



Why not combine some space-age composite fibers with some early technology and engineering for light weight and strength?

LEFT: Trixie Fabry of Milwaukee, hefts "The Spirit of Chernobyl," a lightweight craft designed for the smaller 4-stroke engines. RIGHT: With the O.S. FS 20 4-stroke up front, the Spirit is able to handle grass strips (provided the grass hasn't grown too tall since the last mowing). The FS 26 Surpass or similar sized 4-strokers would be the ideal --- power to spare without losing the more pleasing four cycle exhaust note.



SPIRIT OF CHERNOBYL

A Setback of Technology

This model owes its life to my weakness for bargains. Among the overflow of stuff lying around my shop were a spool of Kevlar sewing thread I'd bought on sale, and an unused O.S. FS 20 4-stroke engine I'd picked up cheap. Like many of my great bargains, I didn't have any use in mind for either, but there they were. One day while pondering my growing accumulation of useless things, I had a brainstorm for the Kevlar thread; use it as bracing wires to make lightweight fuselages ala the World War I stick and wire aircraft construction method. I came up with a technique of sewing the bracing through the structure and anchoring it to toothpicks. This method was described in detail in my article, "Sewing a Fuselage," in the July 1993 issue of RCM.

By William L. Potter

While the concept was old, the material and technique were new and unproven. I decided to build a quick, cheap model to test the Kevlar sewing thread method in actual use. I wanted something big enough to see in the air and big enough that it would be a valid trial of my system. I had a couple sticks of 36" leading edge stock in my scrap heap, so that would be the wingspan --- six feet. I also had the little FS 20 4-stroker, so that would be the power plant. My brother threw in a spare radio and four extra servos (with the provision he could fly the plane if it worked), so it became a four channel design.

Although the model was intended to be only a testbed, I decided it ought to have a

little style just in case it actually worked; should the model survive, I didn't want something downright disgusting sitting around my shop. A simple boxy-looking design took shape in my mind, a spartan craft reminiscent of the 1920's when many aircraft builders went about their trade unencumbered by thoughts of streamlining, compound curves, and other such foolishness.

After I started building I began having nagging doubts about the model; the plane seemed too large, the engine too small, and the structure too uncertain. A bulky mismatch of modern and obsolete materials thrown together by questionable technology and driven by an untried, undersized power plant held the potential for a man-made disaster of epic proportions. Hence the name: **Spirit of Chernobyl.**

SPIRIT OF CHERNOBYL

Designed By:
William L. Potter

TYPE AIRCRAFT
Sport Monoplane

WINGSPAN

72 Inches

WING CHORD

10 3/4 Inches

TOTAL WING AREA

783 Sq. In.

WING LOCATION

High Wing

AIRFOIL

Clark Y

WING PLANFORM

Constant Chord

DIHEDRAL, EACH TIP

2 1/2 Inches

OVERALL FUSELAGE LENGTH

48 3/4 Inches

RADIO COMPARTMENT SIZE

(L) 9 3/4" x (W) 3 1/2" x (H) 5"

STABILIZER SPAN

24 Inches

STABILIZER CHORD (incl. elev.)

7 1/4 Inches

STABILIZER AREA

148 Sq. In.

STAB AIRFOIL SECTION

Flat

STABILIZER LOCATION

Top of Fuselage

VERTICAL FIN HEIGHT

9 Inches

VERTICAL FIN WIDTH (inc. rud.)

9 1/4 Inches

ENGINE SIZE

.15-.20 2-stroke/ .20-.26 4-stroke

FUEL TANK SIZE

4 Ozs.

LANDING GEAR

Conventional

REC. NO. OF CHANNELS

4

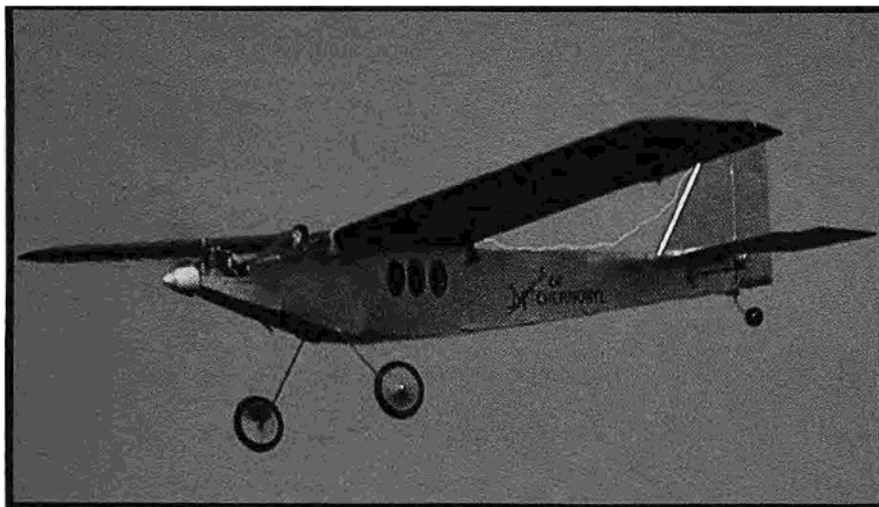
CONTROL FUNCTIONS

Rud., Elev., Throt., Ail.

BASIC MATERIALS USED IN CONSTRUCTION

Fuselage . . . Balsa, Ply, Spruce, Kevlar Thread
Wing Balsa, Ply, & Spruce
Empennage Balsa & Spruce
Wt. Ready To Fly 72 Ozs. (4.5 Lbs.)
Wing Loading 13.2 Oz./Sq. Ft.

But then came the surprise. Despite the dubious engineering and the seemingly too-small power source, the Spirit flew . . . and flew well! Slow, graceful, and very realistic, with flight characteristics similar to many full-sized lightplanes like Cubs or Champs. The O.S. 20 had enough oomph to drag the Spirit off a grass runway after a run of about 20' or 30' and climb out at a comfortable rate. Once airborne, the Spirit flew willingly at partial throttle. Although the only testing was done behind the ramping might of the little FS 20, I imagine that with the more common O.S. FS 26 Surpass (or similar sized 4-stroke) up front, the performance might border on lively without losing any realism. Although the Spirit was created for the smaller 4-strokes, a .15-.20 2-stroker would probably work well if you don't mind the less realistic exhaust note. Or, if you want to



eliminate the exhaust note entirely, you might want to engineer an electric conversion. Be sure to keep watch on your weight and balance when installing different power plants.

The Fuselage Design:

The fuselage structure is made of 1/4" sq. medium hard balsa sticks braced by Kevlar sewing thread. The forward end is strengthened by some 1/32" birch plywood formers, a few pieces of 1/4" sq. spruce, some plywood and balsa gussets, and a 1/8" birch ply fire wall. If 48" long sticks are not available for the longerons, use 36" lengths with extra material carefully spliced on using a scarf joint. If you do use spliced longerons, put the splices toward the tail.

The Kevlar sewing thread came from Brookstone Hard-to-Find Tools. I haven't seen it in their recent catalogs, so you may have to ask about it. This project requires a thread with a breaking strength of over 15 pounds. If your supply of Kevlar thread breaks at a lesser load, just double the strands used. Also be aware that for many uses, Kevlar thread is supplied waxed or with some other form of protective coating. If you have such a material, be sure to test it to make sure CA glues take readily to your particular Kevlar (see Addendum).

