By TOM WILLIAMS . . . The latest effort by one of the top R/C sailplane designers in the U.S., the Golden Eagle is a real floater, yet has as much speed and penetration capability as most heavyweight FAI models.

The GOLDEN EAGLE

• The state of the art in high-performance R/C sailplanes is advancing more rapidly than any other phase of R/C modeling. It is indeed the most exciting part of my entire engineering career to be a professional sailplane designer at such a time in model aviation history. I am proud to present to you, here in the pages of this outstanding modeling magazine, my latest design. I hope it will contribute to the advancement of the sport and to your trophy case.

The Golden Eagle is by no means a trainer. On the contrary, it is a high-performance contest type sailplane designed to make good pilots do even better.

DESIGN PHILOSOPHY (sometimes called BULL)

It has occurred to the designer that you may build a better sailplane or at least derive more enjoyment from it if you know some of the design philosophy behind its creation.

Without burdening you with engineering formulas, suffice it to say that the lighter (lower wing loading) a sailplane is, the faster it will go up in lift and, conversely, the slower it will come down in dead or down air. In other words, you'll get more flight time per launch. However, the forward velocity is also proportional to weight (size being fixed), and the lower the forward speed, the lower the Reynolds number (Rn). You need not understand this term; just accept what its effects are. The airfoil efficiency in the lower regions of Rn (below 1,000,000) goes down as Rn goes down. Gadzooks! A dilemma! What is needed is an airfoil that will perform well at very low forward velocities. To meet this need, I designed the FB1151. It first appeared on the Windrifter, then the Sailaire (by the way, the Paragon has an almost identical airfoil). Unfortunately, this airfoil flies so slowly at 6-1/2 oz./sq. ft. that it becomes ineffectual on windy days. Yet this same slow speed makes it outstanding in the landing circle and as a trainer.

NEW DESIGN GOAL

What if we could design an airfoil that would fly faster at light wing loadings? The sink velocity is proportional to weight and has essentially nothing to do with the airfoil. Therefore, we may still have the unexcelled thermal performance and super-high launches (if the winch goes fast enough), and yet be able to penetrate upwind hunting for or returning from thermals. The only drawback would be that the landing velocity will be higher, which will hurt us older men with slower reflexes. But wait! If we fully turbulate the airfoil, as on the Golden Eagle, we can reduce the stall speed without any noticeable effect on high-speed performance.

PERFORMANCE

Your results are going to depend a lot on how you build and how you fly, but if you can't wait to finish yours, we can tell you that the prototypes performed in every respect beyond the most optimistic dreams of this old designer.

The Golden Eagle thermals as well as a Windrifter, has an impressive launch angle (almost straight up), yet has demonstrated extremely fast times in F3B speed runs . . . less than 11 seconds at 42 oz. flying weight. At this writing, no all-out tests have been made because no wings with carbon fiber spars are yet flying. The L/D has not yet been measured, but it is believed, from observations, that it is at least as good as the Sailaire (21:1).

This sailplane was not designed for FAI competition, but as a Standard Class sailplane that would penetrate the winds which are the norm east of the Rocky Mountains.

The Golden Eagle will be competitive on the typical Southern California calm day, but, when the wind blows, it will be in a class all by itself.

DECISIONS

SPARS: As airfoils are made thinner, the stresses in the wing spar go up by the 4th power. The spars on the plans are sufficient for all lightweight (no ballast) maneuvers and all but the most taxing ballasted maneuvers. If you intend to use this sailplane for F3B type speed runs with heavy ballast, put in carbon fiber spars (about $20, available from Hi-Flight Model Products, 43225 Whittier Ave., Hemet, CA 92343).

WEIGHT: A sailplane built light can fly light or, by adding ballast, heavy, but one built heavy can only fly heavy. The 1/32 ply sheeting used on the fin is a heavy building material but needed for rigidity. You can cut out some of it, as well as the 1/4 x 9/32 center separator and save one ounce in the process. Don't complain if your wood is light (soft); complain if it's rock-hard (heavy). You're not building an outhouse!

WING ROD: If you're going all-out for F3B speed with lots of lead, a second wing rod could be added just ahead of the spar.

ANTI-VORTEX TIPS: Make them! They're not hard to carve, they're easy to cover, and they are aerodynamically effective. Follow the instructions one step at a time.

