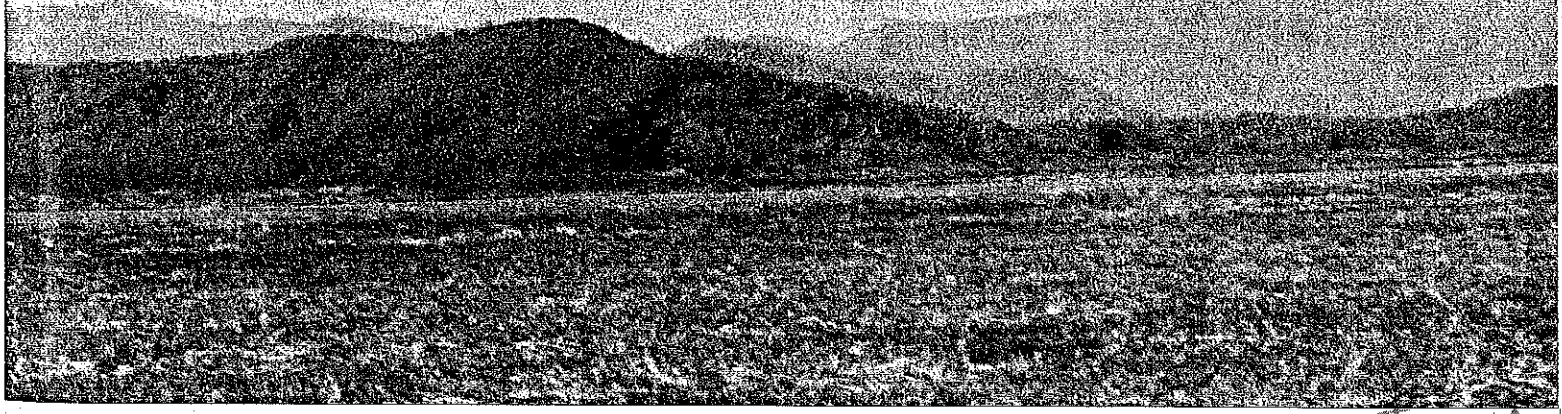
Heat Seeker

Leon Kincaid



Heat Seeker is a sailplane for everyone. It can be built as an aileron airplane, or rudder controlled with polyhedral. It can be 114 or 122 inches in wingspan, and all versions are sheeted over built-up wings and stab (or sheeted over foam).

I wanted to design a new model with modern-looking lines, but I didn't want to go whole-hog high-tech. (I also didn't want to have to plunk out 400 to 800 bucks on new sailplane.) Many modelers still like to build using traditional construction methods.

I designed the Heat Seeker around my standard planform, but I tried to clean it up as much as possible. I elected to reduce my Scooter's airfoil thickness from 12% to 11%, while maintaining the same mean camber (MC). This left a MC of about 3.3%, which is halfway between the well-known S3021 and the SD7032. It's been good to me for the past ten years, so why change?

My airfoils have placed first at the AMA Nats a total of five times, so they can't be too bad. So far, the Heat Seeker has placed first in SMT at the 1992 and 1993 LSF Championships, flown by John Gunsaullus.

The plans show basic built-up wing and tail surfaces, completely sheeted. For those who would rather cut foam cores, templates are also shown.

The first thing most people notice is the light stab. If you have ever flown free flight hand launched gliders, or have seen the drawings of HLGs in the magazines, you will notice the small skinny fuselage. These gliders really get bounced around without breaking. Why? Because the stabs and rudder are built so thin and light, there is less stress on the fuselage.

So if you decide to build a Heat Seeker, don't use solid sheet to save time. Keep the stabs and rudder as light as possible. The spars in the stab are primarily to keep the ribs from falling over, and the webs give a place to hold the stab during installation and removal.

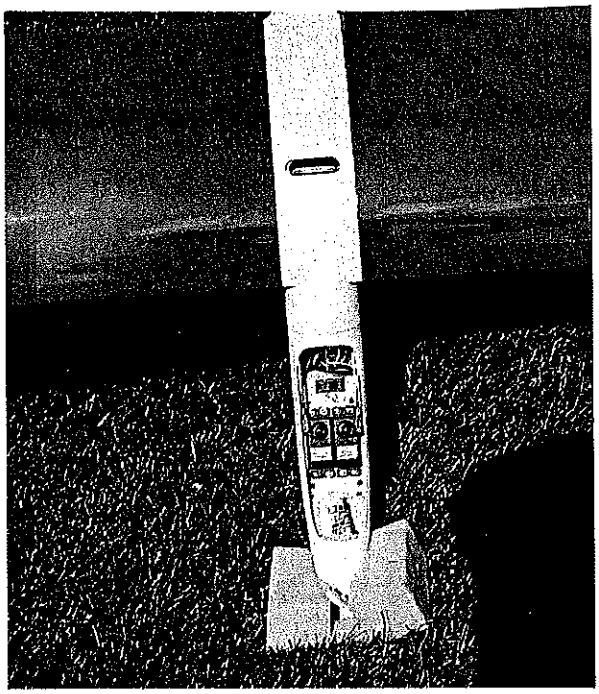
I use eight-inch-wide 1/16 wing sheeting (from Superior Aircraft). I hate to splice narrow sheets together! The foam templates shown are also for 1/16 sheeting. If you wish to use the thinner obechi, you will have to modify the templates. If you have Chuck Anderson's airfoil program, you can select airfoil Scoot 33, reduce it to 11%, and plot any skin thickness you desire.

A number of small details are not shown on the drawings because everyone has their own way of doing things.