CONSTRUCTION

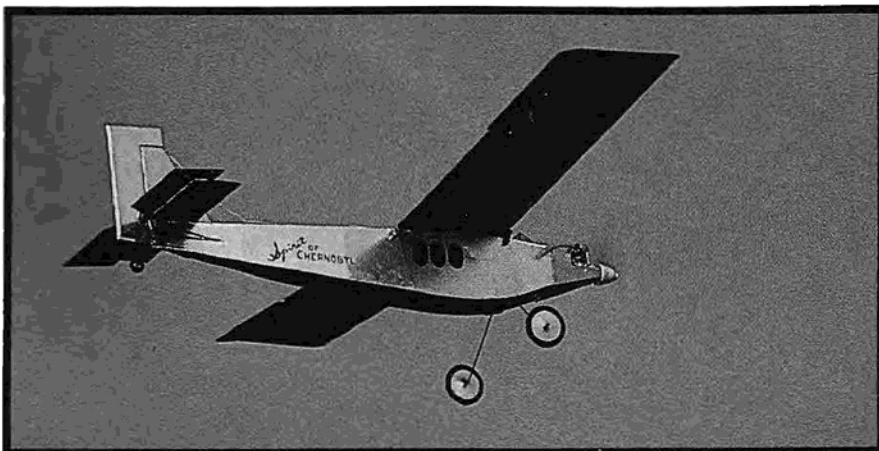
The construction technique is discussed

in detail in my "Sewing a Fuselage" mentioned earlier. The process in brief: A length of Kevlar thread is passed through a needle and tied to form a long loop. For more strength, add more loops. The fuselage sides are built in a jig holding the longerons and the uprights. The Kevlar thread cross-bracing is "sewn" in place by passing the needle and thread directly through the balsa longerons (with the aid of pliers). At each station the thread is wrapped around a short length of round toothpick pressed into the balsa; the thread is pulled taut and secured with CA. The result is a light, rigid structure.

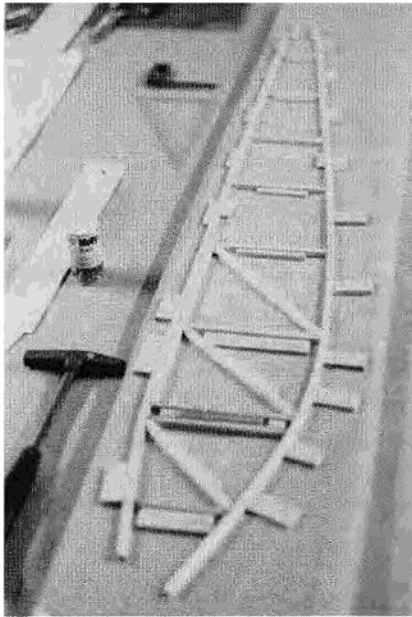
Fuselage:

To begin the fuselage you will need to build a simple jig out of a piece of plywood or flat pine board and a number of small pine jig blocks. Put the plans on the plywood, cover with glue-resistant plastic, and nail the blocks around the outline, being sure to keep the blocks out of the path of the thread and needle. Also, try to keep the blocks away from the areas to be glued so you don't end up with the fuselage side permanently fastened to the jig. Again, some finer points of this operation are discussed in the "Sewing . . ." article.

Incidentally, for this or any other model using "stick" construction, I would strongly recommend using some sort of miter sanding device, either a shop-made



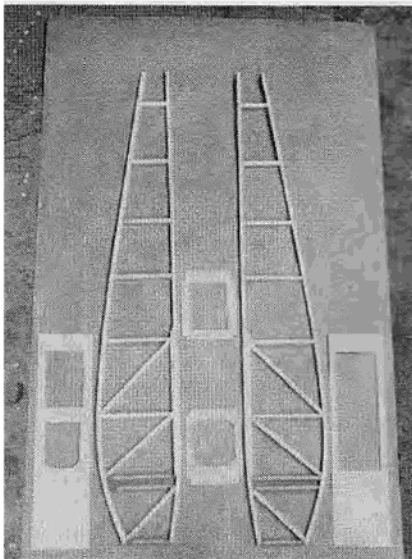
The Spirit flies like a full-sized lightplane — slow and gentle — not like a million horsepower rocketplane! A model for people who want realism, not vertical performance.



The fuselage sides are built in a simple jig that allows the Kevlar thread bracing to be pulled tight without distorting the structure. Just keep the jig blocks out of the way of the thread --- and the glue!

sanding block arrangement, or one of the store-bought models available. These make it possible to create consistently precise joints; just cut the sticks to the approximate size and shape with a razor saw, then fine-tune the fit with the sanding block. A miter sanding fixture makes fitting diagonal sticks a relatively painless chore.

It is a good idea to test the balsa longeron stock by flexing it by hand before trying to use it; I've occasionally come across some good-looking wood that snapped cleanly under moderate bending loads (probably due to compression failures created when the tree was felled --- hard to see!). Once you've got four good, straight longerons, proceed. To arrive at the proper curve of the bottom longeron without overloading either the piece, or the jig, it may be necessary to



The fuselage sides and plywood formers are ready for assembly.

soak the balsa, pre-bend it, and let it dry completely before putting it in the jig. Both the top and bottom longerons can be left a little long at the front and trimmed to exact length before the side is removed from the jig. Cut, fit, and glue the longeron doubler at the top of the radio bay, the spruce uprights, the balsa uprights, and the three hard balsa diagonals. Start installing the Kevlar thread bracing.

The jig enables you to pull up quite snug on the threads before gluing them without distorting the structure. Try to pull up equally each time. With the jig you should be able to produce two exact fuselage sides. Cut two identical tapered stabilizer mounting shims as shown and glue in place on the top longeron at the tail. Now look at the top view of the fuselage on the plans to get some feel for the angle where the two fuselage halves must join at the tail post, then sand each side to that angle. Be sure to make one left and one right.

Cut out the plywood and balsa pieces for the fuselage. For F-1 (fuselage top), F-2 (fuselage bottom), F-3 (fire wall), and bulkheads F-4 and F-5, I set my table saw to exactly 4" and ran the pieces through, thus assuring they were exactly the same width. For cutting such thin stock on the table saw, it is important to use a "zero clearance" table insert (which has a slot just wide enough for the blade to fit through with no gaps to either side). Most saws come with an insert that has a gap so big they are nearly useless for model building. A zero clearance insert can be purchased, or made from a piece of plywood or aluminum of appropriate thickness. Don't fret if you don't have a table saw. All but the 1/8" ply can be cut with a sharp razor knife, a straightedge, and a little care and effort. **Make the pieces as square and as accurate as possible, as they help set squareness and alignment for the completed fuselage.** The center cutouts in F-1, F-2, F-4, and F-5 are also cut out by hand with the knife and straightedge; try not to go zipping across your fingers, or across the "no-cut" areas --- 1/32" wood doesn't have much strength

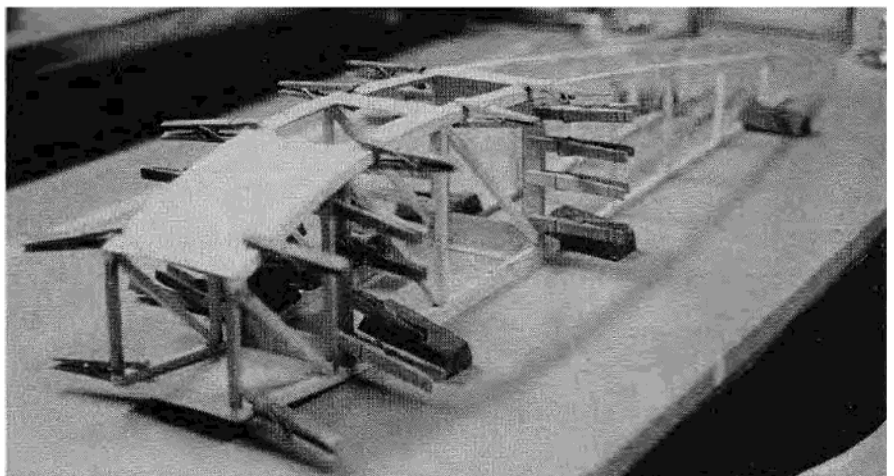
if you score it 1/64" deep!

