BUILDING THE WINDROSE

WIND ROSE

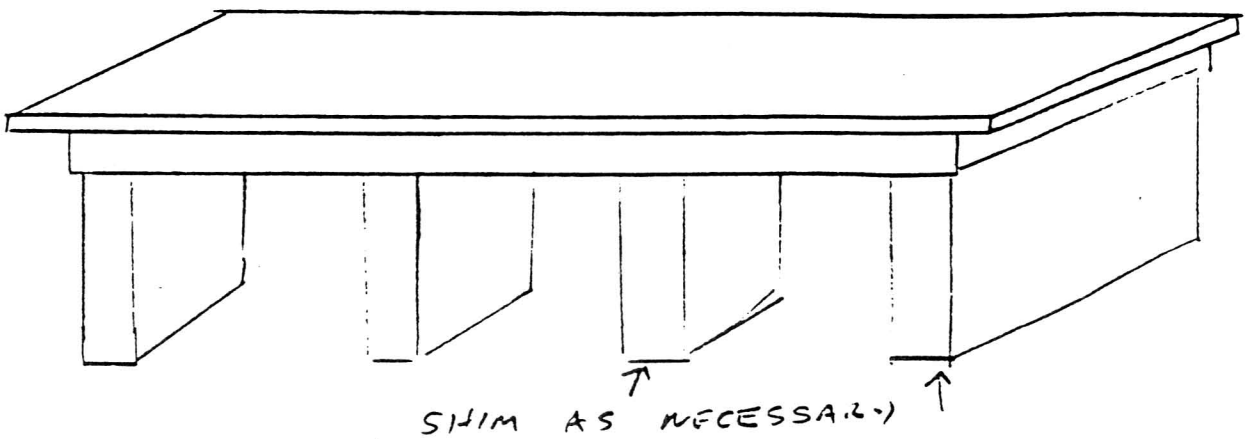
GENERAL

Space: The area needed to build Windrose is set by the fact that one wing is about 21' (feet) long, and you have to work around the ends. So you need a minimum length of about 25' (feet). More is always better, but my shop is 20' by 14' with an 8' by 5' extension, and has proven to be adequate. You can go diagonally in a two car garage.

Light: You need good lighting. I have 2 double 8' (feet) florescent tube fixtures, and use a drop light occasionally.

Humidity-Temperature: All glass work is best done in low humidity, and temperature control is a must. It is important that glass-epoxy layup be done at 70° to 80° F. The material itself is heated to a level even higher. We put our fiberglass roving and epoxy in a cardboard box with lightbulbs inside, and keep it at about 90° to 110° overnight before layup.

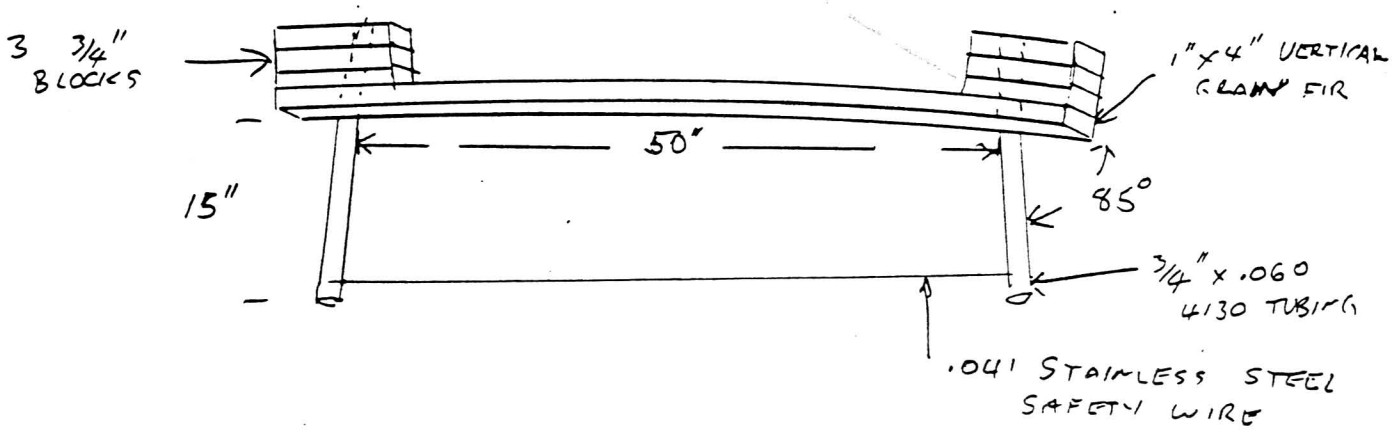
Jigs & Fixtures: The only jig needed to build Windrose is the assembly table. We built ours of 3/4" particle board at a cost of about $60.00. It must be 20'(feet) long, and 30" (inches) to 36 " (inches) wide. I think it is best to build a 12' (foot) table, and an 8 ' (foot) extension. The 12 ' (foot) table can be used to build the tail, the fuselage boxes, etc. The full 20' (feet) is only needed during the wing building, a very short time in the life of the project. The table has to be flat and level. See Drawing:



The supports and box under the top should be set back about 4" on all sides to allow the use of clamps around the edges. Build the frame of 1" X 6" wood or particle board and each foot of the legs should be a point. Then with a carpenter's level, you can work down the table shimming up each leg until the table is level. Use a wire or kite string stretched really tight lengthwise of top of the table and shim it up 1/16" at each end above the top and check the clearence along the table with another 1/16" shim.

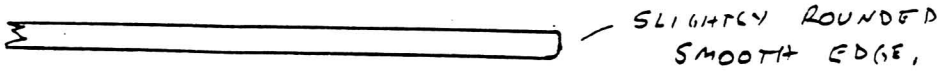
Glass - Foam - Epoxy: This booklet is specifically about how to build Windrose, and it will describe step by step how to do it, but if you are not familiar with working with these materials, I strongly recommend you buy a copy of Burt Ruttan's Moldless Composite Homebuilt Sandwich Aircraft Construction. It's available from RAF, Mojave, CA 93501. In addition, or perhaps instead, Aircraft Spruce and Wicks Aircraft sell a practice kit for $49.95 which includes the above book, and assorted foams, epoxys, fiberglass, and fillers with which you can make up some of the practice items in the book - a worthwhile beginning to see if you're going to enjoy working with these materials.