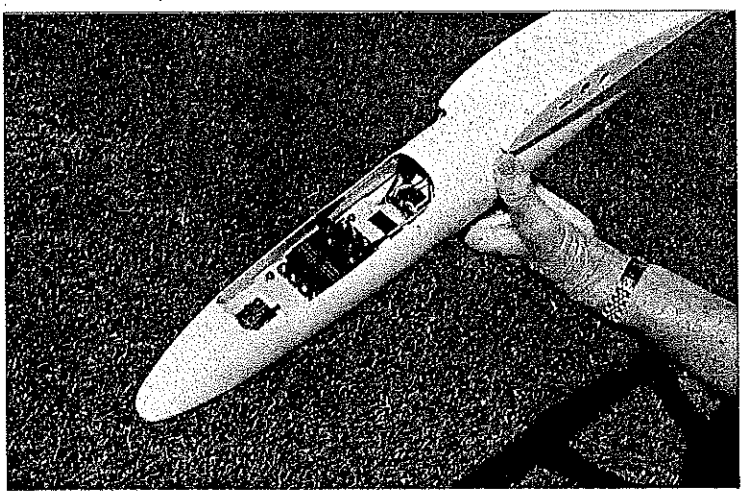
For instance, I cut a small slot in the top of my fuselage to have access to my wing screw-eye retainer hooks; some modelers prefer to tape the wings to the fuselage. If you try this on a film-covered wing, the film will pull away from the sheeting. To eliminate this problem, wrap clear 3M tape around the last

Heat Seeker

Above: Aileron version of Heat Seeker is held by the author's wife, Helen. Wingspan is 122 inches; weight is 72 ounces.



Access hole for wing retainer hooks is optional. Switch and servo mounts are clamped on fuselage rails.



Right: Plug-in section of receiver is accessible with nose cone removed. Standard Futaba S-148 servos are a close fit.

1½ to 2 inches of the wing. Then you can safely tape the wing to the fuselage with narrow vinyl tape.

On my first Heat Seeker, I used a separate Deans three-pin plug for each wing servo and connected them manually when the wing was about two inches from the fuselage. On my second and third planes, I used a four-pin Deans plug to power both the flap and ailerons, with the female glued in the fuselage and the male glued in the wing butt.

In the fuselage I've been using standard Futaba S-148 servos side-by-side. It's close but they fit. I use a sliding or movable servo mounting bracket.

CONSTRUCTION

Building tips: Select only spars that have close grain and in straight layers. Use the best and/or heaviest spars in the inside panels and the poor grain or lightest on the outer panels. Use the same techniques to select the wing sheeting.

Use only the best epoxy around the wing tube. I use Hobbypoxy #2 in many places, including the fiberglass fuselage, but *not* around the brass tube—HP #2 will not adhere to brass. Use Texxon, Devcon, or anything you have tested to be superior.

Always use a template when drilling. I use a twist drill for small holes and brass tubing with teeth filed on the end for drilling larger holes.

Drill vent holes in every wing rib, fore and aft of the spar. Also drill the stab and rudder ribs, and make an outside hole somewhere on the rudder, like on the leading edge.

To reduce future wrinkles on dry days, dehumidify or dry all balsa parts for three or four days in a heated or air-conditioned house, an attic, or a hot box.

Do not cover parts if cold. Warm each surface with a heat gun before covering.

Let's start building! These construction notes are for built-up and sheeted surfaces only.

Wings: The first thing you need is a template of the master airfoil. I use 1/16 phenolic, but you can use 1/16 plywood. Cut five W1 ribs; one for a template, two for W1s and two that will be cut undersize and added to the inside of the fuselage wing butt.

You may prefer to add epoxy on the inside to support the wing tubes, but I like more support, and this gives me some "meat" when gluing the Deans connectors in place.

Cut the spar notches later. I usually drill a W1 first and then transfer the holes to the master and the remaining W1s.

Use a W1 as a template to cut all other ribs, including W29. Add spar notches to every rib. Note that the top spar notch on W1 is only 1/16 x 3/8; all the rest are

⅛ x ⅜.

Lay the bottom spars over the drawing, including the six-inch tip. Add a rib to each rib location. With a fine felt-tip pen, number each rib and the portion that will be the flap and/or aileron rib. Also add a cutoff mark on the tapered ribs at the leading and trailing edge of W16 through W29.

Cut W16 through W29 to overall length. Contour the top of W25, W26 and W29 as shown on the plan.

Stack W15 through W25 on a short piece of spar stock and contour the tops (only). Now stack W26 through W29. The bottom shape of the ribs *does not* change. Note: Maintaining the bottom shape and contouring the top only automatically gives the tip about 2° aerodynamic washout.

Place all ribs over the plan and mark where each rib will be cut at the flap and aileron hingeline, allowing for the two ⅛ thick edges. Of course, if you are building the polyhedral version, you will not cut for ailerons. On the flap panel, just mark W1 and use as a template to cut W2 through W14.

Drill the required holes and renotch the top of the tapered ribs. All ribs should be ready to assemble.

Glue wing rod tubes in W1. Be sure to lay W1 flat and use a square to align the tubes. When dry, file a 1/64 flat on the bottom corner of four-inch tube to maintain 3° when installed. If you use a 5/16 rod with 11/32 tube, a flat is not required.

Lay Saran Wrap over the plan, lay all spars in place, add the 1/16 shim under the Saran Wrap, and add W5 through W29. Add W1 and let the tube lay over until it touches the spar. If you drilled the hole in the proper place, the tubes will be at 3°.

Add the top spars, the 5½-inch-long spacer between spars at the end of the ⅜ brass tube, the 8½-inch plywood web, the ⅛ x 5/16 TE and the ⅛ x ¼ LE.

