EKTACHROME BY DON DEWEY

ESPRIT

A SEVEN FOOT, 20 OUNCE, HIGH PERFORMANCE SAILPLANE BY

Lee Renaud

These words from the poem "High Flight," written 30 years ago by an American trainee pilot, best described for me the thrill of R/C sailplanes. Those of you who have flown sailplanes know and understand the emotion and challenge resulting from the world of silent flight. To them and to those modelers who have not yet tried this exciting sport, this article is dedicated.

My involvement with building and flying model airplanes goes back to the time "High Flight" was written. I have enjoyed all phases of this hobby including Indoor Flying, Control Line Speed and most particularly Wakefield competition in the late 1950's. Nothing has provided me with the satisfaction derived from R/C sailplanes! The challenge is infinite. The variety of models and tasks is limited only by the imagination and daring of the flier. No matter what you are flying now — or if you are a newcomer to R/C modeling, I urge you to try R/C sailplanes. Once you do I believe that you will share my enthusiasm.

While there are many excellent kits available for those who find the convenience necessary, only by designing and flying your own ship is total involvement possible. The model presented here is one persons approach to the ultimate goal of flying higher, longer, and farther than anyone else.

The Esprit is a high performance sailplane designed around modern two channel miniature proportional equipment. With a wing span of 84", it offers competitive performance with convenient size. The plug-in wing panels and removable tail group provide convenient packing for traveling to contests or the local field. It is in the air, however, that this bird belongs. And your first flight will prove that this model was worth the time spent in the shop.

Esprit's most significant characteristic in the air is precise and immediate response to your command. She will fly smoothly, hands off, trimmed for straight flight or an open thermal hunting turn. Once she finds lift you can bring the nose around in a tight flat turn without excessive banking or danger of side slipping. She is equally responsive to pilot control which makes spot landing a cinch — just fly her into the final approach and tap down when you reach the spot. The normal glide speed is medium-slow, but somewhat faster than expected from this type model. By feeding in a little down trim she will move right along and cover a lot of sky quickly.

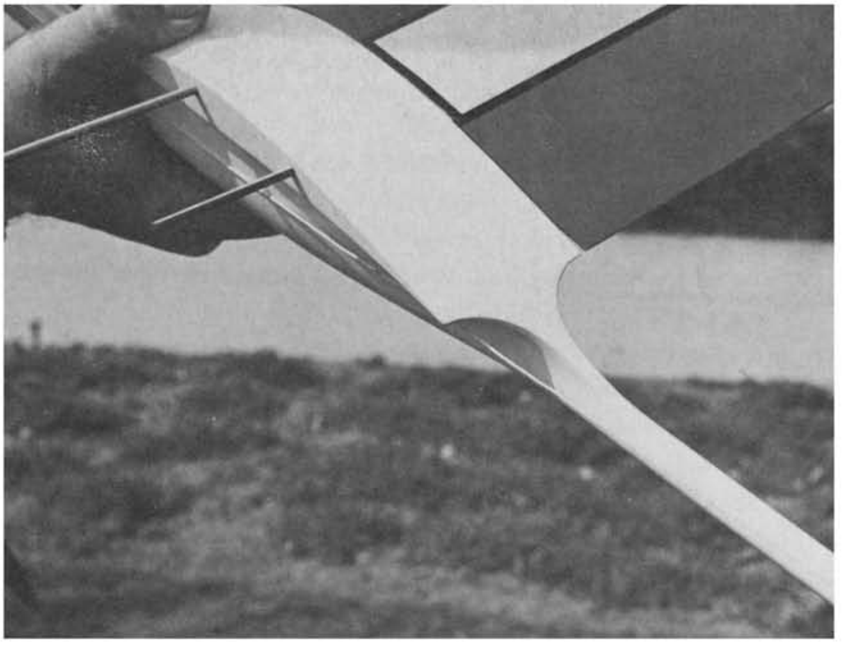
"Oh! I have slipped the surly bonds of Earth
And danced the skies on laughter-silvered wings;
Sunward I've climbed, and joined the tumbling mirth
Of sun-split clouds — and done a hundred things
You have not dreamed of — wheeled and soared and swung
High in the sunlit silence . . . ."