Tools: Besides the usual hand tools, you need a disc sander, electric drill, small saborsaw (it's best used upside down under a Sear's table). You will need access to a band saw and a drill press if you make all the hardware yourself. There is some welding in the control system, but you might cut and fit there and take them to a qualified welder. Finally, you need to make up a wire cutter for cutting foam and a balance for mixing epoxy. Our best effort, after several experiments on a wire cutter, looks like this. It gives a really tight wire at almost any temperature, and keeps the wire tight giving the minimum amount of lag.



CUTTING THE FOAM

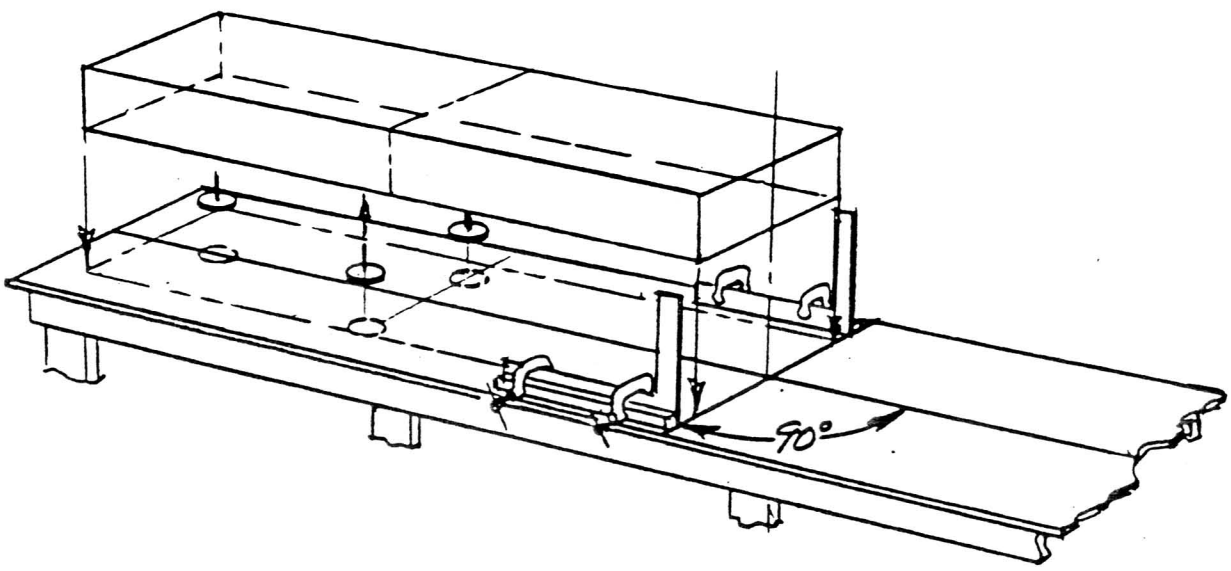
Saw out the rib patterns and shape them carefully on the disc sander. Use 1/8" hard masonite for patterns, and finally, hand smooth them using fine sandpaper and round the edges slightly



The idea is that the hot wire moving along the pattern will not stick or grab. Number as shown on both sides.

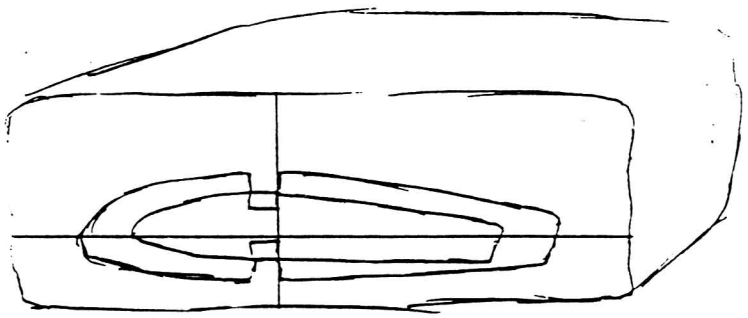
The first step is to cut the big foam billetts into 4 ft. blocks. We did it as follows:

1. Draw a center line down the length of the table.
2. Draw a center line down the face of the 9' foam at each end and down the top to the bottom.
3. With three 2½" nails and three 2" diameter pieces of 1/8" plywood, support the 8' foam block on these supports in the first 4 feet.
4. Weight the foam down with hammers, sandbags, or whatever.



Using the 2' X 16" carpenter's squares, clamp these to 3/4" square blocks, and these blocks to the table. Now with the foam centered on the table, and some weights on the foam, on the end with the 3 "Feet", you can run the hot wire down the surface of the end of the foam and get a square surface. Slide the foam block down the table, still on the centerline, and cut the block to 4' long. Slide it again in the same direction to 4' and run the hot wire down the last end. You now have two 4' blanks ready to cut airfoils from. It takes five 8 foot blocks of foam to build all the foam parts in Windrose and they are all hot wire cut from 4 foot sections.

The patterns attached show how to lay out the various pieces in the blocks. In order to get these cuts with no distortion or twist, I used the following technique: Using a piece of stiff drawing paper, I first cut it out in the shape of the end of a block. On this, I lay the largest rib template. Draw around it and draw in the two 90" lines as shown on the rib template. Now stack the two ribs together and drill two 1/8" "key" holes through both ribs at once. Put the same two holes through the paper pattern. Then hold the paper pattern up against a window and draw the two patterns on the opposite side of the paper. Now, using the opposite sides of the paper pattern, you can locate the ribs on each end of the foam block with no twist or stagger. The horizontal line on the paper to be parallel to the table.



To fasten the rib patterns to the foam while cutting, use two 5" nails or pieces of 1/8" dowling sharpened in a pencil sharpener. Also use two dabs of five minute epoxy about the size of a nickle.