Add epoxy and microballoons around the tube and add the 5⅛-inch web. I usually add tapered scrap basswood to the area above and below the tube to reduce the volume of epoxy.

Cut and add W2 through W4. When dry, pick up and add .003 carbon fiber sheet ¼-inch wide on bottom spar. Add .007 CF 3/16 wide to the top spar. This CF not only adds rigidity to the wing, but also allows the sheeting to bend over the ⅜ spars without leaving a flat spot.

Wrap or bind each end of the tube area with fine Kevlar thread. Do not overlap threads.

Add the bottom sheeting to each panel. Add the servo frames, fabricate the doors, add blind nuts, and all remaining webs. When adding the servo frames, be sure that the servo arm cutout is on the proper side. Before gluing, set the frame in place, drill through the four holes and through the bottom of the wing. Insert the screws, turn the wing over, put the door over the protruding screws, and use the door as a template to cut the door access hole in the bottom of the wing.

Lay the flap and aileron panels back over the plan, but substitute a ⅛ x 2 shim for the 1/16 shim. This will allow you to construct the flaps and ailerons on a flat surface, up against the back of the wing.

Add the flap and aileron bottom sheeting, the ⅛ x 5/16 leading edges, and all ribs. Apply slight pressure on the top of each rib when gluing in place; each rib has a bit of undercamber. When dry, the ribs should pick up the sheeting slightly.

Cut a slot in the bottom of the flap and aileron between the supporting ribs for the bottom horns. Remove the flaps and ailerons for now.

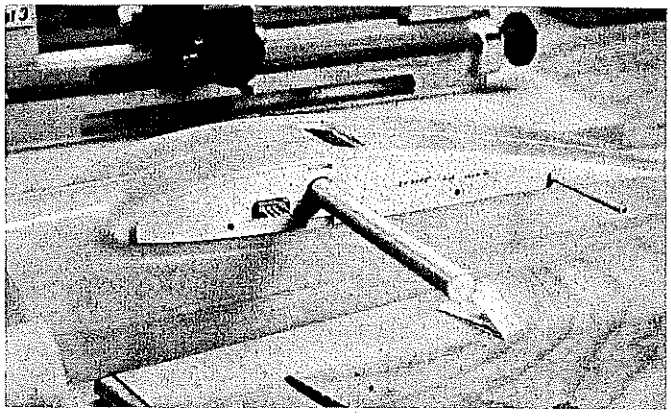
The wing may now be prewired. Add the top sheeting using slow-drying epoxy. Replace the flaps and ailerons and add sheeting to these surfaces.

Lay each panel upside down and sand the joining ends with a square sanding block (aileron version only). When the fit is perfect, epoxy the panels together.

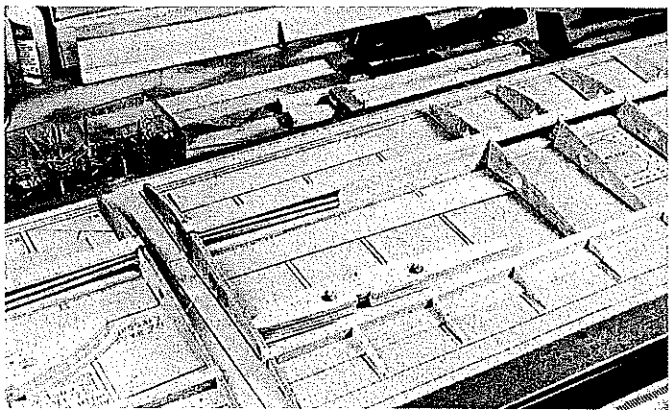
Cut and sand the excess from the leading edge, add the LE cap and tip block, align the ½-inch trailing edge on the bottom of all required surfaces, and tape in place. Then spot-glue with CyA. Remove the tape and complete gluing. Do not add the 1/16 plywood cap rib until the wing is fitted against the fuselage. All that remains is planing the excess from the TE and LE, and sanding. After sanding, smear a little epoxy around the panel joints.

The wings with six-inch tips will end up with about 2° washout. A wing with two-inch tips will need about ½° additional washout to end up with 2° total.

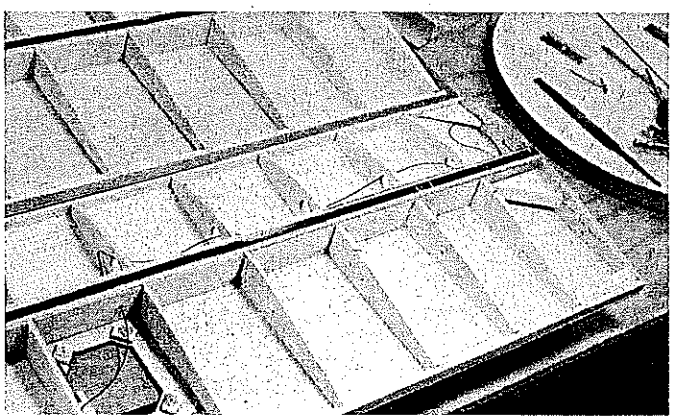
Stab: Build the stab next, because you need the stab template to drill through the rudder/fin. Fabricate a drill template from 1/16 plywood, the



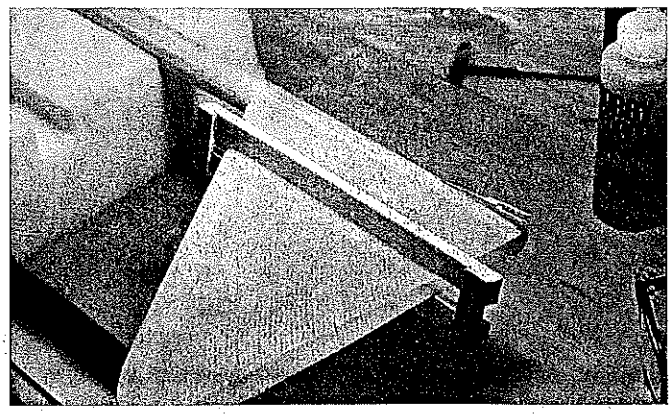
Four-pin Deans connector is trial-fit into the fuselage at this point. Male portion is in wing, female in fuselage.



