The "Spirit of Freedom"

by Harley Michaelis
Photos by John Davis and the Author

118" of slender, sensitive wing. A graceful, beautiful bird to soar on nature's lift. Born and bred for a fine performance. At home on a slope, or spiralling in lift.

The development of airframes for R/C Soaring is a constant challenge and motivation, fulfilling the creative urge as nothing else I know. Once the "last" one is proven worthy, restlessness prevails until another is begun. Configurations come in various ways. A mental picture may pop suddenly into mind, to be quickly sketched, lest forgotten, then with long hours usually following at the drawing board over practicalities of dimension, proportion and structure. At other times, a reference line is drawn and a design rather deliberately worked up to achieve certain objectives. Most often, as in this case, the new bird is a sort of evolutionary offspring . . . a blend of the good old things that comes out looking deceptively new. The designing guidelines are simple. Within their framework the variations are endless and always a new soarer of distinctive appearance and capability may be conceived and born in this "spirit of freedom."

The 118" span "*Spirit*" is an all-round soarer of nice middle size, your easy-going friend for sport and Sunday flying, an ally in competition, at home on hi-start, winch or slope. It is the general practitioner that does many things quite well, as need be for general soaring work in multiple task competition. Objectives were to create a practical, work horse two channel machine with truly attractive lines and excellent capability, utilizing the best materials and construction techniques available, and keeping it simple enough for most enthusiasts to build and fly. In flight, the "*Spirit*" is a sweet handling soarer, working well in a wide range of speed. Response is good at a slow trot. If a boomer threatens to steal it away, you can escape in a high speed dive, as the design is not delicate. The stalling characteristics are very gentle, making for a great steep tow, and easy handling when trimmed out for optimum sink. Strength has not been sacrificed for weight and yet, with 12 oz. radio, the all up weight will be near 3 lbs. to give a wing loading of under 10 oz. on the 723 sq. inch area as plans give. Due to size, design cleanliness and efficiency, this gives fine performance in very light lift.

I wish to give credit to George Popa of San Jose, California and Al Schatzel of Othello, Washington who built prototypes with certain differences, passing on their observations and experiences to me to use in preparation of this article. Each flew "off the board", verifying the soundness of the basic design. George used a wing of different planform and 812 sq. in. area, described in the text later. Al used his "*Cirrus*" wing and stab panels, left over from his unrepairable fuselage. Both used an "all-moving" rudder, while mine was more conventional. Do as you wish.

Construction is facilitated and simplified if you wish with a parts package from Hartman Fiberglas R/C, Argenta, Ill. 62501. It includes fuselage, canopy, wing support blocks, pushrods, 3/16" dia. music wire, full length sitka spruce spars, etc. for builders preferring this fabrication. Fiberglass molding materials chosen give the utmost in a soarer fuselage, lightweight, resilient and properly reinforced. In addition to this yummy parts pak, general construction is kept simple. Panels are built flat on the workbench. There are no ribs to reproduce from paper patterns . . . its all done with the root cap as a master cutting guide, with stack cutting as an option. The airfoil, incidentally, utilizes the upper curve of the NACA 6412 soaring section. Combined with a flat bottom, as here used, it has proven highly satisfactory in both slope and thermal work. Both rudder and stab linkages are internal to keep the ship clean.

Wing support systems have received a lot of consideration, with many abandoned. This one is very lightweight, very strong, permits some give on landings. The dihedral is pre-drilled in the blocks, permitting the support wires to go in unbent, to avoid the rotation nuisance.

At this point, "*Spirit*" represents a six year labor of love with original soarers and reflects the best things learned in disaster and triumph. If the experience of those who have built the ship is any indication, its performance and handling should give you a great deal of satisfaction. Your photos and comment are most welcome.

Fuselage Assembly

Note the fuselage assembly molded in reference line near edges. Work down to the line with sanding block or against sheets glued to a flat board. #80 grit is good. Trim the last 1/2" from the tail end and file away top of the stub fin so these are open.