We found these large billets to have stresses built up inside the blocks, which, when freed in cutting, gives some distortion. After various tries, our most successful effort to eliminate distortion was as follows:

With the patterns in place on each end of the 4 foot section, we cut around the patterns about 3/8 to 1/2 inch outside the pattern. Then go back and cut again with the wire following right on the two patterns.

We found it best to cut straight across the spar cap notches, then go back and cut the notches.

When making a wing section that requires two pieces of foam, cut both pieces about 1/2 inch oversize, and join these together. Then cut both at once to the final line.

JOINING FOAM BLOCKS

Besides holding the two pieces together, the main point in joining the foam blocks is to create a joint that will act as a barrier to liquid epoxy running down through the joint and leaving a drip line on the other side. A few beads on the bottom are inevitable, and these are best dealt with by just breaking them out with a pair of needle nose pliers.

Mix about 1/2 inch of 5 minute epoxy in a cup and add an equal ~~amount~~ VOLUME of micro balloons. Then spread this slurry in a band about 1 or 1 1/2 inches wide along the center of the joint, keeping away from the edges, and press the two pieces together for about 20 minutes.

BUILDING THE WINGS

To make the main wing fittings, just cut out the patterns from the drawing and glue them on 3/8" aluminum plate. Bandsaw to lines, file, and sand edges. It is probably best to drill the holes with a drillpress, and the last ones should be done with the 1/2" main pins in place so they are a sure fit when assembled on the wings. Drill the main pins 1/2" and ream later.

Cut the root ribs from 1/4" ply and the tip ribs from 1/8". Then build up the boxes that take the spar stubs. Note that the bottom of these boxes are parallel to each other, but the top and bottom follow the taper of the wing, about 1/8" in 12'. These boxes are then glued and nailed to the root ribs, making sure they are 90° to the rib.

It is probably a good idea to wire cut all the wing sections at one time, while everything is set up for cutting. It's easiest and best to store the cut pieces within the block until ready to use them. With all the pieces cut, we can install the 3/8" doweling compression pieces. Sharpen a 15" piece of your straight doweling in a pencil sharpener and mark the location of each in all the blocks. They are 4" from each end, and 8" apart. With a helper to line up vertical spanwise, eye the block from the end, and just push the dowel straight down through the block. It should come out the center of the spar through on the other side $\pm$ 1/16". You can make all the holes, then go back and install all the pieces. Take a dowel flat on the end. Push it through until it's flush with the bottom, mark with a pencil, remove, saw off, and install. No glue is necessary.

Using the full length table (20 feet) with a centerline marked the full length, assemble the 5 wing pieces. Sand the ends as necessary so that any gaps that exist are 1/16" or less, and glue them together with 3 or 4 pieces of 1/8" doweling and a 1" bond of 5 minute epoxy slurry.

Block the wing on the table, bottom up and straight. Use a string stretched down the center of the spar to get it straight. With a sanding block, sand off any high spots as necessary. Glue the root and tip ribs in place using 5 minute epoxy and a few pieces of 1/8" doweling. (Unidirectional fiberglass and epoxy used in the spar caps of the wing forms a composit material very similar to wood in that it is strong fibers running lengthwise bonded together with a material of low strength.)

In selecting wood for aircraft, we try to find material with the grain running nearly parallel to the length of the board.

When we lay unidirectional glass fibers and epoxy in a notch to form a spar cap, we are in effect making a form of very strong wood. It follows that if the notch has kinks or abrupt changes, the fibers can have abrupt changes in angle or direction making the spar cap similar to wood with small knots or wiggles in the grain.

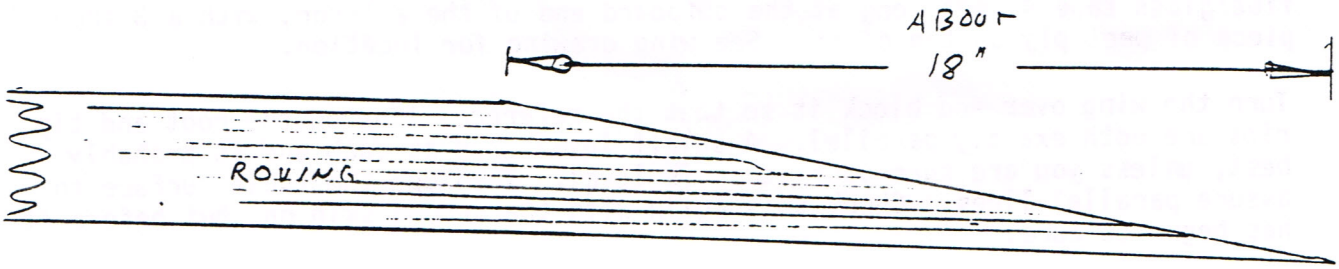
Beam cap slot mismatch at the interface of the foam blocks can be corrected by sanding with an appropriate sanding block. Mismatch at the inboard end rib can be corrected by either sanding the foam or, if the foam slot is bigger than the wood slot, then tapered 15 to 1. Fillers of soft wood can be glued in with a dab of 5 minute epoxy.

Clamp the expoxy bath to the table near the root, and then cut the cloth for the bottom skin to size, and cut the 2" peel ply for the trailing edge. Roll up the skin cloth from tip to root and lay aside. Rig up a stand or hanger from which you can pull off the roving directly from the spool into the epoxy bath, and line up 2 or 3 helpers for tomorrow. It takes a minimum of 3 people, and more than 4 just start to get in each other's way. Put the skin cloth, the roll of unidirectional fiberglass and the epoxy in a cardboard box with lightbulb to heat all to about 90° to 120° overnight.

Cut some small squeeges the same width as the spar slot (1 1/4" wide).

Now thread the spar roving into the epoxy trough. Fill it with epoxy, and one worker pulls this steadily through the trough while number two squeeges out the excess at the front edge of the trough. When the pull is full length, pull out about an extra foot. Cut it off. Then just lift it up, pull it tight, and drop it like a rope into the spar notch. Twist the strands. Up to two turns is OK. This makes a bundle you can drop easily into the slot. Now, while two workers pull the second roving, one works from the center of the wing towards both ends, smoothing it down into the bottom of the spar slot. For the most part, the third worker spends his time mixing epoxy in batches of about 6 to 8 oz. Take care not to disturb the straight run of the fibers.