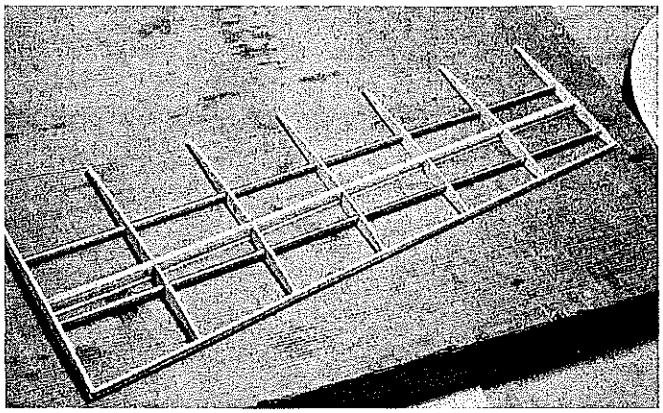
Area above and below the wing tube is ready to be filled. Plywood webs are then added to each side.



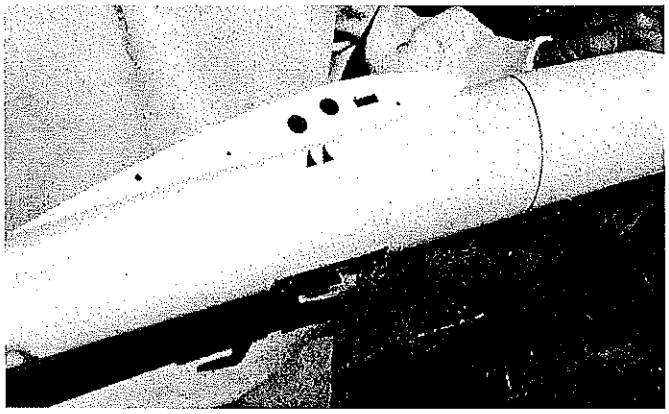
The wing is ready for prewiring and addition of top sheeting. Spruce top and bottom spars have carbon fiber caps.



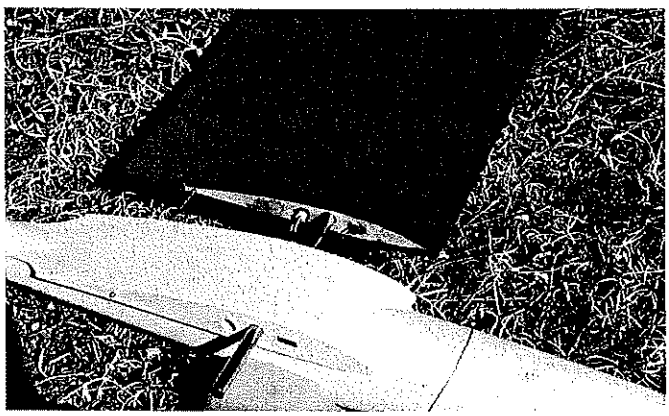
Plans detail construction of jig used to position a rib on the rudder/fin and align the rudder post.



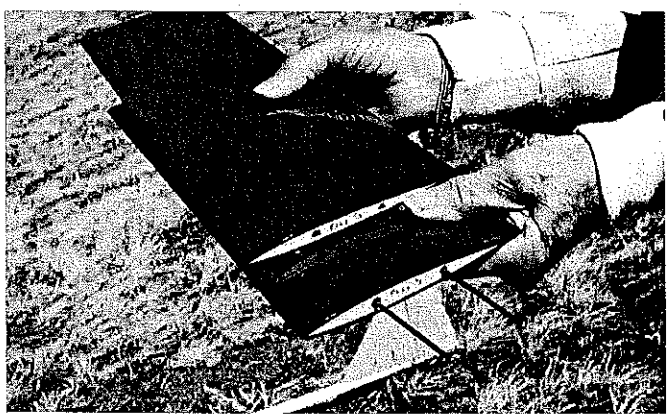
Two 1/8 tubes are inserted through the stab ribs to aid alignment. First two ribs on each stab half are 1/16 basswood.



Fuselage side view shows CG settings, female four-pin connector for flap and aileron, and homemade towhook.



The four-pin plugs make assembly quick and easy. Steel front wing rod is 11/32 x 10; rear is 3/32 x 6. Source in text.



Stab is joined by two 3/32 x 5 steel rods. Fully sheeted stab panels weighed 28 grams (less rods) prior to covering.

same length and width as S1. Leave the template rectangular. Drill the two 1/8 holes for the stab tubes 1½ inches apart and 1 7/16 from the LE.

Use the template to cut and drill four 1/16 basswood ribs for S1 and S2, and ten 1/16 balsa ribs. Number ribs S1 through S7. Contour S1 and S7 as shown on the plan.

With two 1/8 tubes 12 inches long, add the ribs (for one side at a time) and space over the plan. Align S1 and S7 at each end and mark at the LE and TE where the excess will be cut from S2 through S6.

Stack the ribs on two short tubes and contour S2 through S6. You can mark the ribs while stacked and notch them for the spars, or reinstall on the 12-inch tubes, space, mark and notch over the plan.