CONSTRUCTION

Use of the proper adhesives is just as important as using any other proper building material. I feel that this is so important that I have specified the proper adhesive for each joint in the step-by-step building procedure which follows. Where more than one cement type is acceptable, the preferred adhesive is listed first.

A) Aliphatic Resin (Titebond, Wilhold Aliphatic Resin, etc.).

B) Butyrate Cement (Ambroid, Aero Gloss 40% Stronger, etc.).

C) Cyanoacrylate (Hot Stuff, Jet, etc.). Use micro balloons or baking soda as fillers. If structures are fabricated with type C, each butt joint must have a fillet of type A added before covering.

D) Contact Cement: volatile solvent latex, the type used to bond plastic counter tops. Has strong odor (toluene). Water base contact cement is not to be used on the Golden Eagle.

E) Epoxy: Any brand of 5-minute or 15-minute epoxy is acceptable.

WING

The relative performance of your sailplane is directly proportional to how accurately you built your wing. The airfoil shape of the ribs you cut may be within .005 inch of design shape, yet the best of us do well to build a wing within 1/16 inch of being true and the best we can hope for is .015 inches. After you finish all four panels, lay a straightedge across all the ribs on each panel and you'll see what I mean. To minimize this problem, make sure you have a building board that is flat and firm, yet soft enough to take pins without pushing the heads through your thumb. A board made by hinging two particle board shelves together, covered with Celotex ceiling tiles, is recommended.

A wing with a curved bottom is a little more complicated to build than a flat-bottom wing, so follow the steps in the order given below.

1) Cut the ribs out of 3/32 sheet. Don't try to drill the holes in W1 and W2, just cut square holes with an X-acto. You're going to fill them up with epoxy anyway.

2) Taper the tip trailing edge stock. Pin down the lower half of the T.E. and the lower main spars. Pin down the L.E.

3) Glue rib W1 to the T.E. Lean the top outward 6°. Do not glue ribs to the main spar or L.E. The L.E. and main spar are in place to aid in rib alignment. Type A.

4) Laminate two W3 ribs together. Type D. Cut notches for the dihedral wires.

5) Cut notches for the spoiler in four of the W3 ribs.

6) Attach all the ribs to the T.E. Type C or A.

7) Complete the T.E.; i.e., add the top piece. Type A or C. When the glue is dry, remove the pins and block up the T.E. 1/4 inch in the root section, tapering to 1/8 inch at W11. Block up all ribs 1/16 inch just ahead of the main spar to allow for sheeting.

8) Glue all ribs to the main spar and to the L.E. Type A or C.

9) Roughen the 5-inch pieces of 1/16 diameter steel wire (not music wire) with the edge of a flat file and bend 10° in the center. Slip one through the lower notch in the double W3 ribs.

10) Slip in (don't glue) the fiberglass wing rod tubes and fit and glue in the spar webs. Type A. Remove the tubes.

11) Add the spruce spar top pieces. Type A. Set the prepared 5-inch wire spar splice piece in place before putting on the spruce.

12) Put in the spruce turbulator spars from W2 to the polyhedral break and the balsa ones in the tip section. Try to get these exactly flush with the rib tops. Type A or C.

13) Install the spoiler framework. Type A.

14) Install the 1/4 x 1/2 x 1/2-inch spruce screw eye base in the root rib. Type C or A.

15) Install the plastic spoiler horn. Type B.

16) Route the 25-inch nylon spoiler cable housing, as shown, through the ribs. DO NOT CUT THE TUBE SHORTER. Type C with soda.

17) Cut a 1/4-inch square piece of tin from a coffee can lid, or what have you, and cement to the spoiler. Type E.

18) Epoxy the magnet to the rib. Type E. Install the dacron cable and check out the action of the spoiler. Use Scotch Magic Transparent Tape as a hinge.

19) Remove the wing from the board and sheet the bottom of the first bay. Type A or C.

Repeat these 19 steps on the other half of the wing. When finished, proceed as follows:

20) Slip the fiberglass wing rod tubes in position in both wing halves. Check their alignment. Cement the tubes to the ribs and spars with epoxy. DON'T ECONOMIZE ON THE EPOXY. Apply large epoxy fillets around the tubes to insure that the stress in the tubes is transferred to the spar. Plug the tubes with 1/4-inch sq. balsa forced in. Leave four inches unplugged for the wing rods. Type E.