Mark the centerlines on both sides of parts F-1 through F-5. Lay out the fuselage top (F-1) on a smooth, flat surface and put the two fuselage sides inverted on top of F-1. Align the sides perfectly with the front and side edges of F-1. Weight the sides in place. Put bulkheads F-4 and F-5 in place and clamp liberally with spring-type clothespins. Set the edges of the bulkheads perfectly flush with the outside of the uprights. Place F-2 on top, carefully align, and clamp thoroughly with clothespins. Check to make sure the sides are totally perpendicular and perfectly squared with the top and bottom pieces. Then start tacking everything together with thin CA. When that is set enough to hold everything solidly in place, pick the fuselage up and finish gluing the spots you couldn't reach before.

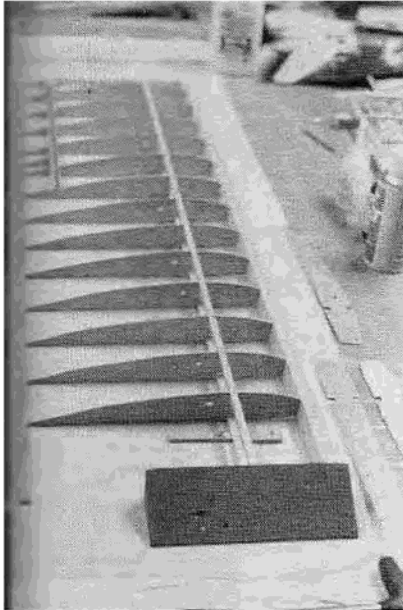
Pinch the tail together and check the fit of the tail bevels; sand as needed for a good fit. Temporarily clamp the tail post together with a clothespin. Put a straightpin in the top front of the fuselage on the centerline and run a thread from the front to the tail post center. Adjust the tail post until the thread sits on the centerline markings; clamp and glue. Cut, fit, and glue the 1/4" spreaders (light balsa is fine). Then complete sewing the top and bottom bracing.

Cut and fit the 1/4" x 1" hard balsa fire wall doublers. Check the fit of the 1/8" plywood fire wall (F-3), then epoxy these pieces in place, making sure everything stays in alignment until the glue sets. Make the landing gear blocks from spruce or pine, but do not drill them for the gear wire at this point. Epoxy them in place. Cut out the tank floor (F-13) and glue it in place, noting that it does not extend to the fire wall, but rather leaves a space for the battery pack at the front.

Make two F-11 gussets, gluing a 1/4" sq. spruce rail for the servo tray to the inside of each gusset (make one left, one right). Glue both F-11's in place in the fuselage interior. You may wish to add some scrap balsa spacers or gluing blocks to the interior as



The top and bottom gussets and two thin plywood bulkheads are rectangular and help the builder get everything into alignment with a minimum of fuss. Clothespin clamps are great for making quick adjustments prior to gluing.



Start of wing construction. The wood block in the foreground helped keep the spar and the leading edge square with the plans; the trailing edge was lightly nailed to the plans with brads --- no movement here!

I needed to reinforce the joints. Epoxy the wing mount gussets F-6 and F-7 in place inside the fuselage. CA the four balsa gussets F-12 to the interior, and glue in the 1/4" sq. medium hard balsa rails for the radio tray as shown.

Glue the pushrod exits (F-15) and the forward rudder mount (F-14) in place, flush with the fuselage exterior at the rear of the fuselage, and glue tail plate F-10 in place on the bottom.

The forward portion of the fuselage may now be planked with medium hard 1/16" balsa sheet, and the switch mount reinforcing plate (F-P) glued to the inside

surface of the planking as indicated. The wing mount dowels are now fitted and glued in place. **Note:** To make it easier to install the fabric around the rear dowel, cut a scrap piece of 1/32" balsa to go around the dowel and fit it flush to the fuselage exterior. The spruce (rear) wing stop must be carefully aligned perpendicular to the fuselage centerline and glued in place. The front wing stop must be carved to fit the wing, so it is installed later. The 1/16" x 1/4" hard balsa braces are glued into the fuselage bay just behind the wing. These may not be totally necessary, but they do add greatly to the strength of the fuselage in a high-stress area. For additional strength, a small shim of scrap balsa can be inserted at the center of the braces to secure them to the thread cross-points.

The landing gear position is carefully marked with a line across the bottom perpendicular to fuselage, and the gear mounting holes are drilled on either side of this line. Note that the holes **must not** encroach on the line; the right hole goes in front of the line, the left to the rear. The exact location and hole size depends on the size of the gear wire used, and the size of the gear wire depends on the axle size of your wheels. The prototype uses a 1/8" hard wire gear, which flexes comically but is adequate for the job. Once your wire diameter is set and the holes drilled, form your gear legs, and the holes drilled, form your gear stops (F-8) up against the gear wires. Don't accidentally glue the wires in place; they must be removable.

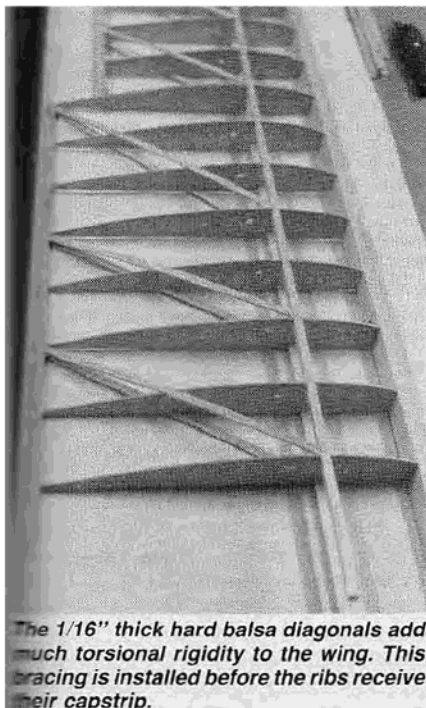
The Wing:

The wing shown on the plans is a little beefier than on the prototype, not so much because the original was weak, but because it was built from whatever materials I had left over in my balsa bin, resulting in some odd sized pieces. The original used mostly

1/32" balsa ribs that were strong enough when the capstrips were installed, but were pretty fragile during the building process and prone to shop rash; 1/16" light balsa sheet is specified here. Similarly, the trailing edge shown on the plans is heftier than the original. The total weight increase is probably less than an ounce, but the wing will be a lot less damage-prone.

You will need to find four good, straight 36" long, 1/4" sq. hard balsa sticks for the main spars. The leading edge also serves as a spar and was made from store-bought 3/4" x 5/8" medium balsa symmetrical leading edge stock. If all you can find is 3/4" x 3/4" pre-formed stock, just recontour it a little with a file to the proper shape. You may also use 3/4" x 5/8" rectangular stock and carve it to shape if you need the exercise. The trailing edge is created from 1/4" x 3/4" medium hard rectangular balsa stock and is cut to taper (in profile) down to about 1/16". You can either cut the taper by hand with a plane, or do it on a table saw.