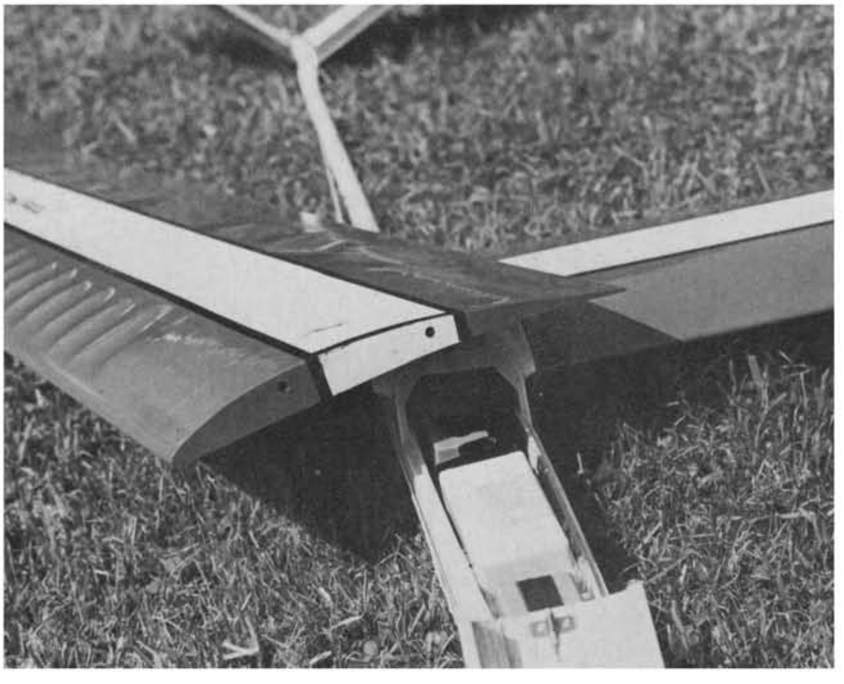
Esprit was designed primarily for thermal duration and precision flying. Most of my personal flying is from small fields using the Can Winch described in the June 1971 RCM. This launching method is quick and easy to set up and the 350-450 foot altitude gained is plenty for this model to find any low lift present. If you prefer to use an electric winch such as the RCM Winch in the May 1971 issue, don't worry about standing on the button and letting loose. She will go up very quickly and won't need full speed on the way up. I have hand towed with excellent results but find the Hi-Start more in keeping with my physical condition! As an extra bonus, if you have a slope site available, just add an extra quarter ounce of ballast to the nose and toss it off. She will fit beautifully in winds up to 15 mph with no other trim changes. In fact, the excellent performance on the slope has been a pleasant surprise.

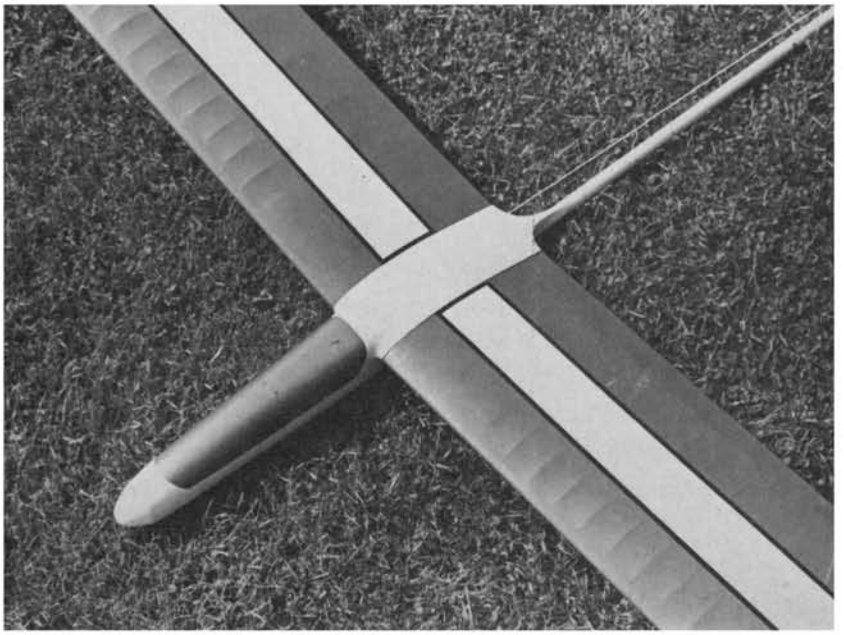
DESIGN

The Esprit design objectives were to provide a lightweight model with minimum drag. With an equipment weight of approximately 7 oz. and a desired wing loading of 4 oz./100 sq. in., an area of 500 sq. in., and flying weight of 20 oz., were selected as basic design parameters. Previous experience has shown that an airframe weight of 12-14 oz. was achievable with a 500 sq. in. sailplane if carefully built and finished.

The heart of any sailplane is the wing since this provides the total lift and major drag of the model. The tail group provides longitudinal and yaw stability while the fuselage houses the radio and ties the whole thing together. Since the wing plays such an important part in overall flight characteristics, it must be the focal point for design.