Lay the spar over the plan and add each rib, the spars and LE, or use the two tubes as a building jig, but be careful not to CyA the ribs to the tubing. Add the bottom sheeting, being careful not to distort the frame. Install the webs and tubing with wheel collar and lay on a flat surface. Shim with long strips of balsa under the LE and TE areas, making sure the stab is not twisted.

Add slow-curing epoxy on each rib, spar, LE and TE sheeted area. Add the .003 x 3/16 carbon fiber sheet on the TE and add more epoxy on top of the CF.

Now add the top sheeting. Since it's hard to pin through carbon fiber, I add two strips of 1/8 x ¼ straight stock to each side of the TE and clamp them in place. When dry, add the tip block, the 3/16 cap rib and the LE cap.

About the wheel collar: don't use a heavy brass or steel collar. I use a Perfect aluminum collar. It has a 2-56 thread, which is okay, but I drill and tap for a 4-40 set screw. Use the set screws and Allen wrench from the heavy collars.

Rudder: This is the fastest part of all. Lay the LE on the drawing, add the ribs, pick up and lay over the right side sheeting. CyA the sheeting to the LE, then to the ribs. Don't forget vent holes. Add glue, CF trailing edge and the left side sheeting. Clamp as done on stab TE. Add the top and bottom blocks, carve and sand, and add the horn.

Fuselage: It sure is nice to have the fuselage almost completed. After I carved the plug, added the wing plug-in area, wing fillets and rudder fin, I sent the fuselage to Bob Sealy to make a mold and lay-up the fuselages. Bob does a very precise job; each fuselage weighs about 10½ ounces.

Wash the fuselage thoroughly, then drill the wing rod holes and other holes as required. You can epoxy the cut-down W1s (with radii on inside corners to clear the large fiberglass radius inside the wing butts) before you drill the fuselage, or drill the fuselage first and predrilled W1s later.

In any case, clamp the master airfoil template on one side of the wing butt. Take time to align with the top of the airfoil and the leading edge. Drill one side, then move the template to the other side.

Put a tube all the way through and check to see if it is square with the butt. Add the tube and wing rods and slide the wing into place to check how they fit. If your drilling was off, you can elongate the holes slightly;