The spar slot is thus gradually filled up. It should be kept level and slightly above the foam. After a few rovings, it will not be possible to go all the way to the wing tip any longer. From this point on, cut the roving off at an angle about 18" long.



Fill the slot to level or maximum of 1/16 inch above the foam. The spar cap will settle down as the epoxy goes into the foam, and the air works out as you smooth it.

Continue to fill the spar box full. The inboard 4 feet will take extra layers because it gets 1/4" deeper in 4 feet. Drop each roving into the box just like a rope, and keep squeeging it flat after each layer, working from the center toward each end.

When the spar box is full and you have checked with a straight edge to see it does not stick up above the foam anywhere, we can skin this side of the wing.

VERTICAL SHEAR

Most wings have a shear web between the upper and lower spar cap. However, the Windrose carries the shear in the skin so be sure the skin is attached to the spar cap. Push down on the skin. May be pushed with fingers and run lengthwise full length and from center out to each end.

SPAR CAPS

After gluing the foam blocks together, check not only the possible joggles at the interface of the foam blocks, but the depth of the notch that you are going to place the unidirectional caps in. See if the notch is as deep as the templates show. Also see if the notch is uniformly tapered in depth from one template point to the next. Note: a slightly oversize notch is better than undersize.

VOLUME

Have the epoxy man measure out several 6 or 8 oz. sets of mixture. Pour about 4 sets together into a coffee can and stir with a mixer in your electric drill for 2 minutes. Add an equal ~~amount~~ of microballoons and stir again. Then pour over the wing and squeege into the foam. Repeat until the whole wing is covered. Install the peel ply along the trailing edge then roll out the wing-skin onto the wing. Keep the micro about 1/4" away from the spar. We want a direct bond there.

Now squeege the skin down into the micro, and add and squeege straight epoxy onto the surface until the wing is done. Lap the skin over the root rib at least 2" and trim the skin along the edge of the aileron at least 1/4" from the radius curve. Lay a piece of peel ply along the joint area under the leading edge, and on top of the skin in the aileron gap. Install 2" strips of fiberglass tape 4 feet long at the outboard end of the aileron, with a 3 inch piece of peel ply on top of it. See wing drawing for location.

Turn the wing over and block it so that the reference line on the root and tip ribs are both exactly parallel. A spirit level used at each end is probably best, unless you are sure your table is level. Then use the table surface to assure parallel lines. Check this again with the second skin on, but before it has begun to cure.

After installing spar and skin on the other side, then saw off the spar stubs to proper dimension, and set the wings up with the center of the wings at the center of the table. Prop up the tips so there is zero dihedral center of wing parallel to this table. Shim the outside hardware about 1/32" each side so they will assemble easily. Put the 1/2" main flight pins in the attach hardware and clamp it all in place. If everything checks out, drill the spar stubs for the 5/16" bolts, and bolt in place. I recommend using lots of epoxy in the bolt holes and on the nuts.

Make sure there is no twist in the wings, and drill or ream to fit the 5/8" main pins.

Saw off the drag spar stubs to proper dimensions, and make the drag spar-wing fitting and drill the metal fittings but not the wood stubs yet. We do this at fuselage-wing mating. Make the 1/8" aluminum torque plate. Drill it to a snug fit on the upper wing pin. Drill and counter sink the four bolt holes.

MATING WINGS TO FUSELAGE

Drill one inch holes in the bulkhead in the front end of the tail boom so the main flight pins can go slightly into this bulkhead. Make and drill the four main fuselage hangers, but don't drill the wood yet.

Put a 1/16" or 3/32" shim on top of the main spar rest on the fuselage, and put the wings together in place on the fuselage. Stretch a wire from the top rudder hinge to the wing tip. Put tape on the wire and tape it to the other wing tip to make sure the wings are right with the fuselage. Put the main lift pins in the main wing fittings and clamp these to the fuselage wood. Put the drag pins in place and clamp the drag spar fittings to the wing spar stubs. (Make sure there is no tortion in the wings). Clean the 1/8" torque plate. Back out the top main wing pin, slide the torque plate on the top pin, and 5-minute epoxy it to the bulkhead using some wedges to hold it in place.

Now remove the wings, drill and bolt in place the lift fittings to fuselage; the drag fittings to wing drag spar stubs, and the torque plate to the bulkhead. Go have a beer.

Add 2 or 3 layers of 2" fiberglass tape along the aileron hinge line.

Ailerons:

Cover the table with a plastic drop cloth. Lay out the aileron foam stright on the table, bottom side up. Make the aileron horn from 1/2" plywood and round the edges. Glue the foam into one piece and glue the horn in place. The aileron skins are all made of DB 170-50 wing skin material. Add a second layer from the root out 18" long. Install the peel ply first, then the skin as per the drawing and glass on the bottom.

Next day turn over the aileron, trim or saw trim the foam and peel up the peel ply and install one 2" strip of glass tape along the trailing edge and ~~the top skins~~ SKIN THE TOP. Mate to the wing. If all the hinges do not match exactly (quite likely), build up either the wing or the aileron or both with a layer or two of 2" glass tape. To get the hinge line as straight as practical, with the hinge pins in place, pop rivit the hinges in place both to the wing and the ailerons.

Build up the wing tips and wheels as shown on the drawing. The wheel is a skateboard wheel cut down to 1/4". It uses skateboard bearings and a 5/16" bolt. Aerodynamically, the basic idea of these tips is to add weight forward of the spar and none, or almost none, aft of the spar.

