading and trailing edges. Please note that it is essential to end up with a perfectly true wing.

All ribs are cut from medium 1/16" sheet, using the sandwich method with two metal end ribs, to obtain a set of tapered ribs. Cut the slots for the 3/8" spruce spars while the ribs are still assembled as a block. Note that the root rib is longer than the final root chord at this stage. Assemble all ribs on the rods at the spacing shown on the plan, and add the ½" x ¾" medium balsa L.E. and the 1" x ¼" T.E. Make sure that the T.E. is at the correct angle. Make a careful job of splicing L.E., T.E., and spars, as this model will be very highly stressed during aerobatics. Add the bottom spar and then the 1/16" sheet webs with the grain vertical; cut these very carefully to size to insure an accurate location of the top spar. Splice the L.E. sheeting to length, using medium sheet, and add the top sheeting. From the underside, make sure that this sheeting is firmly down on all ribs. Now add the bottom sheeting. Note that the sheeting only half covers the spars, leaving half the spar available for the attachment of capstrips. Now cap all ribs except the center three, with 3/8" x 1/16" strip; these overlapping the front of the T.E. by 1/16". Add the center sheeting and make the cutout for the servo. The latter is offset to bring the leads out over the center of the fuselage. With a steel straightedge, cut away the surplus T.E. to make the aileron cutouts. I consider it most important to achieve very close fitting ailerons for low drag and fast aileron response. Complete the T.E. by adding the 1/16" strips which are glued on to the 1" x ¼" T.E. close up against the capstrips. Add a small section of T.E. to extend the center section to the full chord. Build up the aileron from 1" x ¼" T.E. and 3/8" x 1/4" hard balsa.

Bevel the front edge of the ailerons to allow proper downward movement. Plane and sand the L.E. to the required section and sand the wing all over. Fit the 1" x 1" soft block tips and sand to the section shown. Reinforce the T.E. of these blocks with ½" fiberglass tape, folded over the T.E. and secured with resin. Hold this tape in position by covering with polyelthene film and pressing into position with foam rubber while the resin sets. The mountings for the bellcranks must now be fitted, followed by the installation of the bellcranks and pushrods. Use 20 swg piano wire between the servo and bellcranks, running in a straight line and guided through nylon tube in alternate ribs. This gives a rigid but very light drive. From bellcranks to aileron horns, use 16 swg piano wire. It should not be necessary to use adjustable links here, as with a true wing, very little trim adjustment will be required. (No torque problems with sailplanes!) Be sure that there is no play at all in the linkage. This is important as the model is very sensitive to ailerons. Hinge the ailerons with three ¼" Rand top hinges; take care to insure very close fitting ailerons.

Note, that to keep the wing as thin as possible, the thickness is such that the aileron servo just fits in the depth of the wing. As the servo is offset from the fuselage center line and is not, therefore, covered by the fuselage, it is necessary to take the covering over the servo opening. If you need to remove the servo frequently for use in other models, the opening can be covered with MonoKote which is easily replaced.

Aileron horns can be of your choice, but I cut them from 1/16" fiberglass circuit board, removing the copper, and fixing in position with epoxy into slots in the ailerons. No differential movement is provided other than that arising from top hinging, which also gives minimum drag in normal upright flight. With a steel straightedge, trim the T.E. to a straight line between the ailerons as shown on the plan. This thickens the T.E. and removes an otherwise fragile T.E. (In the photo you may notice that I overdid this and ended up with slight inverse taper over the center section.) Fold ½" fiberglass tape over the center section and secure with resin. Give the wing a coat of sealer and rub down, then apply a couple of coats of clear dope and rub down ready for covering. Cover with nylon, taking great care to avoid warps. The ailerons are, of course, removed during the covering of the wing. Now cover these with heavy silkspan. Applying a coat of sealer, clear dope, and finally, spray with the color of your choice. Re-fit them to the wing.

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Having now almost finished the wing, carve out the wing seating in the fuselage, and face the front surface with 1/16" ply. When you are sure that the wing is true to the fuselage and at the correct angle of incidence, add the soft block fairing to the top of the wing, facing its front surface with 1/16" ply.

Completion of the fuselage:

Complete the sanding of the fuselage, making sure that the wing fairing follows the fuselage line. Bind the rear of the fuselage with ½" fiberglass tape using epoxy as the adhesive. Cut the tailplane from ¼" hard balsa, round the L.E., and epoxy to the fuselage, making sure that it is true with the wing. Cut the elevator from soft ¼" balsa and add the hard balsa tips, sanding to the section shown.

Cut the fin from 3/16" hard balsa, sand the leading edge to shape and slot into the fuselage. Secure with epoxy, adjust to be at right angles to the tailplane and hold in position with pins through the fuselage bottom while the epoxy sets. The rudder is made from soft 3/16" sheet.

Add the ½" bulge under the tail; this raises the tail slightly and reduces the possibility of damage on landing.

Cover the fuselage with nylon. (I strongly recommend nylon as the best material for withstanding the very harsh treatment of repeated landings.) Give a coat or two of sealer, then clear dope and finally spray with color. Add ¼" wing dowels and a tow hook, if you want to use a Hi-Start when the wind is light, although it is advisable to have a light soarer available for such conditions.

When selecting your color scheme, choose those that will give the good visibility required for a small fast model that will probably be flown at a much greater distance (in search of lift) than would a power model of the same size.

Install your radio equipment and check the balance point. For first flights, it should be at the point shown, adding weight to the nose, if necessary.

nose weight. Fly with the C.G. as far to the rear as possible consistent with having a stable aircraft. This will give a high spin rate, as well as inverted flight requiring minimum down elevator. The prototype finally had 1 ounce of nose weight and weighed 2 lbs., 7 oz. The final trim is such that when the model is put into a dive and, on releasing the stick, the pull-out is very gradual.

This is a very sensitive model to fly but, in spite of this, I describe it as docile in that it has no nasty habits and can be recovered from what looks like impossible situations by a pilot with fast reactions. This is because very high "G" loadings can be applied without stalling or snap rolling. IF and only **IF THE WINGS ARE FREE FROM WARPS.**

Here are a few comments on aerobatics:

Loop: Dive at about 30° and ease back on the stick, full up will not usually be required. Ease off the stick at the top of the loop to keep it from tightening up.

Roll: Shallow dive, pull up slightly above the horizontal and apply aileron. Give a slight touch of down and release as the model rolls through the inverted position. Too much down will give a fast and barreled second half to the roll.

Bunt: Apply down elevator gradually only reaching full down after about 200° of rotation, ease off again for a smooth recovery.

Inverted: Half roll and apply slight down. Remember that down is now up but aileron response is, of course, normal.

Stall turn: Dive steeply and pull up into a climb of 80°. As the model slows, gradually apply rudder as well as a little down, reaching full rudder just before the model rotates. Pull out along the path of entry into the stall turn.

Vertical roll: From a prolonged vertical dive, pull up vertically and apply full aileron. One and one half rolls can be obtained. Full down at the top gives recovery into level flight.

Spin: Full up, full rudder, full aileron.

Inverted spin: Full down, full rudder, full opposite aileron. Recovery from both is fast, but neutralize and un-stall the model before applying slight up for the recovery, otherwise the spin may re-start.

That covers the basic maneuvers, the rest is up to your skill, since most others are combinations of the basic maneuvers.

I hope you have success with Ladybird, the prototype is still in excellent condition after over a year of very hard use, and you can continue to improve your flying with a model of this type over a considerable period of time. In England the improvement in design of this type of model has been tremendous over the past two years, and it is very difficult to see where any further major changes can be made. □