Pull the halves together with masking tape placed externally across the seam line 4" to 6" apart. Work first for a good match around canopy opening ends and nose, pulling the tape as needed to force edges in alignment. Run the tape around the fuselage at rear of shoulders, and then tape along the entire seam top and bottom to this point. Twist the aft section of the fuselage as needed to align stub fin vertically. If necessary, heat the fin over an electric element to make it more pliable and hold at desired set while cooling. Any irregularities in match between the edges can be later evened up with epoxy putty. Apply masking tape along the remainder of fuselage. Cut seaming tape to 1" width (if not provided that width) and run down and out fuselage with clothespin. Tackiness of the fuselage inside will help hold in center. Mix up about 1 oz. of flexible type (non-casting) polyester resin. With a metal handled, throw away type brush, work into the seam at nose and down the fuselage as far back as you can reach, avoiding excess resin. Bend the brush end to help apply. Attach to a dowel or balsa stick and run through tail end. Pour resin along the seam down the fuselage and brush out to tail end. Clean the brush and mess with acetone. Let the bottom seam cure and then do the top, leaving the fin rear and top behind the fin unseamed. Use resin and cloth to attach the tow hook block, servo platform, etc. Fiberglass finishes nicely with epoxy paints, after a base coat of white. A servo platform of 1/8" ply fitted across the fuselage, will materially stiffen and strengthen the front end and help hold the shape. Use scrap balsa sheet to determine the actual shape to position servos well forward. I cut my opening to fit the D&R Servo tray for two KPS-9's side by side, and extended the platform so the foam wrapped receiver could be placed under it behind servos. The antenna goes on the balsa stick down the fuselage.

Pushrods and Linkages

Make stab bellcrank from 1/16" Sig sheet nylon, etc. Drill for a tight fit to the 1/16" dia. stab wire. Other holes should allow free movement without slop. Use as hole spacing template to now make a matched pair of stab root caps. Starting with smaller bits, gradually work up to 1/8" dia. holes through ply plates in the fin for main stab support wire, checking alignment as holes are enlarged. Add shims to plates to leave about 1/8" clearance. Cut a pair of threaded rods to 6" and epoxy cut ends into 1" lengths of 3/16" dia. dowel, and these into #0 rods. Join to bellcrank with something positive such as the Goldberg Snap-Link and slip in position. Run the 1/8" dia. support wire through and secure with a dab of epoxy. Fashion internal rudder horn from Sterling #111 fitting, removing all excess nylon around the closest hole. Note the rudder bottom is in two pieces, the 3/16" member being grooved to permit the half-round wire to slip in with flat side against bottom of upper 1/8" member, without adhesive. Make a hole behind the fin for the wire to pass down through. Attach the horn assembly to pushrod and put in fuselage. Other pushrod ends are finalized with servos in place.

Rudder Post and Upper Fin

Sand fin top edges down flat. Make the ply post to match width and taper of the stub fin, slit it for hinges and secure to fin with Devcon 5. Minute epoxy. Attach a scrap of hard balsa with epoxy inside at hinge location. Slit through fin and balsa for flange. Make the balsa plug to nicely fit and shape out top opening, notching ends for 1/16" upper center frame members. Epoxy in fin flush with the top. Glue the rear frame member to the post and put ply bits on sides at top hinge location, then add bottom frame member. After the rudder is built, hinge in position and glue front and top frame members to match up with rudder lines. Add and shape the 3/16" balsa cheeks to center frame and top plug. Shape and affix a contoured plug into tail end. Smooth any imperfections with Hobbypoxy Stuff or epoxy putty and wet-sand smooth.