21) Epoxy the dihedral wires to the upper and lower main spars.

22) Sheet the underside from L.E. to the spar. Make sure the underside is as smooth as you can make it. In spite of what you may have guessed, been told, or may seem logical, THE SMOOTHNESS OF AN AIRFOIL BOTTOM IS MORE IMPORTANT THAN THE SMOOTHNESS OF ITS TOP.

23) Sheet the top of bay one. Type A.

24) Reinforce W1 with 1/32 plywood. Scissors cut the 1/32 ply nicely. Type D.

25) Attach the tip block *flush with the top* of W11. Type D.

26) Plane the bottom flush with the rib and radius the bottom surface.

27) Trim ends to continue L.E. and T.E. lines.

28) Carve and/or sand top surface from spar forward to continue top contour of W11. This will form the tip profile.

29) Rough carve the top rear surface to approximate shape (no material is removed from the extreme tip [outboard] from the spar back).

30) Wrap a piece of 60 or 80 grit sandpaper around a piece of broom handle, a dowel, a piece of pipe or what have you, about 1-1/2 inches in diameter, and sand in the convex shape. The T.E. of the tip should be square and 1/16 inch thick. See View C on the plans.

31) Sand the L.E. to the proper contour. It's a good idea to make a template.

32) Sand the top of main T.E. to continue the rib contour and to achieve a square T.E. 1/16 inch thick.

33) Cover the wing with Top Flite Super MonoKote. Make sure the MonoKote adheres to every rib and spar. My designs are "stressed skin" and require the superior strength of MonoKote, properly applied. Our tests have proven, to my satisfaction, that MonoKote is both the strongest and the lightest covering commercially available.

34) Cut out the spoiler. Reseal the covering to the spoiler and all around its frame. Hinge the spoiler with Scotch Magic Transparent Tape 3/4-inch wide. This acts as a return spring. DON'T LEAVE THE SPOILERS OPEN IN THE SUN.

STABILIZER

Divide the 1/8-inch O.D. aluminum tubing into four 2-inch lengths and one 7/8-inch length. Using a knife, cut the five pieces by rolling the tubing with the knife (knife 90° to the tubing) back and forth until the tube severs. The 7/8-inch piece is the bellcrank axle. Ream the hole in the bellcrank with a drill until the tube is just free in the bellcrank, not sloppy. Ream the 3/32 hole until the stab wire is a light press fit.

1) When building two stab halves, considerable time can be saved by cutting two sets of parts at once. Cut a notch 3/32 wide by 3/8 long in the center of the aft end of each rib and the tip block so that the trailing edge piece will be in the center (top to bottom) of the ribs. Cut all parts.

2) Glue the frame pieces together, including L.E., T.E., tip, root rib, braces and spar. Type A or C.

3) Glue in all ribs. Type C or A.

4) Remove the partially completed stab half from your building board. If you used type C cement, apply the type A fillets now.

5) Drill a 1/8-inch hole through the root rib and the next one for the 1/8-inch aluminum tube. Glue in the 2-inch long tube, using type C with soda or type A.

6) Go back NOW and repeat the first five steps on the other stab half.

7) Use the bellcrank to locate the correct position for the rear tubes and drill for the tubes. Before you glue in the rear tubes, set the two stab halves together with the bellcrank in between. Use the bellcrank axle, otherwise the wire will be too small for the hole in the bellcrank. Glue in the tubes. Type A or C with soda.

8) Sand the rib contour to a symmetrical shape (see Section B-B).

FIN

1) Pin the 1/32 x 5-1/2 inch square ply piece, grain horizontal, so that the back edge is coincident with the trailing edge of the tail post.

2) Using a straightedge and a pencil, continue the rear edge line of the leading edge onto the plywood.

3) In a similar manner, continue the top line of the fiberglass fuselage.

4) Use your steel straightedge and your X-acto knife and cut out the fin side. Check its size and duplicate it.

5) Cut the tail post from the 1/4 x 9/32 balsa piece and slot for the hinges. Note: The tail post is 1/4 inch front to back, 9/32 side to side.

6) Now is a prudent time to cut the 1/4 sq. rudder post and fit the hinges.

7) Cut the 1/8 x 9/32 ply fin base to length.

8) Mark the extremities of the slot for the bellcrank.