Start by cutting out all the 1/16" light balsa full length ribs and short ribs, the two 1/16" birch plywood ribs, and the 1/8" balsa center ribs. Make the notches for the spars as precise as possible, but **do not** cut the notches for the diagonal torsion braces at this point. I made a rib template from a thin aluminum printer's plate by first photocopying the rib outline to cardstock or heavy paper, cutting that out, then using the paper template to transfer the outline onto the aluminum. The aluminum I used was thin enough to cut easily with scissors, but I wouldn't recommend that you use your finest pair for this purpose. Touch up and smooth your template with a fine file and/or sandpaper, then add a few dimples here and there with a center punch or nail; the dimples help keep the template from



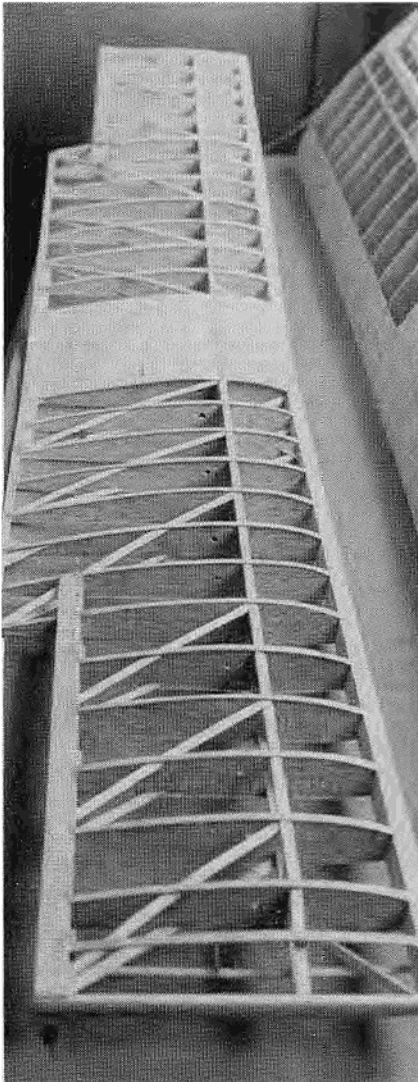
The 1/16" thick hard balsa diagonals add much torsional rigidity to the wing. This bracing is installed before the ribs receive their capstrip.



With weights and brads holding the halves in alignment, the wing panels are joined using slow setting epoxy and 1/16" plywood dihedral gussets.



Brass rods with little dabs of paint on their ends are put into the hinge holes in the aileron and slid into place against the wing, thus marking the exact position of the hinges on the rear spar prior to drilling.



The wing nears completion.

shifting while you cut the balsa. I cut each rib individually using the template as a guide; there may be more efficient ways of doing it, but the thin balsa cuts easily and the job goes quickly. Just remember to hold your blade as perpendicular as possible and keep the cut precise and consistent. Cut all the long ribs first, then trim your template to cut the short ribs. Mark the position for the pushrod hole on each rib, and drill using a bit just larger than your pushrod housing.

Lay out one of the wing panel plans on a flat, smooth surface and cover with glue-resistant plastic. Tack the trailing edge in place with a few brads. Lay out a bottom spar. Be certain to keep the butt ends of the T.E., the spar, and the L.E. perfectly flush with the centerline on the plans. Start putting in ribs. Note that the rib at the inboard end of the aileron bay is in fact a double rib, one short and one long, providing a shoulder to put the end of the false spar against. **Do not** install the 1/16" plywood rib or the 1/8" balsa center rib at this time. After all the 1/16" balsa ribs are in, fit and glue the leading edge in place. Be careful to keep everything square.

Fit the 1/8" x 5/8" hard balsa false (or rear) spar in place. Bevel the edge of the false spar to match the angle of the rib before installing. Now add the wingtip, which is just two pieces of 1/4" sq. balsa glued piggyback and carved to shape later. Add the top of the main spar; the outboard end is cut and angled to meet the wingtip.

The spar webbing is next. The balsa webs go between the ribs from the first 1/16" balsa rib near the center section to the last one near the tip; note that the web thickness changes from 1/16" to 1/32" in the aileron area. Only the inboard most webbing need be hard balsa; use the lightest near the tip. Be sure that the grain is perpendicular to the spars. Put the webs on the backside of the spars only.

Next comes the 1/16" x 1/4" hard balsa diagonal torsional bracing. Align your stock and mark the angle at the forward end, then cut. Test the fit of that angle against the spar/webbing, then hold that end in place and carefully mark the angle on the trailing edge end. Note that the measuring is done with the diagonal piece passing **over** a rib. When both ends of the diagonal are cut and fit, the intervening rib is sliced lightly with a blade on either side of the brace. With the brace removed, the rib material within the cuts is removed to form a 1/16" deep notch; the notch usually just pops out when you insert the blade into the rib. Once the notch for the diagonal is cut, the brace is glued in place at the ends, then at the middle. The remaining bays are then completed. Do the top of the wing panel first. The wing panel should now be removed from the table and flipped over. The bottom side diagonal bracing is now installed, taking care to ensure you don't inadvertently build any twist into the wing at this point.

Three 1/4" sq. hard balsa diagonal braces are fitted in-between the top and bottom pieces of the main spars on the wing panel.

These braces are used **only** on the three rib bays to each side of the center section as shown on the spar detail drawings.

Glue the 1/32" x 1/2" hard balsa cap on the top and bottom of the false spar. Note that these caps continue inboard one bay from the aileron opening.

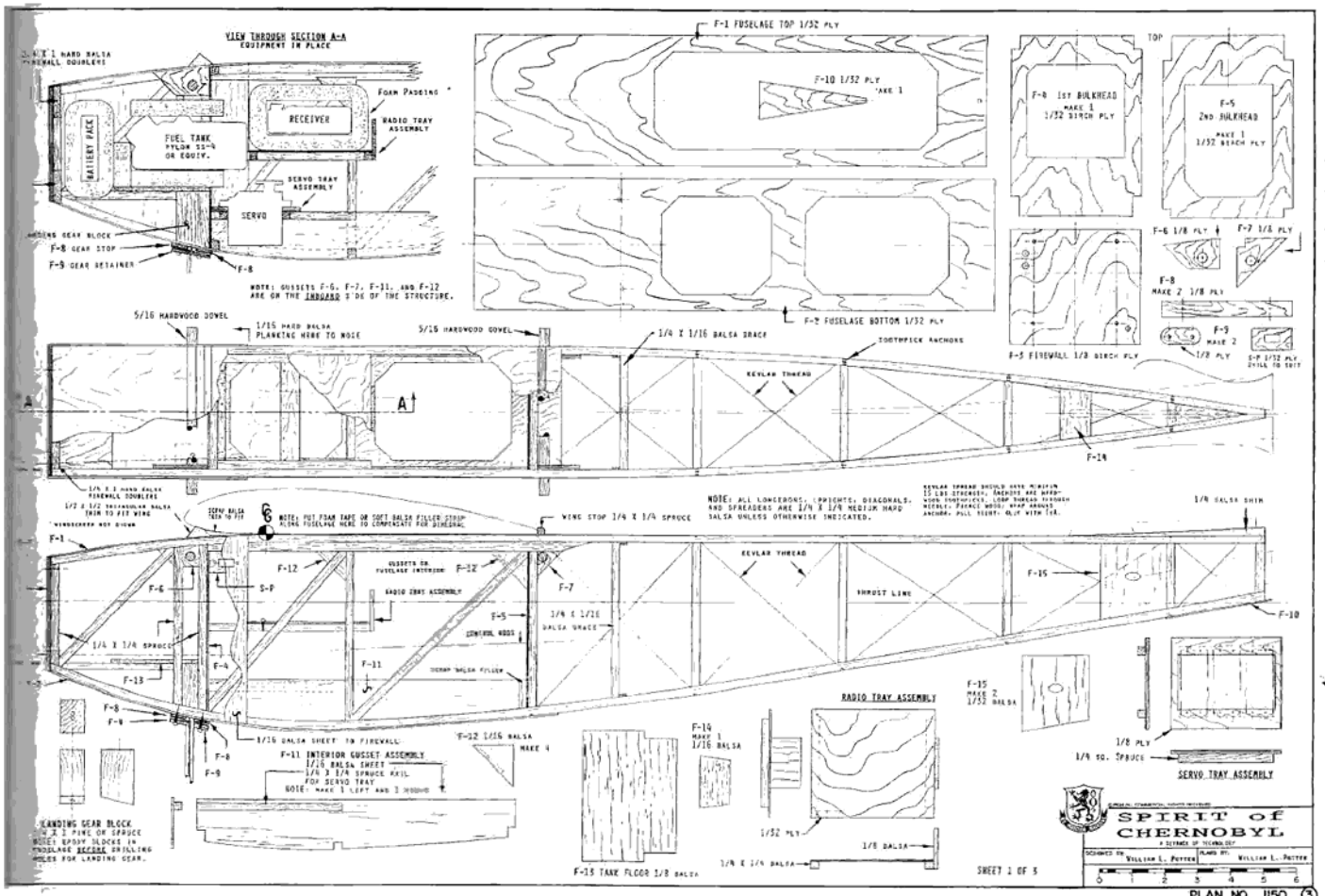
The 1/32" x 3/16" balsa capstrips should now be glued to the ribs, except the inboard 1/16" balsa rib. Bevel each end of the capstrips with a blade before gluing so you will have less sanding to do later. Put the front of the capstrip in place and tack it with CA, then continue gluing to the rear. It may help to put a piece of waxed paper over your fingers so you can hold the cap in place at the point of gluing without cementing yourself to the wing. When all the capstrips are in place, go back over every one with a file or a sanding block and carefully feather them into the contours of the leading and trailing edges.