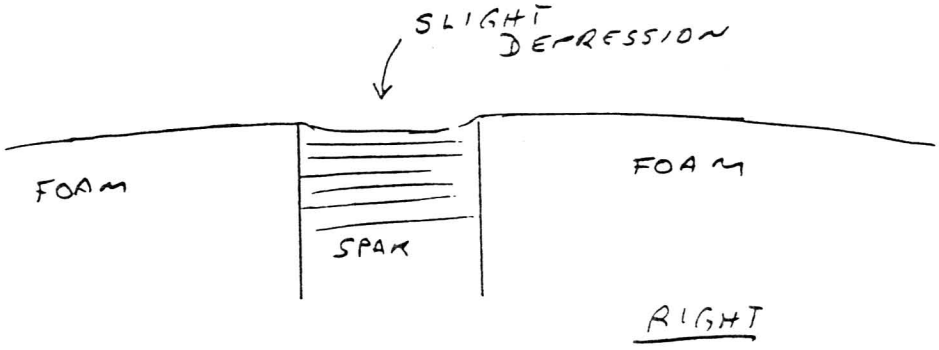
Building the rudder seems self-explanatory. The rudder post has to be routed out to take the tail wheel fork under the lower hinge. The tail wheel is the same as the tip wheels. The mass of the tail wheel is forward of the hinge line for aeroelastic reasons (flutter). The upper rudder hinge can be mounted on the fin post any time. The lower hinge should be clamped in place with the rudder in place to get the exact location.

We will discuss the finishing techniques on all these foam-glass parts in a later section.

HORIZONTAL TAIL

Hotwire the foam blocks to patterns. Saw and shape the spar to dimensions shown. Make the aluminum hinge and horn parts, and bolt these on the spar. Trim the foam away to go around these fittings.

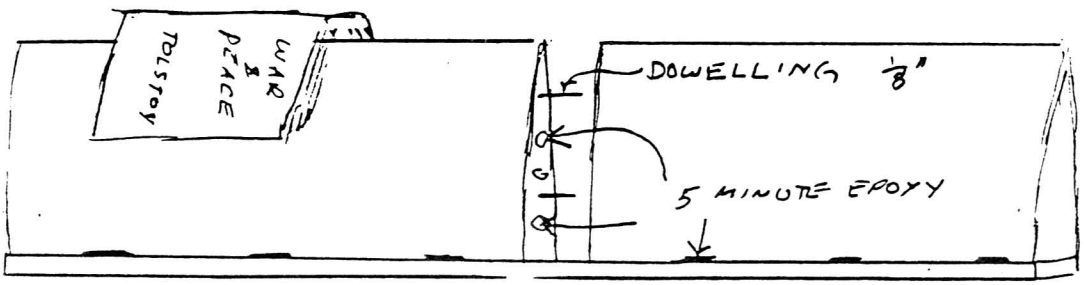
Important! When fitting any of the foam blocks to the spars, it is important that the spar be slightly lower than the surrounding foam.



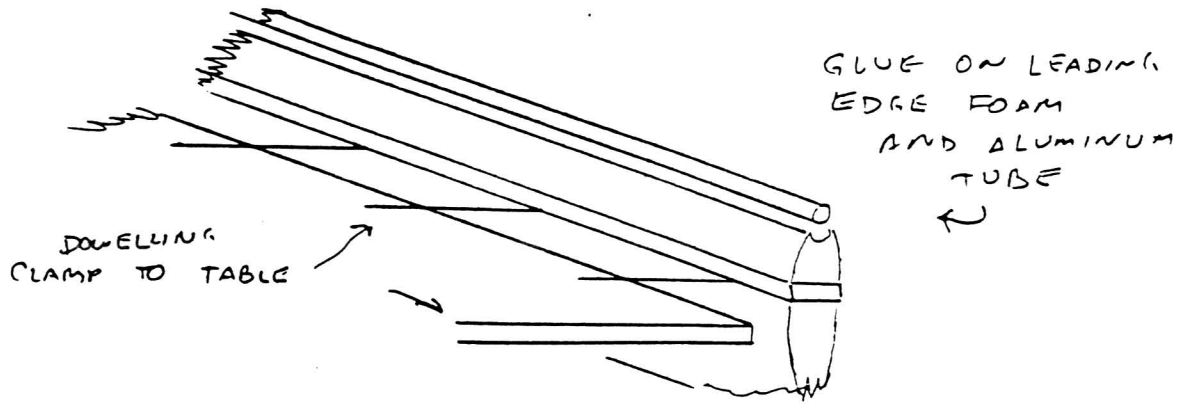
This depression can be filled after glassing and will give a smooth final surface. If the spar protrudes even slightly, you cannot sand it off or the skin either.

I found it best to glue the rear part of the foam on the spar first. You block the spar up off the table and glue the foam to the spar and the two blocks to each other.

To pin the two pieces together, use a 1/2 inch band of 5 minute epoxy slurry and two 4" pieces of 1/8" dowling. To glue to the spar, use five or six dabs of 5 minute epoxy. I held the foam down to the spar by balancing some books on top of the foam.



To glue the leading edge on, push five or six 1/4" doweling pins in the foam next to the spar. Clamp these to the table and rest the aluminum tube in place and put some weights on it.



Glue the end ribs in place, and round their edges. Glue the aluminum tube in place and we are ready to glass our first unit.

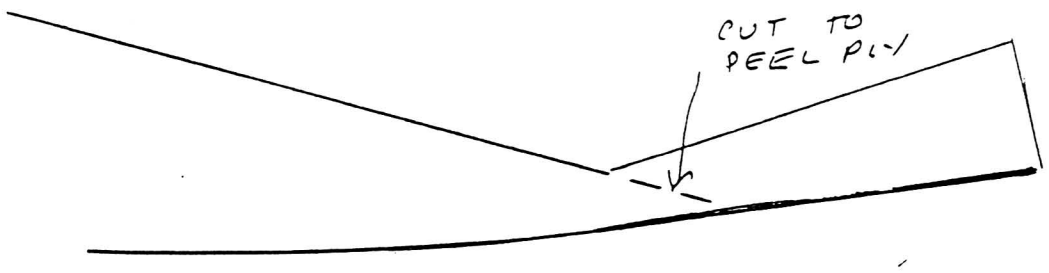
Glassing:

Use straight edge and sand the foam as necessary so that the form will be fair. It shouldn't take much. Use 902 Bidirection Cloth (RA 5277). Cut it to size leaving an overlap of about 2" all around. Cut a piece of 2" peel ply tape for the trailing edge. Put all these and the epoxy in the cardboard box-oven overnight at 90° to 110°. This is a project that works best with two people. One will spend most of his time mixing epoxy.