Heat Seeker

Type: RC sailplane

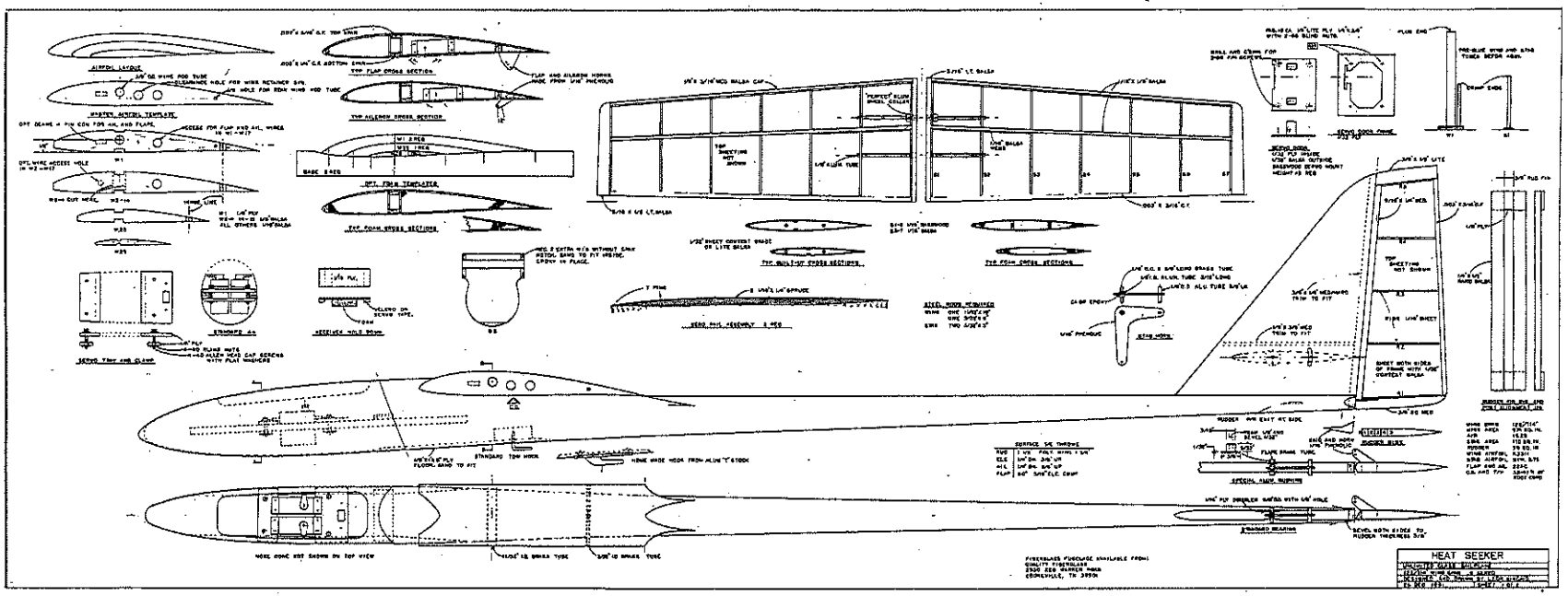
Wingspan: 114 or 122 inches

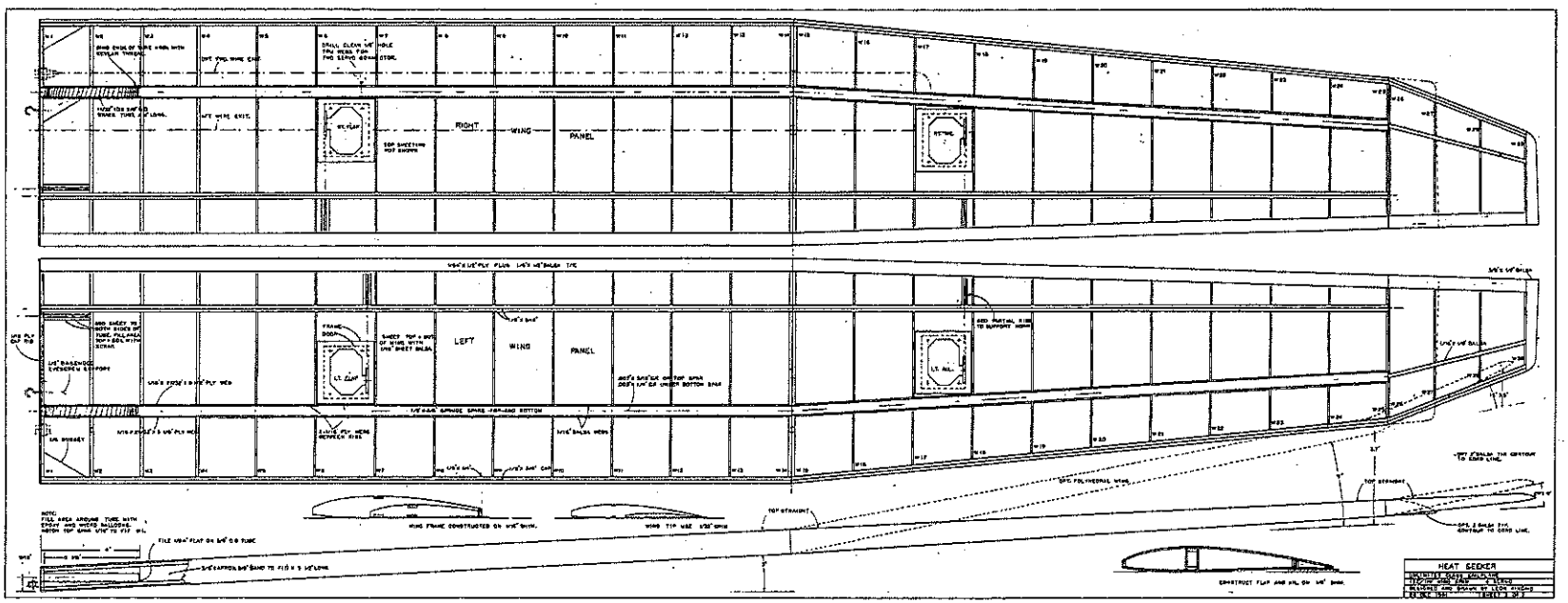
Number of servos: Six

Flying weight: 72 ounces

Construction: Fiberglass fuselage, sheeted surfaces

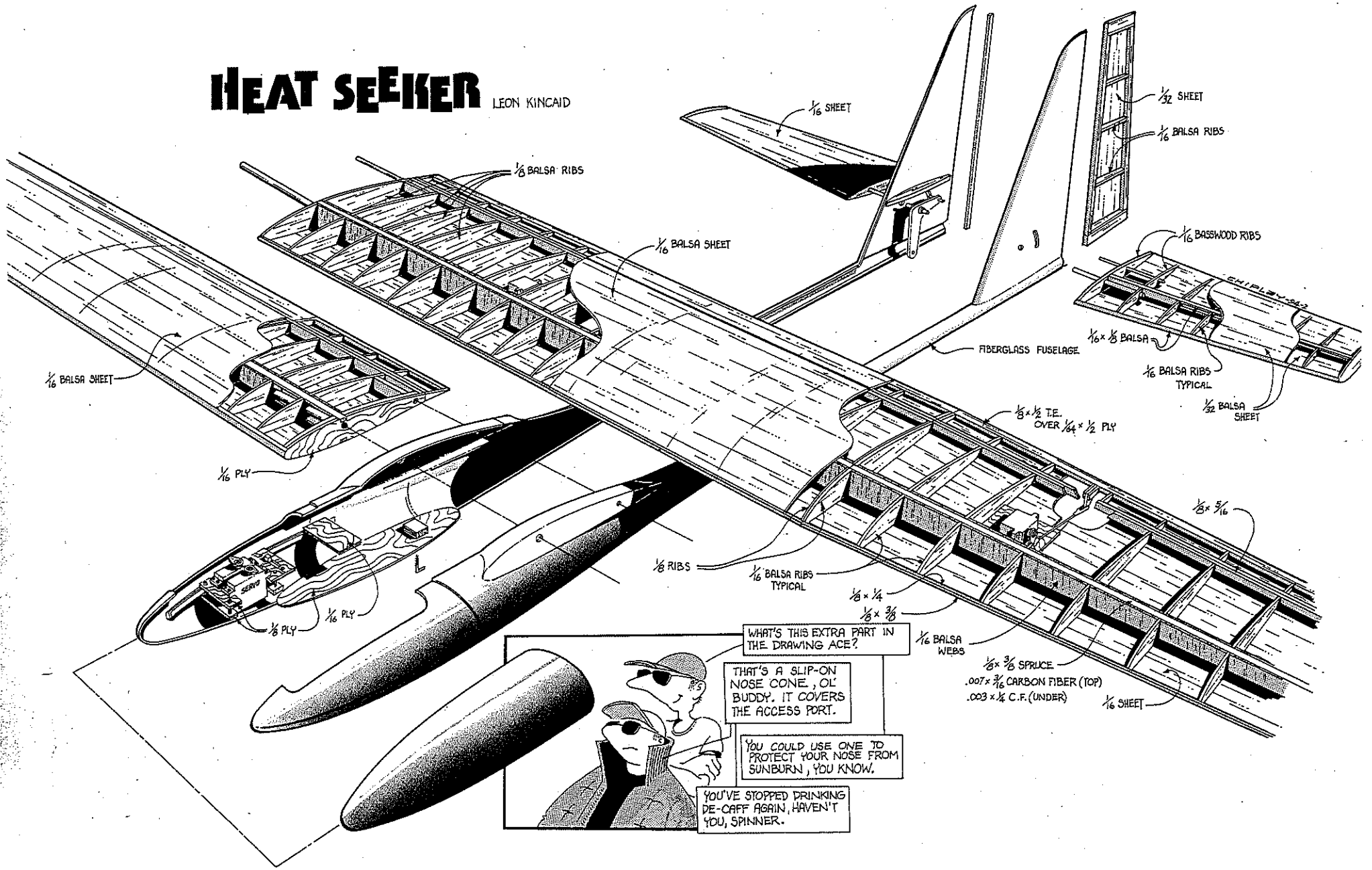
Covering/finish: Hobbypoxy on fuselage, MonoKote on surfaces