Install the hinge blocks in the rear spar (the false spar), the small square of 1/32" planking at the start of the aileron cutout (both top and bottom surfaces), and the bellcrank mounts and pushrod exit. Next, contour the wingtip and shape the leading edge to fit. Make the false rib at the wingtip; the false rib is just two pieces of capstrip bent to a pleasing form with a few uprights fitted in-between for support. This wing panel can be set aside for the moment. Repeat the whole process for the other wing, being sure to make the **opposite** side this time (that might seem obvious, but stranger things happen!).

With both wing panels constructed to this stage, it's time to concentrate on the center section details. A balsa filler block is fitted and glued between the top and bottom spars on each wing panel; this block runs from the centerline to the inside of the first balsa rib. A similar balsa filler block is fitted and glued to the front of the trailing edge in the center section area of each panel; this filler block is made from 1/2" x 1" balsa and must be shaped to the rib contour.

With both spar and T.E. filler blocks in place, the wing panels are ready for joining. The wing has 4° dihedral (measured at each side). This works out to a rise of 2 1/2" at each wingtip. Cut one leading edge dihedral gusset and two main spar dihedral gussets from 1/16" birch aircraft plywood as per plans. Now carefully cut or sand the leading edge, spar, and trailing edge of both wing panels to the 86° bevel required at the butt end. Try to take equal amounts off both panels. A table saw or radial arm saw can make a quick and accurate job of this **if** you do it carefully, but there are many ways of doing it by hand, too, such as by using a long sanding block slid flat on the table with the wing panel secured at the proper angle.

Put both panels on a long, flat table and block up each wingtip at exactly 2 1/2". Put waxed paper or plastic wrap under the center section. Mate the two halves using a slow-set epoxy applied to the butt faces of the L.E., the spar, and the T.E. before joining. Apply the dihedral gussets with



slow-set epoxy and clamp carefully in place. Check the alignment every which way, and make certain the dihedral gussets haven't slipped out of position. Let the whole mess sit until the epoxy has cured.

Next prepare the center section ribs for use. Cut through the 1/16" plywood ribs at each side of the spar notches, then trim 1/16" further from these cuts, as well as 1/16" from the front, and trim off the rear portion of the rib to fit the T.E. filler block. Check the fit of the two rib halves, but, before gluing them in place, enlarge the hole for the aileron pushrod to allow some movement up, down, fore, and aft. Now glue.

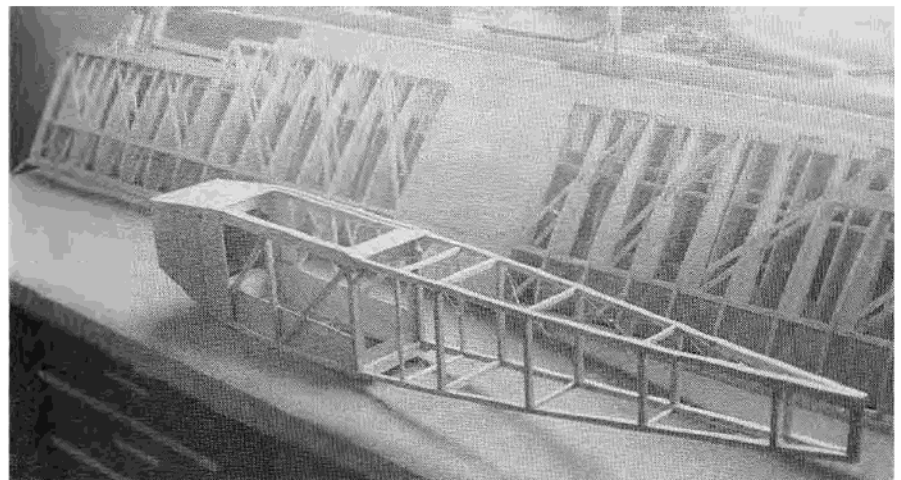
Take the pair of 1/8" balsa ribs and cut at the front of the spar notch to form nose ribs. Trim 1/16" off the front and back of the nose ribs, check the fit, and glue in place. Cut a 1/8" x 1" piece of balsa to serve as the rear wall of the aileron servo compartment and glue in place as shown on the plans. Trim the remaining pieces of the 1/8" balsa ribs to fit in the space to the rear of the servo compartment between the compartment wall and the trailing edge filler block. Check fit and glue.

Apply the top planking, which is medium hard 1/32" x 3" balsa sheet. Note that the planking runs right across the angle formed by the two wing panels -- they are not planked separately. Cut and fit the two 3/8" x 1/2" spruce servo tray mounts. Be sure they are the right distance apart for your servo tray when you glue them. A factory style aileron servo tray works best in this

situation. Note that you will have to push the spruce rails up against the top surface planking, altering the shape the planking wants to take naturally. This should pose no problem. Now plank the bottom center section surface, but before beginning, run a few lengths of Kevlar thread along the spar in the area to be covered by the planking. Leave the servo compartment area open.

Ailerons:
The ailerons consist of a spar made from a length of 3/8" x 3/8" medium balsa triangular stock, a piece of trailing edge (same as on the rest of the wing), and 1/16" balsa ribs. The ribs have 1/32" x 3/16" capstrips that feather into the trailing edge. Note that the ailerons protrude past the rear

of the wing intentionally, helping to give the design that 1920's look. Since the aileron rib capstrips fasten to the aileron spar at the sharp edge of the triangular stock, there is very little to glue to there. After each capstrip is glued in place, come back and add a fillet of thick CA to the interior of the joint as a reinforcement. The hinge points are reinforced with balsa backing blocks. The mounting surfaces for the control horn are sandwiches of 1/32" medium hard balsa on the outside with a doubler of 1/8" soft balsa on the inside between the ribs; the exterior of the horn mounting area should be "conditioned" with a coating of thin CA. Triangular gussets of 1/16" balsa in the four corners of the aileron add to the rigidity.