Stabilizer Halves

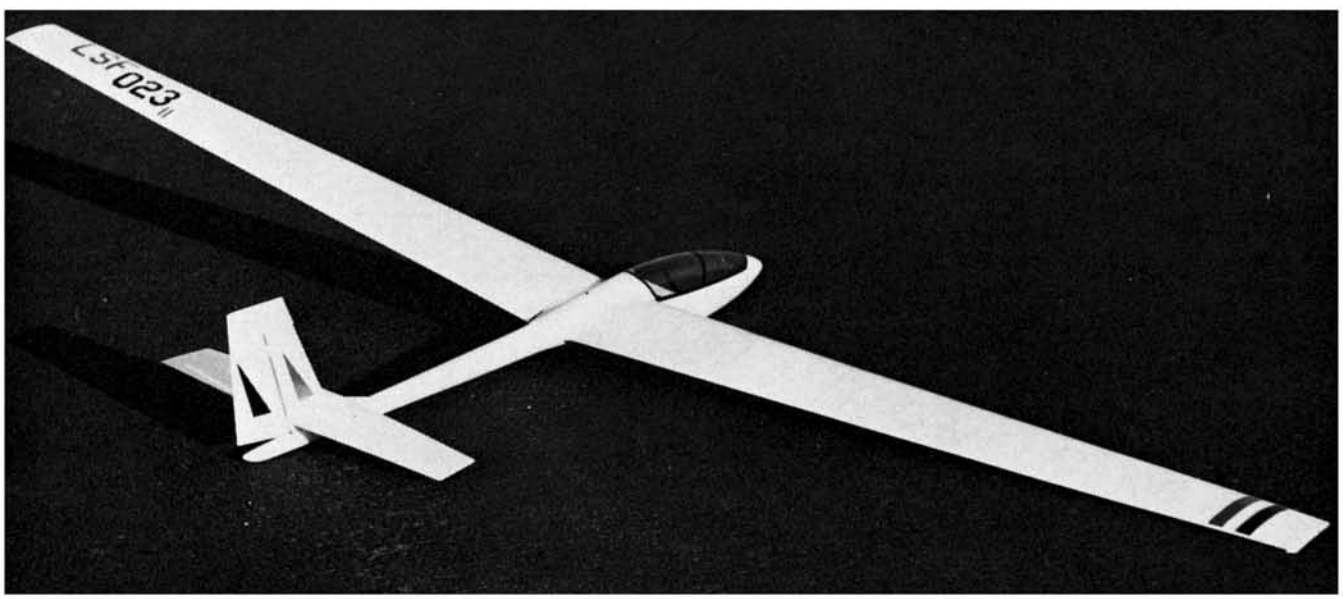
Shape ply end caps and parts to rib 1. Others can be inserted as rectangles and sanded to symmetrical shape. Slight bend may be put in 1/16" dia. stab wire ends for a good hold in flight. If the halves don't align well with fin, the 1/8" I.D. tubing can be angled through rib 1 as needed to look right. Smooth burrs so halves move easily on the support wire.

Wing Support Blocks

Use 3/4" wide scrap sheet balsa to determine distances between shoulder plates. Cut blocks to fit with a slight snug fit, trimming equal amount off either end to keep the "V" at the center. The holes in the shoulders will have first been located as described below in wing construction. After cutting blocks to length, trim off tops and bottoms as needed to properly align block holes with shoulder holes. Insert bits of #0 rod into the blocks and cut off flush with block ends, not shoulders. Final positioning and alignment of blocks is done with panels attached, as follows: Shift blocks in shoulders as needed to get alignment of panel to shoulder. Place a drop of quick epoxy on *rear* block ends at plates and let cure, with panels in proper position. Now remove the panels and front block. Drip epoxy heavily all around the butt joint edges and let cure. Similarly secure front block with panels again in position. A little play will exist between the 3/16" support wires and the #0 rods to permit each attachment and detachment. If desired, this can be minimized by epoxying the wires into panels. Make a wire tool to pull retaining bands through to wing hooks.

Wing Panels

All ribs are 5/16" high at the front of the trailing edge. Heights of front of ribs are determined from a "Rib Front Height Gauge" which should be accurately drawn, as follows: With a very fine point, draw a line about 8" long. Erect uprights spaced



A "Spirrus"? Al Schatzel (on right) has a blend of "Spirit" and "Cirrus", clearly a "Spirrus". Whichever the wing, it's a silent dream in the sunset. The big soarers really float superbly.

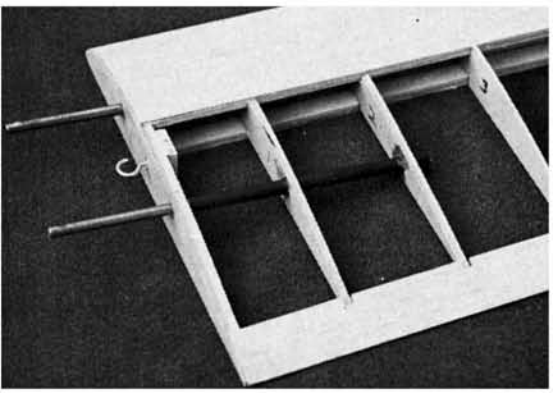
exactly 7" apart. Make a mark across the left one precisely 15/32" up, and one up 19/64" on the right. These are rib front heights at root and tip. Draw a connecting line. Erect uprights at 1/4" intervals to give heights of other rib fronts. The root chord should be exactly 8" and plans should be checked for any distortion in reproduction and correcting lines drawn as extreme rear line of wing. Then the trailing edge front line should be drawn to be 7/8" wide, all along. Cut ribs as follows: Trim sheet straight for bottoms. Lay wood across plans with bottom along rib line. With a sharp point, mark wood for front of wing, front of rib, spar notches, and the front of the trailing edge with pencil, mark uprights across the wood at these points. With a fine pointed dividers, get rib front height from gauge and mark on the rib front upright. Make a mark 5/16" up on trailing edge upright. Position the ply root cap top at these points, with its front against the front upright. Make the cut, trim rib at rib front and 1/8" behind the trailing edge upright. Notch 3/16" deep for the spars and trim off 1/16" top and bottom for sheeting. Note that the balsa rib attached to the root cap, plus #1 and #2 are to be fully sheeted. Make duplicates of all ribs. If you can cut by the stack system, first make a ply tip template as above and have at it.