HEAT SEEKER


RIGHT WING PANEL
LEFT WING PANEL
HEAT SEEKER

HEAT SEEKER

LEON KINCAID



when you add the W1s inside, the tube can be located in the proper place. Or you can sand the butt of the wing until it fits perfectly.

When it is perfect, you can add the 1/16 cap ribs on the wing. The holes in the cap ribs should be the same OD as the wing rods.

I fabricate the servo rails to the inside contour of the fuselage. Use strong T-pins or small nails to align and glue the spruce strips. If you don't have five 1/16 x 1/4, you can use 1/8 x 1/4, but you must use three strips in order to hold its shape. You will have to sand or cut 1/16 away from the width in the servo area. Use either epoxy or CyA to laminate. Do not glue into the fuselage at this time.

I use a clamping type of servo mount on the rail. This allows me to move the servos around, or replace different servos with no problem. After everything is right where I want it, I glue a small piece of scrap plywood on top of the fuselage rail to keep the servos from sliding forward after one of my hard landings. Try my clamp mounts, at least while you're lining everything up:

Insert the lower part of the mounts that have the blind nuts. Add the long rails and the top part of the mounts, and insert the Allen bolt into the nuts until the assembly comes together, but don't tighten.

Attach servos and screw to mounts. Slide the assembly forward until the servos just touch the bottom of fuselage, and the servo arms clear the fuselage sides. Raise the whole assembly slightly so the servos will not touch the fuselage when all screws are tightened.

Mark the inside and/or outside (fuselage is rather clear) and epoxy the side rails into place. You can epoxy the rails by removing everything and reinstalling the rails on the marks you added, or add Saran Wrap between the clamp/mounts and the rail and reassemble everything. Use Hobbypoxy #2 for best results. If you have larger servos, you will have to move them further aft.

Fabricate the stab horn from 1/16 phenolic. Draw a horizontal stab centerline on the rudder/fin, using the top of the rear fuselage as a reference line. Mark where the stab bearing is to be drilled.

Cut, trim, and fit a rib just above the horn position. Before epoxying this rib in place, drill a hole near the leading edge to run thin-wall teflon tubing up the leading edge of the rudder for the antenna. The rib should be 1/4 inch from the rudder hinge line. Epoxy rib in place using the alignment jig shown on the plan.

Cut and trim the rudder/fin post, but do not epoxy in place. Use the stab drill jig to drill the stab bearing hole through the rudder/fin. Since it's difficult to hold the fuselage and drill this hole on a drill press, I fabricated a jig to drill perpendicular to the surface.

Insert a piece of tubing or wire and add the wing rod, and eyeball from the rear to make sure they are parallel. If not, you can elongate or file the hole as required. When you add the 1/16 plywood doubler to the inside, make sure the tube or stab bearing is level and square with the sides. Don't glue the stab bearing in place yet.

If you can machine a special stab bushing as shown, you must drill a 3/16 hole. These flange-type bushings need no doublers, and may now be epoxied in place.

To drill and slot clearance in the rudder/fin for the rear stab rod and spacer, insert the main ⅛ stab bearing, and add the stab drill jig over the bearing. Drill through the rear jig hole where the top of the slot will be. Continue to drill a series or line of holes, rotating the jig on the front bearing, to the bottom of the slot. Now drill the opposite side. Remove the jig, insert a ⅛ OD jeweler's or needle file and file webs between the holes. Presto! a neat slot.

Add the pushrod and antenna housing. I use steel cable for pushrods. Hobby Lobby sells cable and ⅛ OD housing in 20-foot lengths. Cut cable and housing length slightly oversized and set aside. Using a hand drill to make a ⅛ hole on the right side for the rudder pushrod exit.

Drill bits are not designed to cut on the sides, but can do so on rather soft material. Once the bit is through the fuselage, lay the drill over and elongate the hole so the pushrod will exit at an angle. Remove the drill and complete the angle with a ⅛ OD file. Continue to file until the pushrod housing is at an angle that will allow the cable to run directly to the rudder horn without bending.

Add the housing and epoxy in and around the exit. Install the cable and clamp it to the edge of the canopy opening in the position to line up with the servo arm. Lay the fuselage on the right side.

Looking inside, the housing and cable should be lay against the inside of the fuselage, with a long gentle curve, and line up with the servo arm. Use a long piece of music wire to carefully add globs of epoxy every five to six inches. When complete, leave the fuselage on its side to dry.