The root wing chord is 6.5 inches since this has proven out well in Nordic A/2 gliders which fly at similar speeds. The planform selected is a constant chord center section and parabolic tip outlines. The parabolic outline provides more area for a given span than the more usual elliptical tip shape and was selected for that reason. This results in a flat span of 84" and an aspect ratio of 14:1, with a total area of 508 sq. in. Polyhedral is used for its superior turn characteristic. Polyhedral is not as aesthically pleasing as straight vee-dihedral nor do full-scale sailplanes have "bent" wings – but, it just plain flies better which is what this sport is all about. The airfoil selected is the Eppler 385 which seems optimum for thermal work. This section has a low entry profile with moderate undercamber and a flapped trailing edge. Maximum thickness is 8.4% and the general shape is similar to the NACA 6409 which I have used with success over the past twenty years. The only problem with this airfoil is that the trailing edge is thinner than standard stock and must be carved from sheet to maintain correct cross-section.

A Vee-tail was chosen because of its lower drag and lighter weight when compared to a conventional tail group. In addition, the high dihedral angle gets the surfaces out of grass or weeds for landings; particularly the wingtip style so many of us favor! The flat area of the tail is 116.5 sq. in. with each panel raised 35 degrees from the horizontal. This provides an effective stab/elevator area of 96 sq. in or 19% of the wing area. The effective rudder area is 33 sq. in. or 6.6% wing area. Rather large elevons are used with a fully sealed hinge line to ensure precise control response. A flat structure with tapered elevons is easy to build and align for proper incidence and provides a slight lifting section.

The fuselage is a modified pod and boom design with minimum cross section to reduce drag. A reworked Williams Bros. spinner provides a clean nose and convenient ballast box. A removable cabin gives access to the R/C equipment. The maximum area is located near the midpoint of the chord and, when combined with the filleted junctions, ensures that the entire wing panel is working effectively.

The structure shown has been proven strong enough to withstand all normal handling and flight loads. There is no way to build a successful crash proof sailplane, so attention has been given to 'survivability' and 'repairability' rather than to walking away from vertical landing approaches! My first Esprit survived a 2000 foot terminal dive with both wing panels intact, the fuselage was intact and radio equipment was working normally. Damage was limited to both sections shearing off at the fuselage junction (that was glued in place rather than bolted on) and a fuselage finish that looked like a hard boiled egg dropped from six feet!

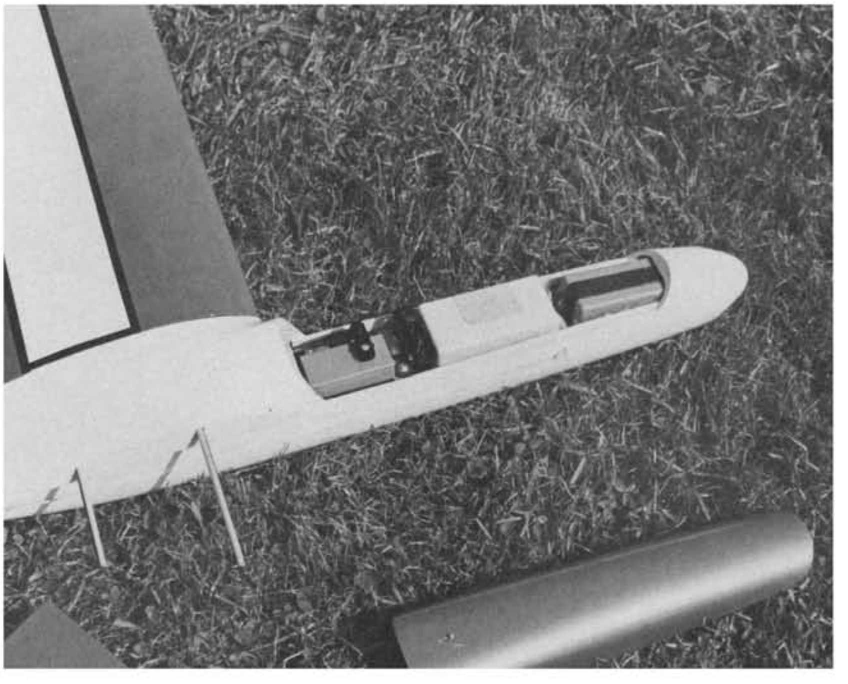
The wing tips and tail group are of lightweight construction to minimize polar moments with the major masses grouped near the Center of Gravity. This improves response to lift and minimizes deviations from the flight path from gusty or turbulent air. This is good practice with any flying machine and particularly important for soaring models.