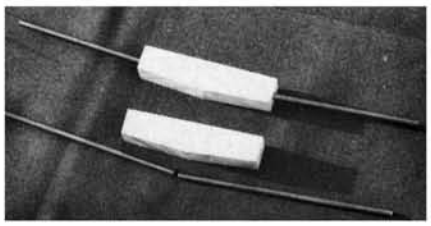
Note that ply caps and ribs #1 and #2 (ply-balsa laminates) have #0 fiberglass rods set in as support wire housings. These should be centered vertically in root and shoulders (ignore photo of this detail on my ship). The support blocks have been drilled for an amount of dihedral I personally find satisfactory and eye-pleasing. I rig rudder to throw a full 30 degrees as permitted by the Rand 1024 hinge to handle the extreme turn situations. Some of you may prefer more dihedral. If so, run the #0 rods through 1 and 2 on a decline. A drop of 1/16" to rib #1 to rib #2 will add nearly two degrees dihedral per panel without looking ridiculous, or requiring any bent support wires. The decline should be engineered and worked in these ribs before trimming off for sheeting. All holes should be gradually worked up to full 1/4" (diameter of #0 rod) to avoid tearing the work. A 1/4" dia. rattail file is useful. After making the holes in root caps, lay these on shoulders to locate holes there, also making 1/4" dia. to leave some play between holes and wires to help the alignment.

Prepare the bottom sheeting from 36" and 24" lengths of 1/16" sheeting, 3" wide. Use stiff, medium-hard stock. Overlap and cut splice. Join with quick epoxy between Saran Wrap and hold flat while curing. Use a long straight edge and trim to fit plan, noting bottom extends to front of panel. Similarly do top which ends at front of sub leading edge. Pin bottom over plans and add bottom spar, ribs, top spar, shear webbing, trailing edge and hook block. A long straight board, set on edge is a good tool to hold spars down to bottom sheet and top sheet to top spar. One about a foot wide is heavy enough (3/4 ply). Taper and bevel sub leading edge to match rib fronts and glue on. Wipe away any glue in front. Note #0 rod ends are plugged with bits of 3/16" dowel to stop 3/16" dia. support wires. These wires *must* extend through rib #2 and meet at centers of support blocks. Use Devcon 5 Minute Epoxy to secure rods to ply when all aligns well.

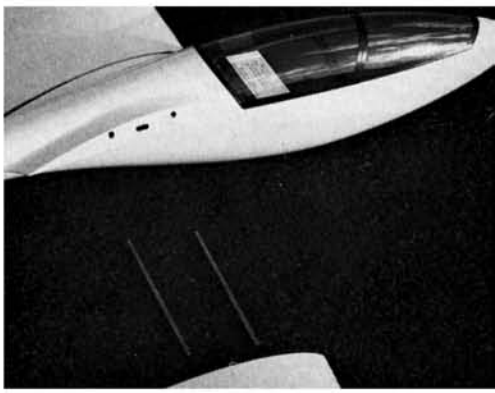
Using the same relative bluntness along the entire leading edge of my panels, I found nearly 3/8" washout (leading edge down, trailing edge up), starting at rib #20, to be needed to avoid tip stall. No doubt, less would be needed with progressive blunting toward the tip. Normally, since washout can be twisted in and held with MonoKote while shrunk tight, I don't actually build it in. In this wing, however, with the spruce spars, hard shear webbing, and good stock used for sheeting, I was hard pressed to do so. I suggest that at least some of this be built in by wedging up the trailing edge and then applying the shear webbing and top sheeting, with the board laid on just to rib #20 and pins from there to tip. Finally add the actual leading edge, tip blocks and center sheeting. Other wing planforms can be built to provide more area if desired, and still using the same system for cutting ribs. For example, using the same span, tapering symmetrically to 7" chord at about the 33" mark, and then down to 5" at the tip, may be of interest to some who work in marginal lift conditions.