9) Cut away 1/4 inch of the bottom of the bellcrank stiffeners so as to require only a narrow slot for it to pass through the fin base.

10) Cut the slot (or notch) in the fin base. Note: The notch will be off center. It is 1-3/16 long x 1/8 wide, all on the right side.

11) It is wise to drill a new 1/16 dia. hole 1/4 inch up from the old 1/16 hole in the bellcrank to raise the elevator control rod clear of the rudder control rod to prevent interaction. Cut 1/4 inch off the bottom of the bellcrank arm.

12) Cut the center 1/4 x 9/32 separator.

13) Mark the place where the center separator is to join with the fin base and taper the width of the fin base forward of this point symmetrically to 3/16-inch wide.

14) Cut the 3/16 sq. forward separator to length.

15) Locate and drill a 1/8-inch hole for the bellcrank axle in the left side only.

16) Cut the slot for the rear stabilizer wire in the left side.

17) With wax paper over the plans, pin down the left side and glue on the tail post. Type C or A.

18) Glue on the 1/4 x 9/32 center post and the fin base (slot on left side). C or A. DO NOT ATTACH THE 3/16 sq. OR THE TOP RIB YET.

19) Glue on the right side. Type C or A.

20) Remove from board and squeeze the forward end of the sides together and glue in the 3/16 sq. separator. Type C or A.

21) Drill through the left side to locate the axle hole in the right side. Ditto for the slot. Use a drill press if you can, but

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make *sure* the hole is perpendicular. Complete the slots with knife, Dremel, or file.

22) Set in the bellcrank. *It can't be done later.*

23) Glue on the 3/32 x 1/4 top rib. Type C or A.

24) Glue on the 1/4 sq. leading edge. Type C or A.

25) See Section A-A on the plans. Cut the 1/4 x 1/2 stabilizer roots to fit the fin. Make the roots in one piece and, after gluing on, cut out the sections covering the slots. Glue on the roots one at a time, each time drilling through for the axle. Type C or A.

26) Trim the stab roots so that the overall width is 7/8 of an inch. Insert the axle (7/8-inch tube) through one side, through the bellcrank and through the other side. Check that everything is square and true; IF NOT, FIX IT! You don't want to go to the flying field next weekend with a crooked airplane. (The difference between a good builder and a poor one is not that the good builder doesn't screw up, the difference is that the good builder fixes his screw-ups.)

27) Shape the leading edge and the stab roots' leading edges.

28) Glue in the axle. Use Type C.

RUDDER

1) Pin down the rudder post previously made.

2) Cut all the 1/4 sq. pieces and glue in place. Type C or A.

3) Fit the 3/32 x 5/8 trailing edge into slots in the 1/4 sq. top and bottom frame pieces. Type C or A.

4) Install the ribs. Type A or C.

5) Install the corner brace. Type A or C.

6) When dry, sand to an eye-pleasing symmetrical airfoil shape.

FUSELAGE

Note: Fiberglass fuselages and other hardware for the Golden Eagle are available from Craft-Air, 20115 Nordhoff St., Chatsworth, CA 91311. Send SASE for a complete list and ordering information.

1) If you wish to tint your canopy, here's how. Get a pot full of hot water (hot tap water is about 135°-140°, which is ideal; boiling water will ruin your canopy) and add one package of Rit dye (dark blue, dark green, maroon, etc.). Dip in your untrimmed canopy and check it frequently until it is the shade you desire. Now, freeze in the color by rinsing in cold tap water. Dry it off promptly to prevent water spots.

2) Sand the fuselage at the parting line with 100 grit, then 320 grit. Take care not to round off the flat area where the fin attaches.

3) Use a letter P drill bit to drill through the wing tube indentations. (Letter drills are almost as scarce as hen's teeth — you can use a 5/16-inch bit and a little persuasion).

4) Install the 2-1/2 inch fiberglass tube and fill the indentation to flush. Type E. Sand flush.

5) Fabricate the canopy tray from 1/8-inch poplar ply. Type A or E.

6) Paint the tray, or cover with self-adhesive trim. (Top Flite's new Sparkle-Kote is a good choice for this.)

7) It's a good idea to tack-glue a strong brace to the canopy tray while gluing on the canopy to make sure it stays flat during the gluing. You've got one shot with a canopy; if you glue it wrong, it's scrap. Attach the canopy to the base. Type B.