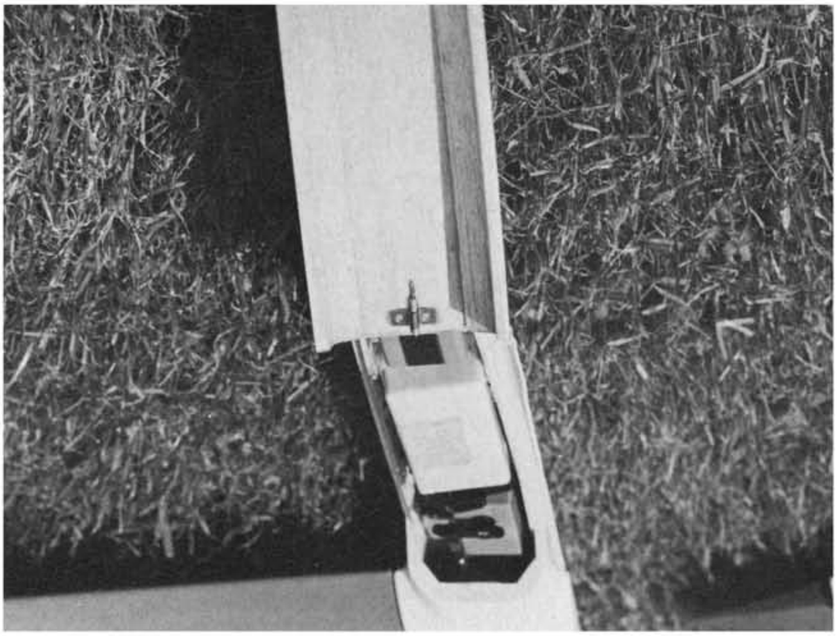
CONSTRUCTION

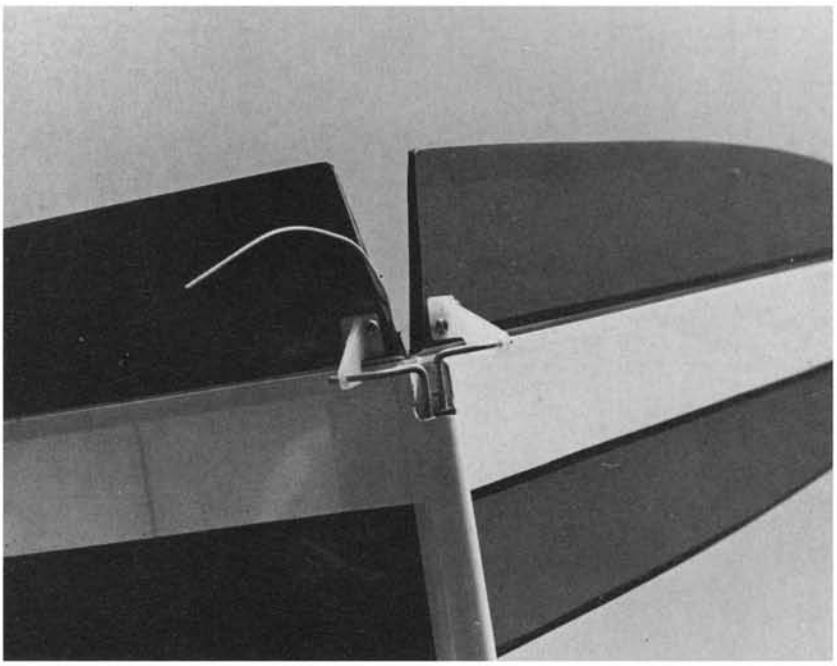
Those of you familiar with free flight models, particularly Nordic gliders will find no strange construction techniques. Those accustomed to foam wings and .60 engines will have to develop a feel for the lighter construction necessary for sailplanes. Select your wood carefully using lightweight stock throughout unless otherwise noted. I suggest that you follow the construction sequence indicated. First, mail a check for $4.95 to Airtronics, P.O. Box 132, Sierra Madre, California 91024, for the finished lightweight fiberglass boom. Visit your friendly hobby dealer and pick up the material not already in your shop. Everything is standard wood size and hardware normally stocked.