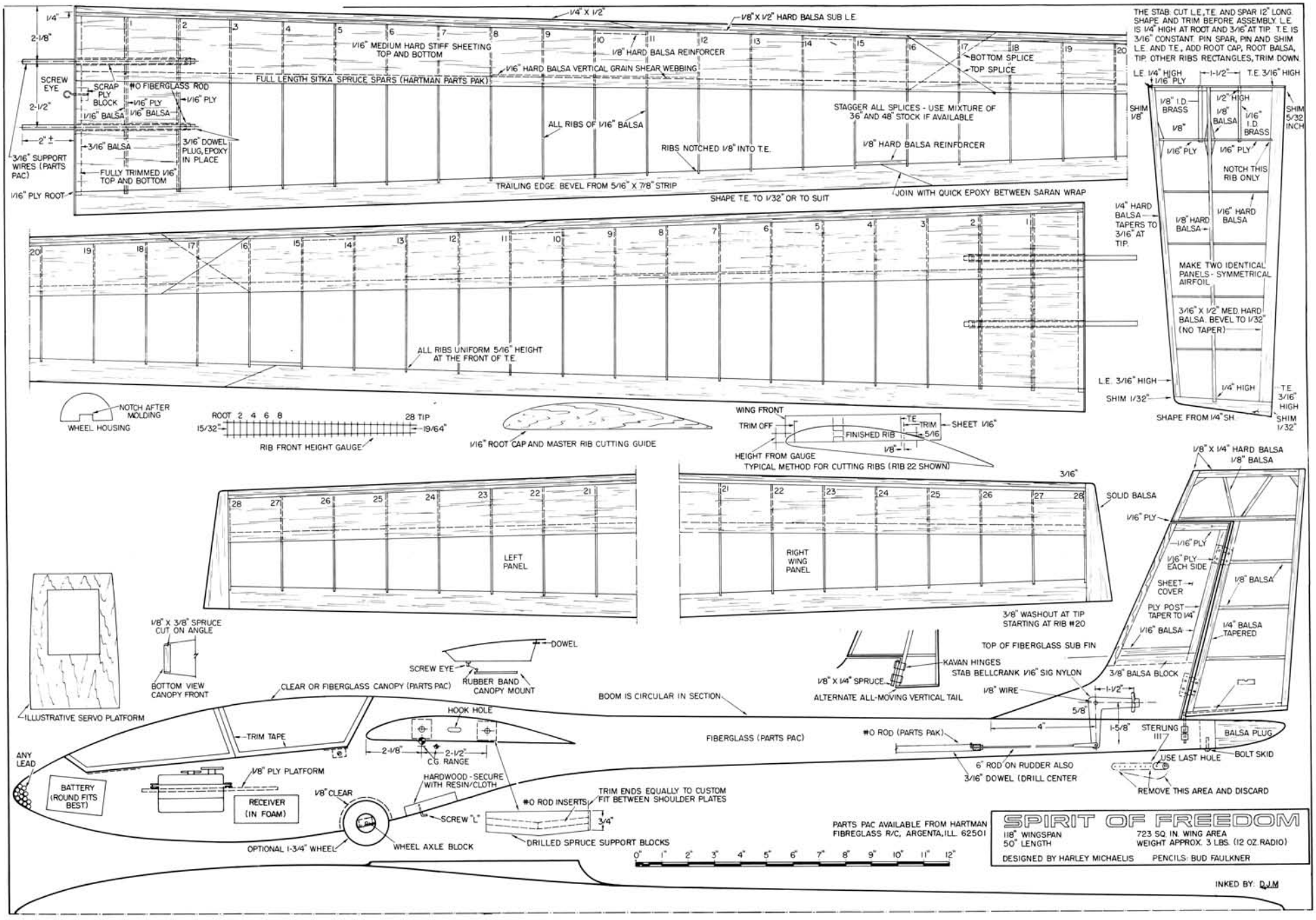
Another idea would be to make a planform that sweeps back 1" at the leading edge from root to tip in a straight line, and forward 1/2" from root to 36" mark at the trailing edge, and then forward to make 5" chord at the tip. This is similar to that on my Hi-Pro design kitted by Dumas and is a particularly fine operating wing.