Lay the horizontal tail flat, up on four sandbags (made from paper sacks full of sand) so you can work over the leading edge.

Mix an 8 oz. cup of epoxy (stir 2 minutes by the clock). Then stir in an equal volume of microballoons, and spread this slurry over the foam. Come up to about 1/4 " of the spar and keep slurry off the spar. We want a good structural jont there. The best way to spread slurry is to pour it on and squeege it around. When the surface is covered, lay down the 2" peel ply along the trailing edge keeping it straight, paint straight epoxy along here and on the spar (no micro), then lay the cloth on the whole side of the horizontal tail. Squeege it down into the slurry. Get all the air bubbles out. Then paint on and squeege epoxy over the whole surface. Cut the cloth while wet, about 2" past the leading edge. Smooth into place and wipe off all excess epoxy on the bare foam. Put peel ply over this surface so the next layer will go on easily covering this edge. Squeege down.

When this has cured, turn it over and with a fine saw or knife, trim the foam at the trailing edge to the peel ply as you lift it up.



After removing peel ply at the leading edge, sand the other side as necessary along the overlap. The best tool to use is a high speed dremel tool with 1 1¼" disc sander. Feather this edge down to the foam. Slight depressions don't matter as we fill these later before finish.

Cut the next cloth to fit. Cut two 2" fiberglass tapes to reinforce the trailing edge. Glass these tapes in as you cover the second side. Overlap the leading edge about 2" and glass around the end ribs.

To install the balance rods in the tail (one in the rudder, three in the horizonal) clean and then roughen the iron bars with a file or grindstone. Mix epoxy slurry with microballoons and pour 3 or 4 tablespoons into the aluminum tube. Push in the rod, turning it around as you push it in. In the horizonal, you will have to use two pieces of dowling between the three steel pieces, otherwise pneumatic pressure moves the middle one about! (Guess how we found out.)

FUSELAGE BASIC STRUCTURE

Saw out and sand to contour the 3/4" blocks for the fuselage. Cut the longerons to length. Build all four flat sides first, boom and skid flat on the table using staples or small nails. Assemble the tail boom by gluing on the top and bottom skins. Assemble the forward skid by installing the top and bottom skins. Use small brass nails and leave them in, or use staples and remove them later. Make and install the metal fittings and the tow hook before closing the top of the bottom skid. I installed the top rudder hinge and the horizonal tail supports by cutting a 2 1/2 X 3 inch hole in the side of the tail boom near the end and reaching through to put the nuts on. If you do this, glue a 1/8 inch doubler inside around the hand hole. Saw out the two 1/2 inch pylon sides and cut the round holes in them. Prop the tail boom and skid upon 1/2" blocks on their side and locate the pylon pieces. The bottom of the tail boom is parallel to the top of the skid box and 30 inches above it. Glue and nail the pylon sides on. Use brass boat nails. Glue and staple the stringers and front and aft skins on the pylon. Put one layer of DB 170-50 fiberglass on the front side

of the pylon, overlapping the sides about 1½". Cut to size, and glue and bolt the lift struts on the sides of the pylon. You can now make and install the control system and the drag spar fittings. The main lift fittings should be mated to the wings. Then with the wings in place on the fuselage, and the lift pins in all the fittings, drill the holes to mount the main lift fittings to the fuselage. SKIN THE TAIL BOOM WITH ONE LAYER OF DB170-50 GLASS OVERLAP ABOUT 2" ON THE BOTTOM.

Glue and bolt the ventral fin to the rear of the tail boom. Make the rudder spar and install all of both hinges. Turn the fuselage upside down and fasten the aluminum tube leading edge in place. Glue blocks of foam in place, and hot wire the ventral fin right on the glider. Skin it with one layer of RAF 902 cloth. Carry the cloth out about 1 inch onto the box.

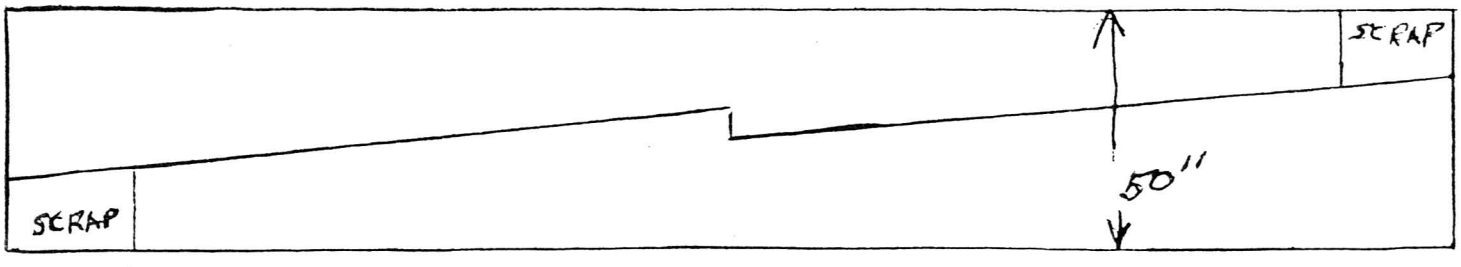
BUILDING THE PILOT POD

Cut out the 1/2 inch plywood pod frames from the patterns. Cut out the canopy frames and cockpit combing. The frames are glued to the skid box with 1/2 inch square corner blocks. Glue the cocpit combing in place, and the rear cockpit frame. Bevel the edges of the combing to shape. Then make the canopy frame in place on the glider so that it will fit nicely.