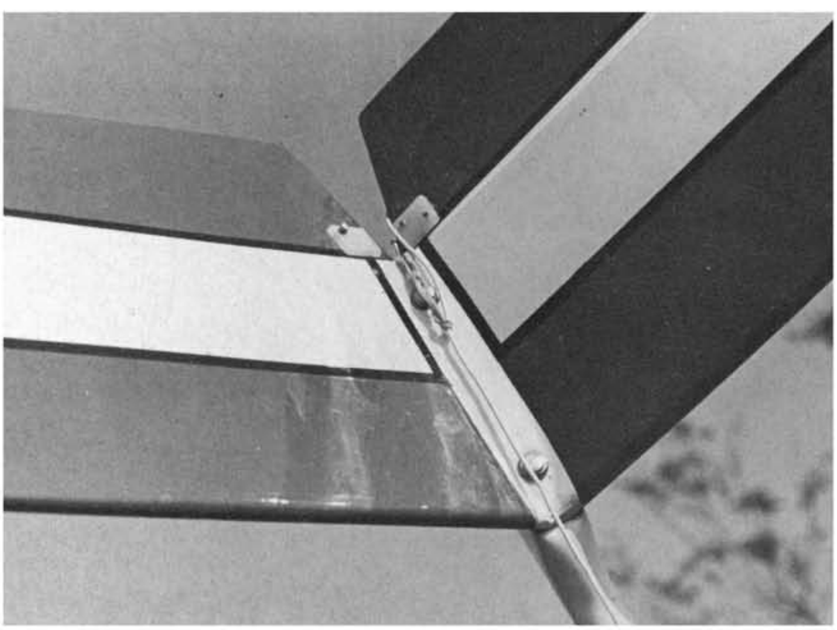
TAIL GROUP

The trailing edge can be cut from sheet stock but the time spent to laminate it from 1/8 sq. strip is repaid in a stronger structure. Soak 3 lengths in the bathtub. Cover plan with Handiwrap and drive stiff pins 1/16" inside the inner edge of the outline. Remove the strips after 15-20 minutes and strip off the excess water by running through your fingers. Run a bead of Titebond Glue down the opposite sides of one strip. Press the 3 pieces together. Lay a piece of 1/16" x 1/8" spruce vertically against the pins and press the balsa strips against the spruce. Put another piece of spruce outside the rear edge. Now, starting at the center, press tightly against the inner pins and drive the pins against the outer spruce strip to hold in place. Work out toward the tips allowing the 1/8" sq. strips to slide against each









other around the curve. The spruce strips prevent the balsa from being squashed by the pressure of the pins. This outline must dry for at least 8 hours before removing from the board so I suggest laminating the wing tip and trailing edges, letting both dry thoroughly.

Now, pin down the 3/16" sq. spars and leading edges. Spot glue the spars together to aid sanding later. The leading edge will follow the curve without soaking in water. Cut the center and tip blocks from soft 3/16" sheet and all ribs from 1/16" x 3/16" strip. I suggest dry fitting all parts then gluing all at the same time. Use Tite-bond or Devcon 5-Minute Epoxy for all joints. Carefully lay out and drill the 1/8" holes for the mounting screws.

When dry, remove intact from the boards. Using a block with #320 paper, sand smooth on both sides. Round leading edge, taper elevon ribs and sand smooth taper along the span, blending tips carefully. To maintain a straight hinge line, the tail is inverted from the position when built on the boards; so do all shaping near the tips on the bottom surface. Now split the elevons loose and bevel leading edge. Cut fixed section into two pieces centering cut through mounting holes. Use a square or triangle to ensure accuracy. Block up the tip of the panel 8" above the work surface and bevel the center joint using a sanding block against the bench edge, ala hand launch glider style. Be careful not to sand a sweep into the joint. Prop up each tip 8" and join with Devcon. Cut a reinforcing block to fit the joint and glue in place. When thoroughly dry flip over and, using holes as pilots, drill through the tail and block from bottom side. Insert eyelets for mounting screws and the tail is ready to cover.

WING

Cut out 4 root ribs R-1 and 6 center across ribs W2, A, B, C from 1/16" plywood. Stack together and sand to ensure accurate outlines. Now, drill 1/8" dia. holes for the wing mounting wires through each pair of ribs, doing the 4 root ribs together. Mark location on each rib. Work very carefully and remake any deffective parts since the alignment of these ribs is critical to the model's performance.

Cut 26 balsa rectangles ¾" x 6" from soft 3/32" sheet and sandwich between any pair of center section ply ribs. I use pushrod ends with one end bent at right angles and a #2-56 nut as tie rods to hold the stack together. Carve to outline. Cut spar notches, and sand the stack. The tip ribs W-4 to W-9 are cut in pairs by spot cementing two blanks together. Gluing the proper template from the plan to the balsa with rubber cement. Cut through paper and both ribs together then sand smooth and peel the paper off. Split ribs apart and mark.

Since no standard tapered trailing edge stock will match the proper airfoil shape, you have to carve your own. This is actually quite easy and takes less than 30 minutes to complete. Select the hardest quarter grained 1/8" sheet balsa you can find – strip 1" width from wider stock if necessary. Set up a simple jig using a 24" length of .125 and .045 music wire epoxied 1" apart to a flat stiff piece of wood. Lay 1/8" x 1" stock between wires and plane or carve a rough taper in the section. Now sand smooth, resting the block against the wires which provide accurate stops. Repeat for the second panel and you are finished. Notch for ribs using an 8" warding file or two hacksaw blades taped together to cut slots.