Note dihedral plug-in wires. The correct angle is assured, stressed for winch or towline pull. Left: Straight wires avoids rotation problems. At right: panels connect to wing root fairing.





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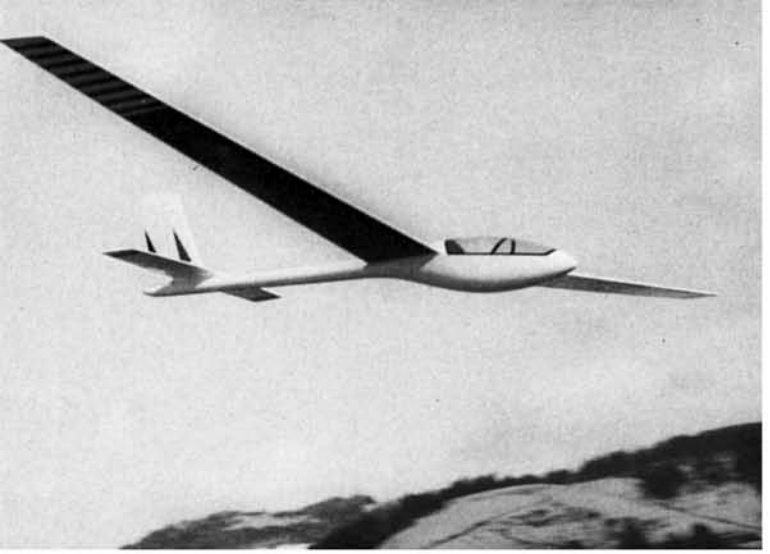
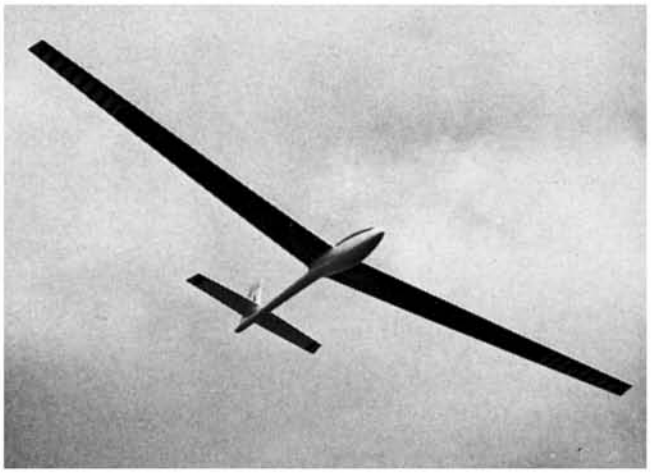
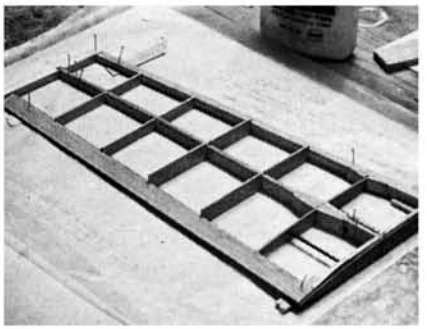


Gravity calls it earthward, but an "inclined plane" is the route that it chooses. If the air is rising faster, your ride will be all for free.



Sailing, sailing! It imitates the birds and indeed they may be envious. Just shy of 10 feet, Spirit is a thing of grace wheeling high overhead.



Stabilizer halves are symmetrical, build pair. Light, full flying type, no hinge gap visible. Tubing inserts guide wires, hold the incidence.

George Popa used a planform similar to this on his prototype, with progressively blunted leading edge in lieu of washout, and praised the result. You are free to proceed in a complete spirit of freedom!