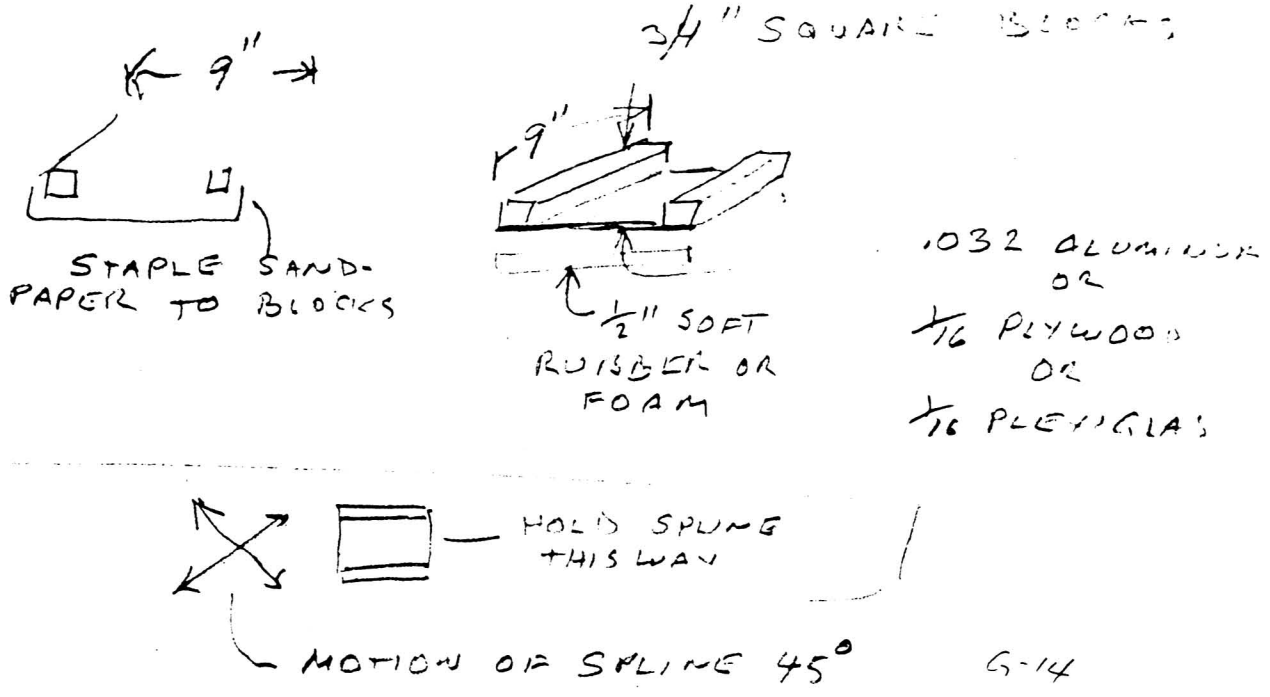
The stringers should be installed in pairs, left and right, so that bending them does not distort the basic shape. I would suggest fitting the dive brake control, instrument panel, tow release, and floor boards before covering. Cover with dacron, heat shrink, put tapes over each stringer, and the frames that touch the cloth, and brush on one or two coats of varathane varnish. Finish as you like.

There are a couple of alternatives here. You can buy a molded pod from the kit suppler. Another possibility is to glue 1/2 or 3/4" thick 2 pound per cubic foot foam in flat slabs between each pair of stringers. Then sand the foam to a clean aerodynamic (aesthetic) shape, and glass over this with 9oz. RF cloth. You don't have to try and get perfect lines along the stringers. Just get close. Then glass, then fill and sand the outside to your demands for perfection.

Pattern for cutting two wing skins from 50" fabric. (not to scale)
Cut it rolled out on the wing.



PATTERN FOR CUTTING TWO WING SKINS FROM 50" FABRIC. (NOT TO SCALE) CUT IT ROLLED OUT ON THE WING.



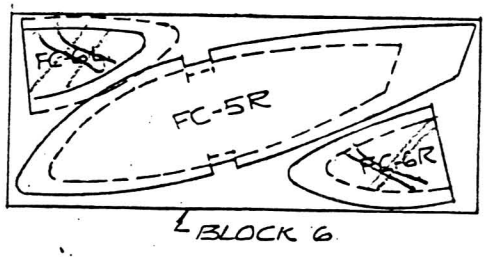
FINISHING FIBERGLASS SURFACES

Sand the whole surface lightly to get rid of burs and to give the finish a "tooth". Don't sand into the fiberglass structure.

Fill all major holes and dips over .030" (such as along the top of the spars) with a dry mix of microballoons and epoxy. Next brush or roll on two or three coats of primer surfacer. San again. Then mix some lamp black, or any dark coloring agent with primer surfacer and spray on a light coat. As you sand this, it will show very plainly any irregularities. Continue with primer-surfacer until you are happy with the finish. Then spray on the finish coat.

The final sanding before paint is best done with a spline. See sketch.

COLOR MUST BE WHITE WITH A MINIMUM OF TRIM MARKINGS.



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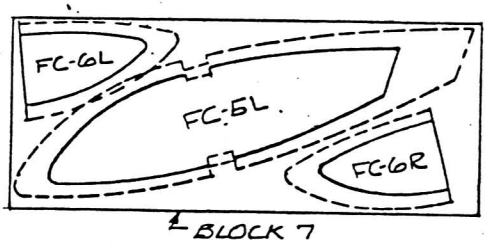

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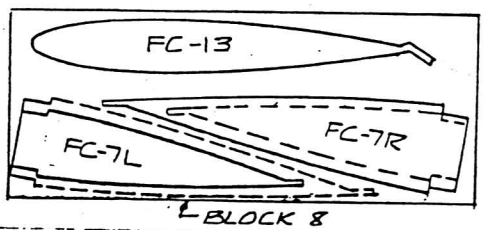

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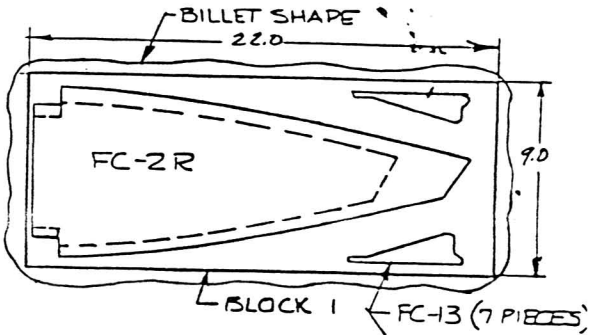