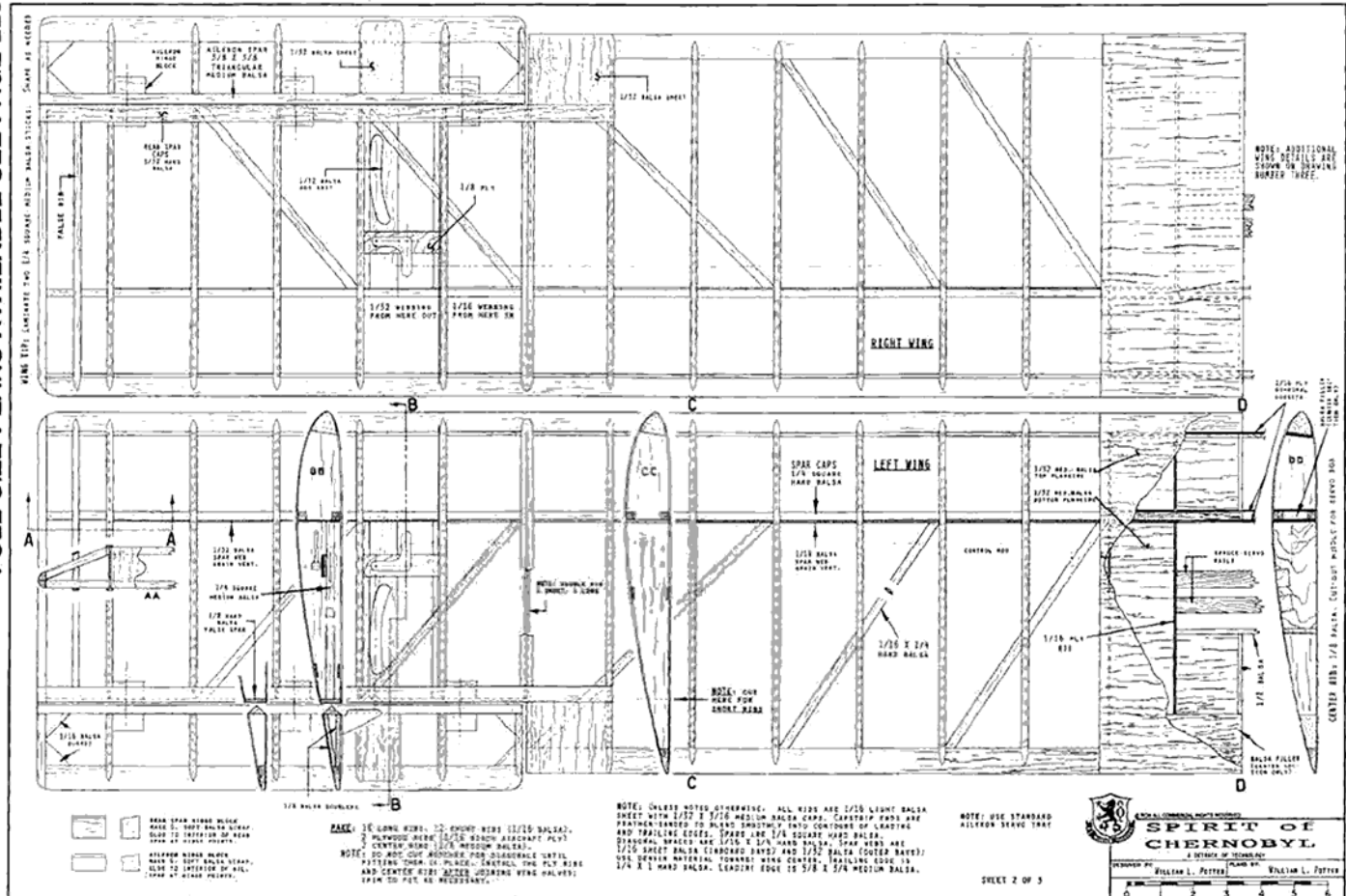


The wing awaits covering, while the fuselage awaits fitting of the tail feathers.

SPRINGER MODEL AIRCRAFT
PLAN NO. 1150

SPIRIT OF CHERNOBYL
DESIGNED BY WILLIAM L. PATTER
DRAWN BY WILLIAM L. PATTER

SHEET 2 OF 5



There are three hinges per aileron. I used Klett hinges on the original. The holes were drilled in the aileron leading edge first, right at the "point" of the triangular stock. Keep them in a straight line. Short lengths of snug-fitting brass rod were inserted partly into the holes and a slight dab of paint put on the ends of the rods. Both the wing panel and the aileron were placed on a flat surface. Keeping the proper end gap, the aileron was slowly pushed towards the wing until the rods touched, thus leaving a mark exactly where the holes needed to go in the rear spar.

I have a set of Klett hinges that I have filed all the "barbs" off the shafts so I can stick them in place temporarily for test fitting without destroying the mounting holes --- very useful for setting up the controls. Test fit the control horns and linkages, and permanently install the pushrod tubes and bellcrank in the wings at this stage.

The Tail Feathers:

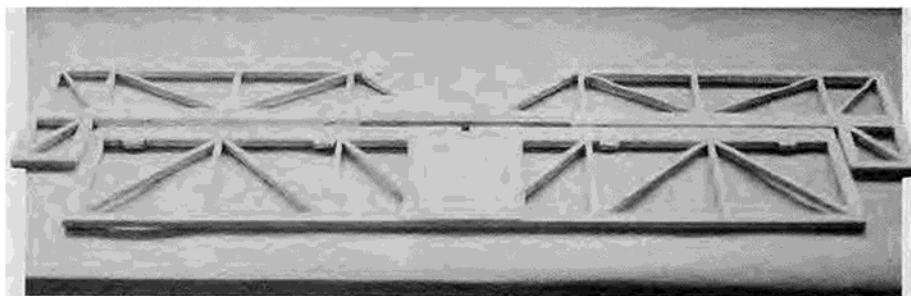
Construction of the tail surfaces is pretty straightforward and should be fairly clear from looking at the plans. Note that the long post on the fin interlocks with the notch on the stabilizer; the fin post then mounts on the back of the fuselage tail post. Also note the short length of 1/4" sq. spruce spliced into the leading edge of the elevator to serve as a reinforcement between the two halves. You may wish to add a small piece of lightweight fiberglass reinforcement at the ends of the spruce; use CA to glue the glass. The 1/32" decking at the center of the stabilizer is there mainly to give you something to stick both the fin and the fabric to.