8) Put 1/8-inch wide striping tape around the canopy to cover the edge of the tray.

9) Cut the notch in the aft top of the fuselage to accept the tail post.

10) Cut the slot in the top of the fuselage to allow the bellcrank to work freely.

11) Decide exactly where your radio must be put; namely, AS FAR FORWARD AS POSSIBLE. Install the servo rails. Type E.

12) Install the antenna tube. Antennas that hang out not only look amateurish, they add considerable drag. Type E or C with soda.

13) Install the towhook base, 1/4 x 1/2 x 2 spruce. Type E.

14) Towhook. There is only one correct place for a towhook. If you know where that is, an adjustable towhook simply doesn't make sense. The one on the plans makes the best towhook money can buy. Screw it in and glue it in place with epoxy. It's cheap (about 15¢ each), but that's not why it's on the plans; it's there because I don't know how to design a better one. Captured releasable towhooks are all right in theory, but you're going to have to learn the proper technique to get a better launch from one. I know a lot of pilots who think captured towhooks are great, but they can't outlaunch me. I've met one pilot who knew how to use one. I don't! Do your own thing.

15) Fashion the control rods from 3/8-inch sq. balsa, rounded. Make the wires as short as practical. Use the 1/16 wire in the front and the threaded control links aft. Slot the fuselage on the left side for the control link to exit. Wrap the rods to the wires with thread and glue. Type B or C with soda.

16) Install the servos and temporarily fit the fin and rudder.

17) When everything works smooth and free, attach the fin to the fuselage . . . VERTICAL. Type E.

18) Fit the wing halves to the fuselage. Make sure the wing incidence is correct and identical on both halves. Robart makes an incidence measuring tool that should make this an easy job. Drill 3/16-inch holes through the sides for the incidence dowels.

19) Sand and paint your fuselage (white, I hope). Remember, the prettier a sailplane, the better it flies.

20) Fashion hooks from paper clips and attach to the canopy tray back piece and the fuselage floor. Type E. Use two No. 10 rubber bands to hold the canopy on.

FINAL ASSEMBLY AND TRIM

1) Cover the fin, rudder, stabilizer, and wings.

2) Glue the hinges to the tail post and rudder post.

3) Make sure your control rods are positive. Sloppy controls are the prime cause of rudder and stab flutter.

4) Cut oval-shaped holes in the fuselage sides for the screw eyes and the spoiler cable. Put a flat washer on a No. 2 x 5/16 sheet metal screw and install in the last hole in the spoiler servo arm. Slip the looped ends of the dacron lines over the screw and check that both spoilers start to open simultaneously.

5) Initially set the trims to zero, using a 7/16-inch servo arm on both elevator and rudder and a 9/16-inch arm on the servo. The Golden Eagle is very responsive to the controls.

6) Balance your ship from the center of the spar at first. After you have flown it a few times, move it back as far as you can before the ship becomes unstable. This will vary from plane to plane and especially from pilot to pilot.

7) I believe you will be pleasantly surprised at how well the Golden Eagle will penetrate, but for all-out speed runs, ballast will be required. It takes at least one pound of lead to make any noticeable difference in the speed of a 980 sq. in. sailplane. You may wish to add much more.

8) It is not easy to find all the warps in a semi-symmetrical airfoil wing. That incidence gauge mentioned earlier should help, but it is imperative that the wing have NO WARPS . . . no washout, either. If a sailplane is a turkey in the air and/or does unpredictable maneuvers, the chances are 1000 to 1 that it's got an untrue, warped wing. FIX IT BEFORE YOU FLY IT THE FIRST TIME. Your first impression of a new ship determines, in large measure, how well you will fly it later.

FLYING

Keep the speed up! This is a high-speed airfoil. If you slow it down, as you may be used to doing with your Paragon or Windrifter, the Golden Eagle will fall out of the air. On the other hand, it will do some cute tricks the aforementioned cannot do. With sufficient control movement, it will loop so tight that if you bat your eyes, you'll miss it. It can thermal inverted and it will do the nicest outside loop you could want.

The launch is almost vertical, but the speed must be kept up. This is a different breed of cat and you're going to have to put in some stick time to get the most out of it, but the more familiar you become with its characteristics, the more pleased you will become with its capabilities. •