Bevel the leading edge to rough shape using a small block plane, and start assembly of the center panels. Lay the plan out flat on your work surface. Spot glue the shims for the spars and trailing edge to the plan. Cover plan and shim with Handiwrap, and pin the trailing edge in place. Use 3-4 ribs to locate the leading edge and pin it in place. Lay the lower spars approximately in place and start gluing ribs in place. I strongly recommend the use of Titebond glue to assemble the wing since the flexibility of the joints prevents shattered panels in rough landings. Check the alignment of your ribs and also check that the spars are flush with the rib lower surfaces.

Now cut and fit the 1/32" vertical grain webbing for the forward spar. The web fits between the two spars and, because of variations in wood sizes or rib notches, should be cut to fit. They will be approximately 11/32" high. Now add the 3/32" sq. hard balsa anti-torsion diagonals. Add the top spars, inserting scrap balsa ties between the rear spars and against the diagonal. These add a great deal of stiffness to the wing so don't leave them out! Let dry.

If you haven't already laminated the tip trailing edges, do it now. When dry, carve the taper. For better accur-

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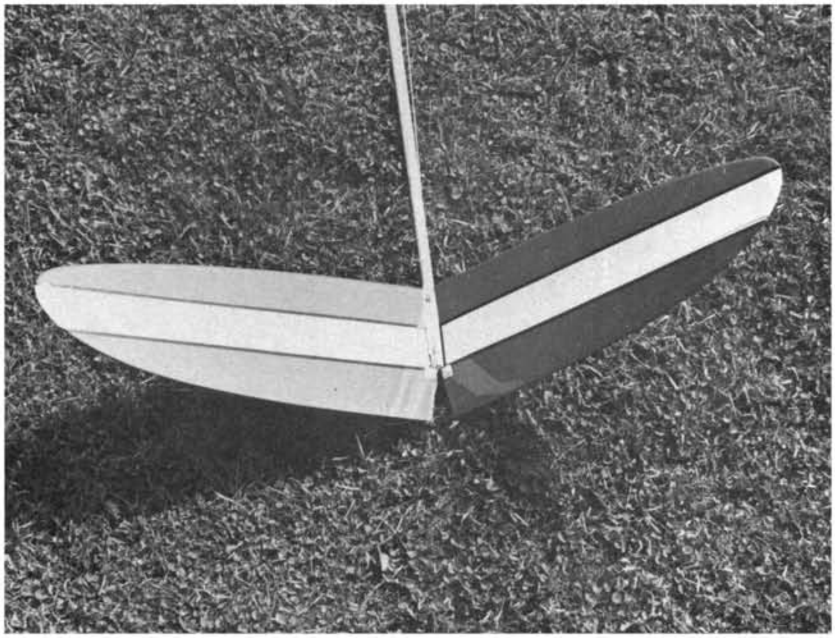

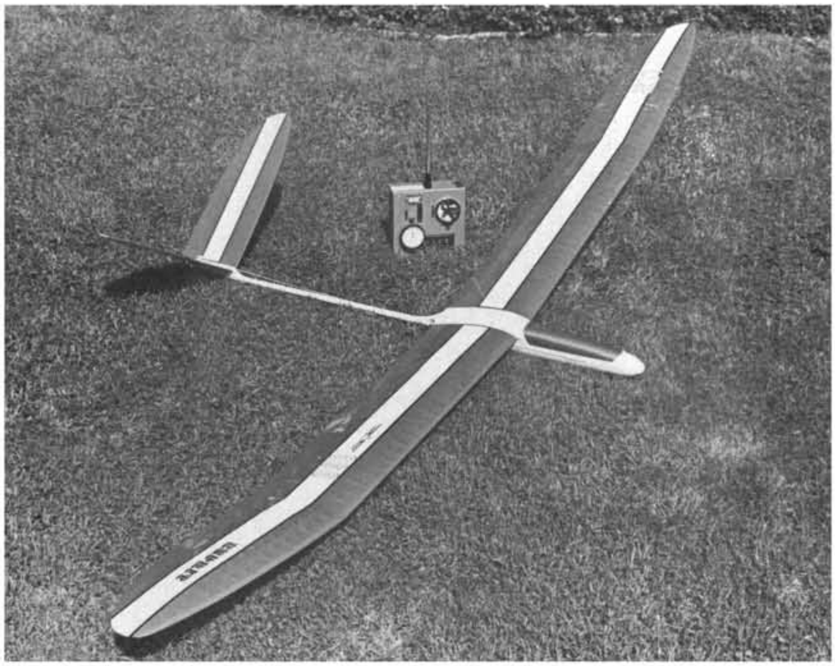

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acy I suggest building the tip panels onto the completed center panel, but they can be built separately and joined as a second step if you prefer. Butt center panel to port rudder. Break line and prop the root rib above the board. Pin the tip T.E. and L.E. in place, and glue the ¼" thick end rib in place. Because of the tip shape the spars are not straight but curve upward in a slight arc. By cutting the lower spars to fit tightly between the tip rib and end rib of the center panel it will spring into place with a natural curve. Add ribs, checking fit of spars against lower surface of ribs. Spar webs are not required in the tips but the diagonals and rear spar ties must be added. For ease in construction the false ribs are installed as simple balsa rectangles fitted individually between the L.E. and front spars. These are rough carved and finish shaped by sanding. Cut full depth slots in the ribs at polyhedral break and insert 1/16" bass or ply dihedral braces. Add top spars and let dry.