Once the tail feathers are completed and the hinge holes drilled and slitted, glue the fin and stabilizer together, making certain the fin is directly on center and at 90° to the stab. Test fit the assembly to the fuselage. Use a length of Kevlar thread anchored to

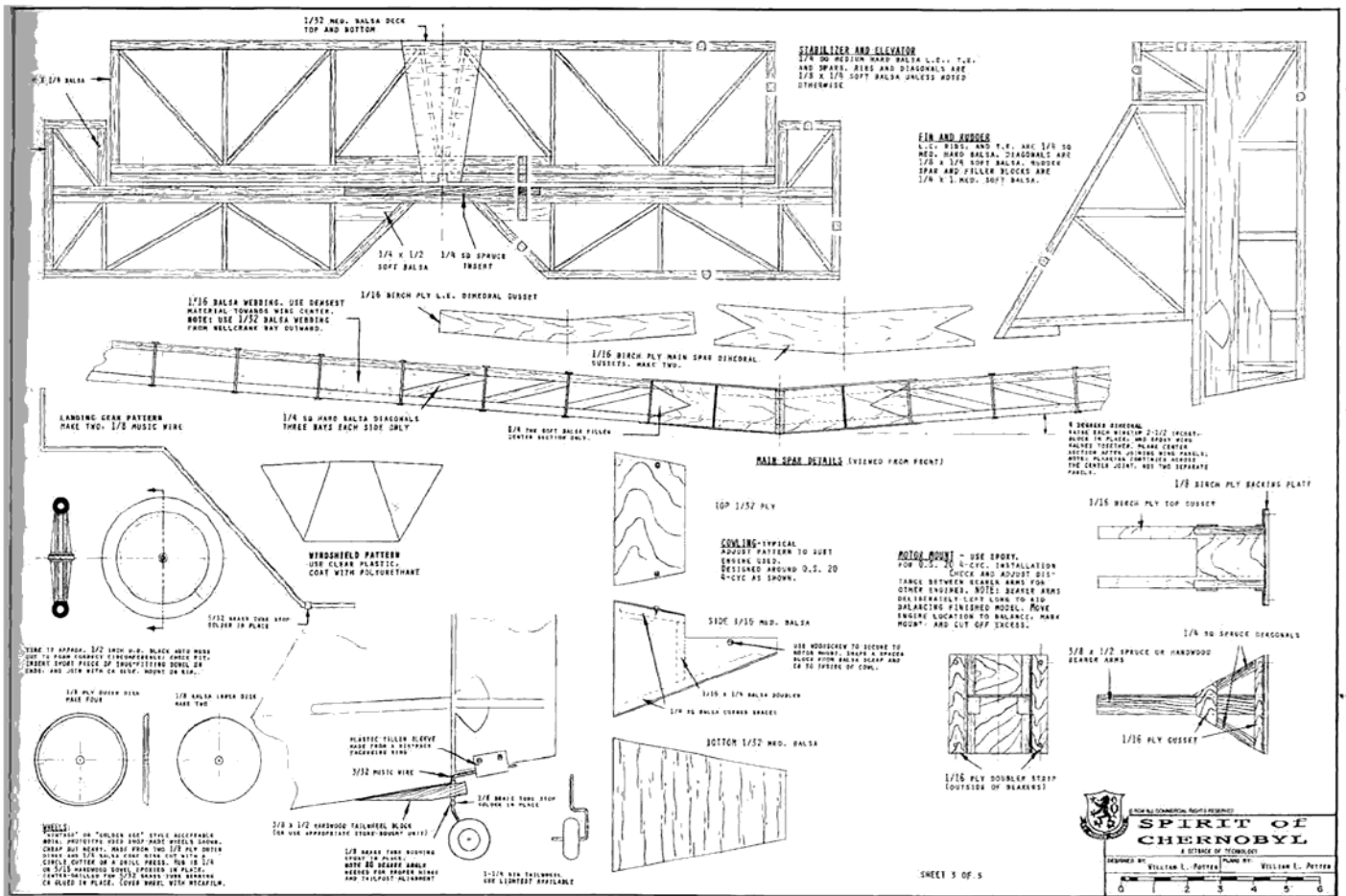
the top centerline at the fire wall to test measure the distance to each tip of the stabilizer (which of course should be the same distance). Put a straightedge across the top of the fuselage in the wing mount area and sight down the model from behind to make certain the stabilizer is sitting in the same plane (level, that is). Adjust as needed. When all checks out, glue the assembly in place.

Engine Mount:

I made my own mount, partly because I wanted one longer than the commercial ones, and partly because I didn't feel like going out looking for one. The bearers are made of 3/8" x 1/2" spruce with a decking made of 1/16" plywood (grain lengthwise). This mounts to a 1/8" birch plywood backing. The diagonal bracing is 1/4" sq. spruce with 1/16" birch ply gussets. I put a 1/16" birch ply strip down the front face on each side as a doubler to reinforce the screw mounting points. Use slow setting epoxy, and make everything as square and precise as you can. **Note:** Before getting too far along, be sure to check the width between the bearers to make sure it will fit your engine. You want a snug fit without spreading the bearers. I'd recommend making the bearers longer than shown. This is very helpful in balancing the finished model: With all equipment aboard, put the engine (with prop and spinner) in place and hold it there with a rubber band. Move the engine back and forth until the plane balances at the C.G. shown on the plans. Mark and drill the mounting holes, then cut



The stabilizer and elevator are simple, and probably quite a bit more rugged than they really need to be.



the excess off the mounting bearers. This way only the smallest amounts of additional weight will be needed to fine-trim the model.

Cowling:

The cowl is a very light box arrangement consisting of 1/16" balsa sides, some 1/4" gluing blocks, a 1/32" balsa bottom, and a removable 1/32" plywood top. It is held in place by two wood screws that pass through spacers and into the motor mount. The rear is held to the fire wall with Scotch "Magic" tape (yes, it works). Each different engine installation will probably require a slightly different cowl, so this drawing is offered as a starting place. Although boxy-looking, the cowling **does** clean up the airflow, which is important with a small engine on a large plane.

Wheels And Tail Wheel:

Although the Spirit was built as a testbed, I still wanted to keep it looking kind of '20s-ish, so big, skinny wheels were called for. But I also didn't want to put a lot of money into a potential disaster, so I decided to build a set of wheels. I cut out a couple of 2 3/4" disks from 1/8" plywood using a hole-cutter on the drill press. One of the traits of this sort of cutter is that it leaves a beveled edge on the piece being cut free --- perfect for my needs. Adding a 1/8" balsa disk between two plywood rims gave me a reasonably thick sandwich. The hub was drilled for a hardwood dowel, which was then epoxied in. The dowel protrudes a little from each side. I then center-bored the dowel to receive a short length of 5/32"

brass tube to work as a bearing on the 1/8" music wire landing gear. I got a couple of feet of black automotive hose of about 1/2" outside diameter from the hardware store. I cut and tried the hose length until I got it to form the right circumference for a snug fit on the rim, then CA'd a small plug into one end of the tube to act as a joiner. The two ends were then joined with CA (which took to the hose material pretty well), and I had my tire ready for mounting.

Before the tire was put on the rim, the wheel disk was covered with Micafilm and brought up tight. The "tire" was then forced over the rim and glued in place. Although these wheels are a lot heavier than I'd like, they also cost only about 65¢ each. If you want to save some weight, look into the store bought wheels such as the "Golden Age" or "Vintage" styles. Keep the diameter at about 3 5/8", not only for looks, but to give the Spirit more of a chance of lifting off grass fields with the small 4-stroke engines up front.

The tail wheel mount was also shop made, mainly because I didn't have a store bought one handy when I hit that stage of construction. Although the one shown certainly works, a commercial unit will work fine (and probably save some weight at the tail). Watch the pivot angle --- keep it in line with the hinge line. Use the lightest tail wheel you can find. To connect the tail wheel tiller to the rudder, I cut some plastic material from the handle of one of those plastic ring six-pack packaging doohickies; I folded that to make a sleeve, which I later

bolted with small machine screws to the bottom of the rudder. Very cheap, and it is effective in reducing shock loads to the rudder.

Finishing:

Cover the model with Micafilm to keep the weight down. I used about two and a half



A sleeve of plastic cut from a six-pack ring makes a simple, shock absorbing sleeve for the tail wheel tiller. Like the rest of the model: somewhat crude --- but effective!