The Canopy

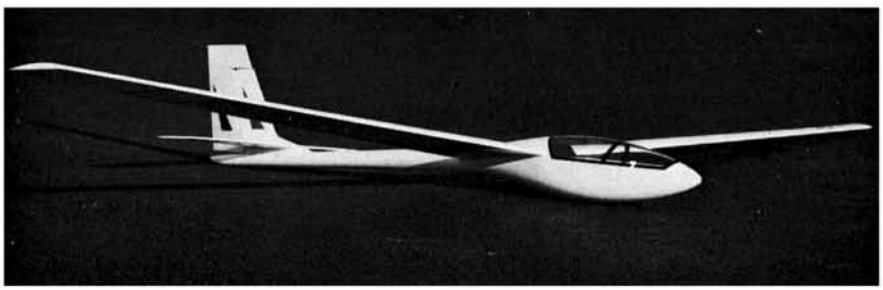
Both fiberglass and clear are available, the former needing no base to maximize space for gear. Its front can be keyed with a wood block to go under canopy lip. Blocks at rear with "L" shaped wire bits inserted to slide under lips secure the rear, the natural spring of the fiberglass being utilized to attach and detach. If the clear is chosen it tints nicely in 30 to 45 minutes with a pack of Rit dye mixed in 1/2 gallon of water. Avoid hot water as it will distort. Let moisture evaporate thoroughly before attaching to base.

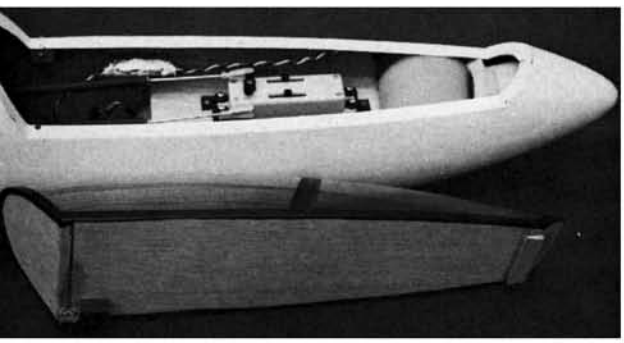
To make the base, first protect the fuselage around opening with masking tape. Carefully fit a bottom of 3/16" balsa to the bottom, then ends, epoxying pieces together at the proper angles and to nicely fit the opening. Secure in place with a dab of quick epoxy, and then carefully work all edges and contours conform to those of the fuselage. Remove and work edges down the thickness of canopy material. Trim canopy to nicely fit base, noting reference lines in canopy. Place base and canopy on the fuselage to check out overall fit and take the time and patience to make it look really good. Cover the base top with Mono-Kote, except edges where the canopy touches. Attach identification, then the canopy with your favorite (?) adhesive. I find Devcon 5 Minute Epoxy sticks well. Bind canopy to base with masking tape in position on the fuselage while glue dries. Attach the hold-down system as on plans. Add trim tape (Scotch brand, cut 1/4" wide) around the edges and across the top.

Initial Flights

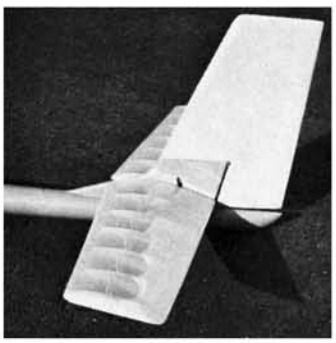
Rig stab for moderate throw, rudder for maximum, as servos permit. Hand glide in straight and level attitude with plenty of airspeed. Make indicated mechanical trim changes. On winch or hi-start, try the hook 1" forward of balance point, gradually working back to optimize the climb. At the slope, make initial flights in light to moderate winds. On a good hand toss you should get about 90 yards distance. ROG tow (winch) is easy, with a steep attitude quickly taken for rapid ascent. The rest is up to the whims of the thermals.

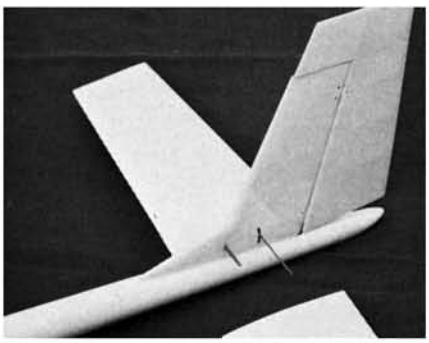
Below: line of fuselage suggests pod and boom arrangement. Gentle dihedral, adequate rudder. Formed fuselage, canopy available, or build up.





Lift the canopy and radio is at your fingertips. Position to achieve center of gravity shown. Mis-balanced designs sink. Canopy adds a final touch of elegance. Pod is roomy enough.





These photos give a look at tail feathers and method of control. Rudder is adequate, swings enough to handle things on tow or in glide. Flying stab pivots on a wire, gives elevator-like action without drag of a hinge line affair. Offers a fine degree of flight control.