Remove from board and check fit of ribs at leading and trailing edges and spars. Correct any deviation from proper alignment by cutting joint apart and re-cementing. Now comes the tedious job of filling in around the root ribs with balsa sheet. There are 48 separate pieces to fit and glue in place, but they are critical in tieing the center section together. If the work seems too much for you then wrap a 1/64" ply or Marvelite around the root section. Complete the lower surface and let dry. Now run a 5/32" dia. drill through the 1/8" pilot holes in the ply ribs checking that both holes are parallel. Insert the tubing for the wires and trial fit both panels together. Correct any misalignment without shifting location of holes in the root ribs to maintain fuselage alignment. Check dihedral angle and make sure that the center panels are not twisted. When satisfied, rough up the outer surface of the tubing with file or coarse sandpaper and epoxy in place. I find that Sig Epoxy does an excellent job for these high stress joints. Now fill in the top suface spaces using soft 3/32" sheet moistened on the outside so that it curls to follow the airfoil shape. When this is completed, sand the wing all over using care not to sand flat sections on the ribs, particularly on the bottom surface.

FUSELAGE

If you use Devcon the fuselage can be completed in 3-4 hours. By now your boom should have arrived. Since it is ready to use when received, start cutting the rest of the parts out and join together. Glue the ply root ribs and 1/8" balsa filler ribs together. Drill through with #21 or 5/32" dia. drill. Carefully line rib up on one side following the drawing to get the proper incidence. Now pin both sides together in proper alignment and drill through to transfer the hole location to the second side. Run two lengths of tubing through the holes to act as pilots for the second root rib. This ensures that both wing panels have the same incidence.

Using a #11 X-Acto blade cut through the side along the bottom edge of the root rib from F-2 rearward. Join the sides together with F-1 and F-2 over the bottom view checking squareness. Allow to dry throughout. Now wet the outside of the rear section with household ammonia – I stick it in a water glass full of the stuff. After 10 minutes remove and draw the rear together carefully. Install F-3 and put a glop of Devcon at the back and where the sides come together. Hold the thing for 10-15 minutes or clamp till dry. Don't panic if the sides crack at F-2 and, if you have trouble bending together, then cut half way through the sides from the inside and bend sharply rather than following the gradual curve. Check that both sides are bent evenly by laying over the bottom view on the plan – that's why the bottom of the pod is straight. The rest is easy.

Insert the boom through ½" holes in F-2 and F-3. Lay the pod over the plan and check the boom alignment. If necessary, file the hole in F-3 until the boom is flat on the workbench and falls on the centerline. Epoxy the boom in place.

Make a gauge from scrap plywood to just slip over the root ribs at F-2. Then slide back to the trailing edge to squeeze the root ribs parallel. Install the 3/32" floor between the sides, following the contour of the lower surface. Check the distance between the ribs which should be 1¾" (if you cut the formers accurately) and fit the rear section of soft ¼" sheet between rib extensions. Cut the forward piece of top sheet the same width and glue in place. When dry, trim to follow the side curvature, but do not shape. Layout hatch cuts on the side and cut out with a razor saw and knife. Use a metal straightedge taped in place to get straight cuts. I make the side cuts first with a knife then saw through the ¼" sheet and corner pieces following the knife cuts as a guide. Now you can install the 3/32" x ¼" spruce rails – wedging apart with scrap balsa so they fit tightly against the sides. Check the fit of the hatch which should lightly snap on over the rails. Then add the hatch front holdown tab.

Before gluing the bottom in place, I suggest a trial fit of your radio installation – you did make the pushrods and slide when the wing was drying, didn't you? If satisfied, then close up the bottom with soft 3/8" sheet. Cut the rear skirt off a Williams Bros. 1-5/8" dia. spinner leaving a flange 1/16" thick. Sand flat and drill for #2 mounting screws. Square off the front end and epoxy and screw the hub to F-1. Carve and sand to the cross section shown on the plans. I find squeezing the pod between my knees with the boom hooked between my feet while sitting securely, holds the beast while sanding shoe shine fashion with a 1" wide strip of sandpaper. Start with #120 then follow up with #220 and #400 paper. When properly rounded there should be a 5/32" wide portion of the corner piece visible. Add fillets of Epoxilite or Hobbypoxy Stuff. Sand smooth. Now drill through top block for the wing tubes and epoxy the tubes in place.