Like its namesake, the Spirit of Chernobyl's curious combination of modern and archaic technology held the potential for disaster. Fortunately for the model, those fears proved unfounded. Although the author created the Spirit as a testbed, he decided it should have the look of an airplane that "might have been." The finished model has the simple lines of mid-1920's aviation.

rolls of aluminum Micafilm. I selected the color not only because it looked neat on the Spirit, but also because I had a couple rolls of it lying around the shop. Balsarite was used as the adhesive; I also used it to fuelproof the fire wall, engine mount, and interior of the cowl.

I figured the square corners on the wings, tail, etc., would make covering easier, but I was surprised to find it was more difficult to get things wrinkle-free because of all the right-angles. However, some tugging and pulling plus a little well-applied heat will get the job done. Before covering the fuselage, lay the wing in place and fit a piece of 1/2" x 1/2" soft balsa triangle to the fuselage at the leading edge. It will probably take some carving to get the shape right to match the wing contours. Because of the dihedral, the wing will not want to sit on the fuselage top without rocking. You can either add balsa strips of appropriate thickness to the top sides of the fuselage now, or install some wing-mount foam tape after the fuselage is covered. After the model was covered, I found it useful to install some half-dowels to the underside of the wing to serve as positioning guides. Put some plastic around the fuselage, then mount the wing, taking care to get it sitting square and true. Then split a few short lengths of hardwood dowel, round off the ends, and glue the dowels to the wing fabric tight against the fuselage sides with CA (making sure the plastic is in position to keep the glue from adhering to the fuselage). The wing will fall easily into alignment in the future, but the positioning dowels should pop off without doing much harm in a mishap.

Install the battery, tank, servos, radio, etc. I suppose you could eliminate any trim changes caused by fuel burn if you switched positions of the tank and the receiver, but you would have to reengineer the mountings, plus you would have the potential for fuel leaking all over the radio gear. And really, there is not much C.G. change noticeable to begin with.

Bill of Materials

Note: All measurements are in inches, unless otherwise noted.

BALSA

Sticks:

- 5 — 1/4 x 1/4 x 36, hard
- 4 — 1/4 x 1/4 x 48, medium
- 14 — 1/4 x 1/4 x 36, medium
- 3 — 1/4 x 1/4 x 36, soft
- 1 — 1/4 x 1 x 36, hard
- 2 — 1/4 x 1 x 36, medium
- 1 — 1/4 x 1 x 36, soft
- 1 — 1/2 x 1 x 36, soft

Triangular:

- 1 — 3/8 x 3/8 x 36, medium
- 1 — 1/2 x 1/2 x 36, soft

Shaped Leading Edge:

- 2 — 5/8 x 3/4 medium symmetrical (substitute 3/4 x 3/4 if nees.)

Sheet:

- 4 — 1/32 x 3 x 36, medium
- 2 — 1/16 x 3 x 36, hard
- 6 — 1/16 x 3 x 36, soft
- 1 — 1/8 x 3 x 36, medium
- 1 — 1/8 x 3 x 36, soft

SPRUCE

- 3 — 1/4 x 1/4 x 36
- 1 — 3/8 x 1/2 x 36

PLYWOOD

- 2 — 1/32 x 12 x 24, 3-ply birch
- 1 — 1/16 x 12 x 24, 3-ply birch
- 1 — 1/8 x 12 x 12, 5-ply birch

MISCELLANEOUS

- 1 — 1/8 dia. x 36 music wire
- 1 — spool Kevlar sewing thread (or equiv. Kevlar product), 15 lbs. test or better
- 1 — stout sewing needle
- 1 — 5/16 hardwood dowel
- 1 — handful round toothpicks
- 1 — pr. 3/8" dia. wheels
- 1 — 4 oz. tank
- 1 — tail wheel
- 2 1/2 — rolls Micafilm (Coverite)
- 1 — can Balsarite (Coventry)
- Thin and thick Cyanoacrylate glue, slow set epoxy, and misc. horns, pushrods, and hardware.



ABOUT THE AUTHOR

William L. Potter started out as a ramp rat and grew up to be a full-fledged airport bum. Much of his 42 years have been spent around model and full-sized planes. He was already building models at the age of eight when he talked his father into dragging home the remains of a junked Goodyear racer to play in. He soloed a Supercub before he soloed in a car. He has been involved in several aircraft projects --- including a Pitts Special --- with his two brothers, both of whom are aircraft mechanics. He has been active in the Experimental Aircraft Association since he was 15, and has served as a judge at several International Aerobatic Club contests. In the 1960's, Bill was involved with "Low and Slow," a group of soaring enthusiasts who eventually spawned the rebirth of hang gliding in the U.S., which in turn begat the ultralight movement (a form of aircraft he still finds interesting). He currently owns and flies a Citabria.

Bill scratch-built free-flight model gliders, FF rubber powered jobs, and 1/2A control-liners throughout his high school years, but other interests gradually displaced his model building activities (although the interest was always there). Then, a few years ago, the chance find of a discarded model eventually led to his full-tilt re-emergence in the hobby: Bill's somewhat unorthodox re-entry into modeling was outlined in his article in the May 1992 RCM.

The initial control set-ups are as follows (measured at the trailing edge of the surfaces). Elevator: 1" up, 1 1/8" down. Rudder: left 1 1/4", right 1 1/4". Ailerons: 5/8" up, 5/8" down. For the first flight, adjust your elevator trim to give about 3/16" down elevator with the stick neutral.

Flying:

The Spirit flies very much like a full-sized Cub or Aeronca. It is slow and graceful, and may even have just a hint of nimbleness. Allow it to have its head on take-off --- it will fly off from a three-point attitude. It is not eager to stall, and, when it does, there are no nasty surprises. Airborne, the Spirit will do the maneuvers a Cub (full-sized) will do, and it will do them just like a Cub or many other low-powered light planes: Sloppy loops & lumbering rolls are possible, but it takes a skillful pilot using all the controls to get them to come out looking right. All in all, the Spirit and its little 4-stroke performs much closer to real life flight than the typical pattern model with a million scale horsepower. Indeed, the lessons learned flying the Spirit are far more applicable to full-sized lightplanes than

those experiences with the hot performing models.

Addendum:

Since completing this article, I have learned that the Kevlar sewing thread I've been using in the "sewn" fuselage technique is no longer available from my original source. **However, not to worry!** I have found an alternative that is in many ways better than what I had been using: **K&S Engineering** (6917 W. 59th St., Chicago, Illinois 60638 --- the model tubing and metals people) sent me samples of their **Kevlar Thread, stock number 801**. This product should be available through your local hobby shops. I have tried it and found it to be about twice as strong as the stuff I'd been using --- my test pieces broke consistently at about 25 lbs. It takes CA glue quite well and is reasonably economical; a couple bucks will get you enough thread for at least two or three fuselages.

When shopping for the K&S thread, be aware that they have done some development on the product since it was first introduced. The first version was in the form of loose roving packaged on a card; although quite useful in many applications, it was pretty awkward to "sew" a fuselage with it since the individual filaments tended to separate from the bundle and tangle. Happily, the K&S thread as it is now supplied comes with a binder applied to the filaments to keep them together; it's kind of like super high-strength dental floss and is much easier to work with than the older version. I might add that the binding agent does **not** affect the glueability. You can easily tell the difference between the two incarnations in the store: The latter version of the K&S Kevlar thread comes on a small spool rather than wrapped on a card. For sewing a fuselage, you want the package with the spool, not the card. Needless to say, you will undoubtedly find many other uses for this high-strength wonder stuff!

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