Remove the cable and trim excess epoxy and housing at the rudder exit. With a solder link on the elevator pushrod, connect the cable to the stab horn and temporarily install the cable, housing, and horn in the fuselage. Again, clamp the cable to the inside of the canopy opening. Be sure the housing is close to the horn, but not so close as to keep the horn from freely moving through full *up* and down. To hold the housing in position, I usually wedge a small piece of balsa over the top of the housing at the smallest point in the fuselage.

Now lay the fuselage on its left side and add epoxy. When dry, add a teflon antenna housing down the rudder LE and into the fuselage. You cannot glue the teflon anywhere, so stick a short pin through the end of the tubing, inside the rudder/fin, to keep it from sliding forward.

The pushrod and antenna tubes can also be held in place by fabricating a few soft balsa or foam bulkheads and lightly gluing them in the fuselage boom. I add a plywood keel inside the fuselage to add strength and give me a base to add blind nuts for the towhook. It also makes a good base to add a block of hardwood to screw in an angle-type hook. It's not shown on the plan, but I also add a piece of ¼ dowel inside from one LE area to the other as an anti-crush bar for my hard landings.

Finish: Sealy recommends a spray of

automotive primer first, primarily for finding pinholes. He could add more epoxy or gel-coat to eliminate the pinholes, but this would add weight and very little strength.

On my first Heat Seeker, I sprayed white automotive primer, filled the pinholes with Model Magic, sanded and primed again, and finished with white automotive lacquer. This finish chips easily.

I primed the second fuselage the same way, but finished with white Formula U. This is a much harder finish, but is heavier than lacquer.

On the third model, I sanded, got out my old Miller spray unit, and sprayed on white Hobbypoxy undercoat with their quick spray hardener and filled the pinholes with thinned-out Stuff, wiping off the excess. After a light sanding, the fuselage was sprayed with white Hobbypoxy paint, again using their quick spray hardener. This is a super-hard, light finish.

Whatever you do, spray it white. Other colors will absorb heat and weaken the fiberglass.

I highly recommend covering the wings, stabs and rudder with MonoKote and Vinylwrite lettering. I hinge the wing flaps and ailerons with MonoKote tabs. If you use tape, tape the flaps on the bottom and the ailerons on the top of the wing.

Radio: I am presently using a Futaba 7UAFS with S-148s in the fuselage. The standard servo that comes with the JR X347 sailplane version even fits better.

For flaps I have two S-9601s in one model and S-3002s in the other. Both use the same case and have metal gears. The 3002 is slower and has higher torque. Both are the same size as the Airtronics 401.

My ailerons use two S-5102s; this is really an S-133 with metal gears. My third plane uses JR 341s in the wings.

On the plan I show the servos held in place with short blocks glued to the door. These blocks should be marked, put in a vise, drilled and tapped with the servo screw, and glued to the doors. Putting the screw into the block while in a vise will keep the block from splitting.

If you like to use servo tape, leave the blocks off, smear some epoxy on the plywood side of the door, cover with Saran Wrap, lay face down on a slick surface, add weight, and allow to dry. When dry, peel off the wrap and you have a super-slick surface for the tape—it

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must be slick. I've tried several servo tapes, but the best I've used is Permabond from Radio Shack.

Balancing: With everything finished and assembled, sit the plane on the floor, and balance at the most aft position you plan to use. Tape a small paper cup on the top of the nose. Pour in lead shot until the plane balances.

Remove the nose cone and battery, sit or hang the fuselage vertical, and pour the lead shot in the nose. Mix about a tablespoon of epoxy and pour on top of the shot. When the epoxy has cured, add a round disk of foam and reinstall the battery. Each of the three Heat Seekers weighed 72 ounces.

Flying: Heat Seeker flies much like a fast Scooter, but the way it flies will depend mainly on the pilot, not the airplane. Most experts know how they want to set up their surface throws, based on how fast they plan to fly, whether they plan to use dual rates, etc., but the throws on the plans will get the average novice safely in the air. Final correlation between rudder/aileron and flaps/elevator will depend on you, your radio and your trimming technique.

Most fliers are pretty good at adjusting that new model for the first flight, but why go through all that hand launching and stab adjusting and take a chance of breaking a new plane? Here is a sure-fire safe first-flight procedure:

Balance on the CG mark shown on the drawing. Put the towhook directly under the CG.

Place the fuselage on a table or workbench (you can remove the wings).

Shim the fuselage until the top of the tailboom is level with the table. In this position the wing will be at approximately 1.4 to 1.5° positive incidence.

With the radio on, adjust the stabs to a 0° setting. You should measure the same distance from the table to the center of the stab leading edge as to the stab trailing edge.

With a felt-tip pen, put a small mark on the rudder/fin at the stab leading edge. With this CG, wing angle, stab setting and towhook position, your first launch should be perfect, and the glide should be nice and level. You will find that you can grab this fuselage under the wing and not be forced to awkwardly launch by holding the tailboom.

Good luck, and have fun! ✈

Sources: Fiberglass fuselage and foam cores: Bob Sealy, 2530 Zeb Warren Road, Cookeville, TN 38501; Tel.: (615) 526-4770.

Thin carbon fiber and kevlar thread: Bradley Model Products, 1337 Pine Sap Ct., Orlando, FL 32825; Tel.: (407) 277-9132.

Eight-inch-wide balsa sheeting: Superior Aircraft Materials, 12020-G Centralia, Hawaiian Gardens, CA 90716; Tel.: (800) 488-9525.

The best 11/32 wing rods: Dave Squires, 935B La Mesa Terrace, Sunnyvale, CA 94086; Tel.: (408) 245-8111. ✈