Cut out the tail mounting saddle parts from plywood. Locate the holes in the 1/8" floor from the stab and install Tee-nuts. I used #2 metal screws to hold the tail but 4-40 nylon would offer additional shock insurance. Don't try #2 nylon screws – they are not strong enough for air loads. Glue the sides and floor together upside down using two pieces of 5/32" tubing under the floor to space the saddles accurately. Wrap sandpaper around the end of the boom and fit the saddle to the boom similar to fitting a canopy. Now bolt the tail to the saddle; install the wing rod in the front tube, and rest on the blocks 3" up from the bench on each side. Apply epoxy to the saddle and place on the boom, blocking tips until equidistant from the bench. When dry, remove tail, add front fairing block and shape.

COVERING AND FINISHING

The wing and tail are best covered

in one of the heat shrinkable plastic materials. They do a quick job and minimize warping problems and are better flying and more durable than other coverings. The original models were covered in Solarfilm, using six pieces for each panel with seams on the spars.

The pod should be covered with light silk for additional strength. The original model used epoxy as a base which developed stress cracks after some rough landings. The weight with silk is the same, and durability greatly improved. The entire pod except the top section between the ribs can be covered in one piece of silk without seams. Fill the pores with Stazon Sleek or your favorite sealer and sand smooth.

There are many materials available today for final finish and if you have a favorite method, go right ahead. I have had good success with Duplicolor Automotive Touch-up Acrylic in spray cans. Available in a wide range of colors it is fast drying, sands easily, and rubs out with high gloss. It is tough and durable. Repairing Touch-up is also easy – give it a try. It is available at all Sears automotive departments.

RADIO INSTALLATION

The original models were flown using a Kraft Series '71 KP3-S System with KPS-12 servos and 225 mah battery pack. Full details for this equipment are shown on the plans. Orbit/Micro and Cannon gear have also been checked and will fit if you remove the case from the pack and tape the 225 cells together. For other gear, you are on your own. Space is tight so either enlarge the pod or layout your installation very carefully.

Several different installations have been tried including placing the receiver under the wing, with servos forward. NyRods have also been used but I prefer pushrods for greater control precision. The 1/8" dowels are adequately rigid and the use of inner tubing from Pylon Golden-Rods epoxied into 1/8" I.D. aluminum tubing provide end fittings which are tapped 2-56 for ease in adjustment with parts made from .074 dia. push-rod ends.

Sequence of installing equipment is as follows:

1. Make up pushrods w/o rear links and attach to the rudder servo mounted on the slide. Insert the rear end into the forward end of the boom and push through. Dowels will flex sufficiently to ing along the rails travel.
3. Install the elevator servo using the forward mounting screws and 1/16" thick mounting tape. Adjust for neutral position with the threaded link to the slide.
4. Now install the receiver and batteries.

FLYING

Check all surfaces for proper alignment and remove any warps. Wash-out is not necessary in the tip panels but wash-in is very undesirable. Center panels and tail panels must be flat. Check proper C.G. location and ballast if required to balance at rearward location shown on plans. If you selected your wood and finished the model properly very little ballast should be necessary. This balance point is for calm air flying and is the most rearward position recommended.

Experience with all types of models has shown me that a slight nose heavy trim is safer for initial flights. A slightly fast glide is easy to control with elevators but a tail heavy trim leads to stalls which are harder for the inexperienced pilot to control. I have seen many models broken from stalls and none from mild dives. Thus I suggest you add ½ ounce of ballast within the spinner for initial flight testing. Final trim can be obtained by removing weight.

Unless you have a great deal of experience, I don't recommend hand glides to verify trim. It is easy to stall the model with resultant damage if thrown too hard. In addition, ground effect influences the flight path significantly and makes fine trimming impossible. If set up as described, the Esprit can be launched safely in winds up to 18 mph by winch, Hi-Start or slope. The slope with light wind and lift is perhaps easiest for the novice since the model is closer and nearer eye level which makes flight attitude and response easy to judge. If no suitable site is available then use the Hi-Start or winch. Don't worry about maximum altitude, just get up in the air high enough to establish a glide path and try out the control response.

Detailed trimming and flight instructions would require a separate article so it cannot be included herein. Write RCM if you would like to have this kind of information published in the magazine. The basic idea is to establish a minimum sink glide with neutral control in 5-10 mph wind conditions. Then adjust for variable winds with elevator trim. I will be happy to answer any questions about this model if you will send a stamped self-addressed envelope to Lee Renaud, c/o R/C Modeler Magazine.

Good Flying! □