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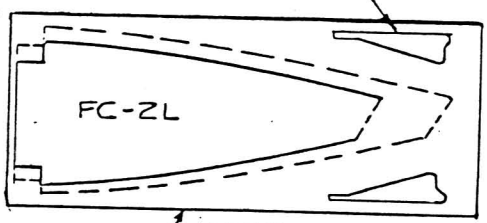

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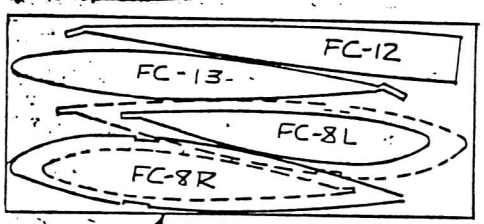

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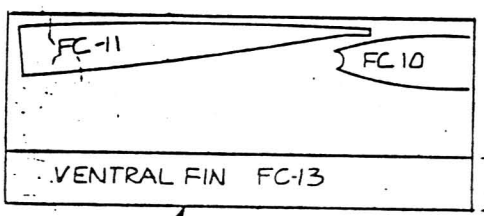

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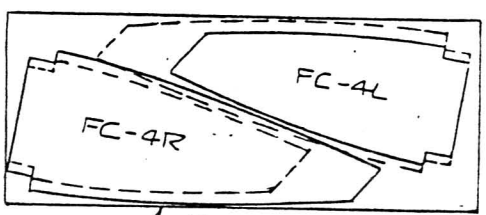

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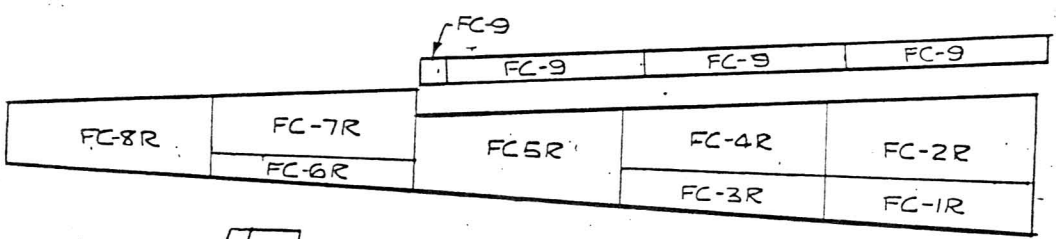
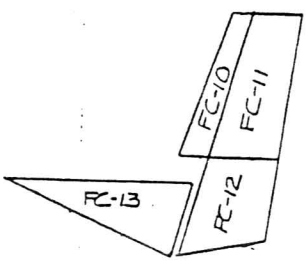
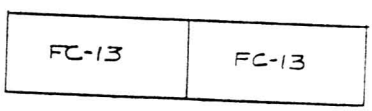




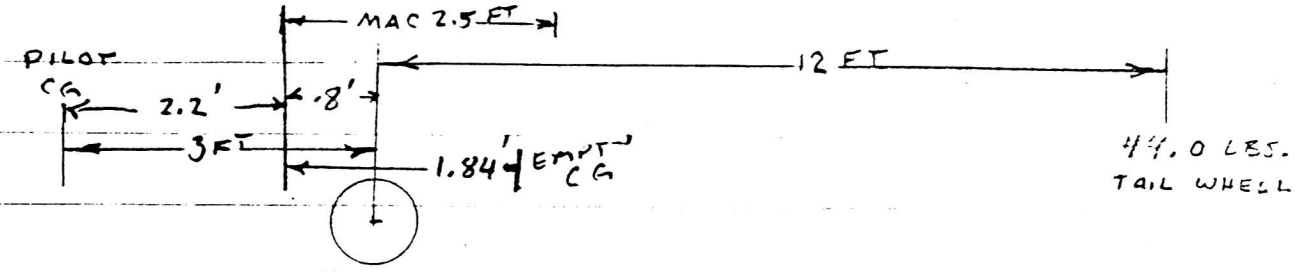


HORIZONTAL TAIL

WINDROSE

WEIGHT AND BALLANCE STATMENT PROTOTYPE N.325P

1. LEADING EDGE OF MAC IS 3.2 IN. AFT = .26 FT OF LEADING EDGE OF ROOT RIB.
2. MAIN WHEEL = .8 FT ÷ 2.5 FT = 32% MAC
3. CONTROLLABLE LIMITS ARE; MAX. FWD. CG 5.33% MAC
   MAX AFT CG 44.66% MAC



EMPTY CG IS TAIL WEIGHT X TAIL DISTANCE ÷ GROSS WT + .8 FT

$\frac{44.4 \times 12}{512} = 1.04 + .8 =$ 1.84 FT AFT OF LE OF MAC = 73% MAC

CG WITH 228 LB PILOT & CHUTE

CG = (EMPTY CG IN FEET AFT OF L.E OF MAC × GROSS WT) − (PILOT WT. × DISTANCE PILOT FWD OF L.E. OF MAC ÷ (EMPTY WT + PILOT WT) × LENGTH OF MAC

$$\frac{(1.84 \times 512) - (228 \times 2.2)}{(512 + 228) \times 2.5} = \frac{942.0 - 501.6}{740 \times 2.5} = \frac{440.4}{1850} =$$

.238 = 24% MAC. = .6 FT AFT OF L.E OF MAC. = 7.2"
.6 + 1.26 = .86 FT AFT OF DATUM = 10.3".

CG WITH 150 LB PILOT & CHUTE

$$CG = \frac{(1.84 \times 512) - (150 \times 2.2)}{(512 + 150) \times 2.5} = \frac{942 - 330}{1655} = \frac{612}{1655} =$$

.369 = 37% MAC = .925 FT AFT OF L.E. OF MAC = 11.1 IN.
1.925 FT + .26 FT = 1.185 FT = 14.22 IN. AFT OF DATUM.

WINDROSE COCPIT PLACKARDS REQUIRED BY F.A.A. ON THE PROTOTYPE

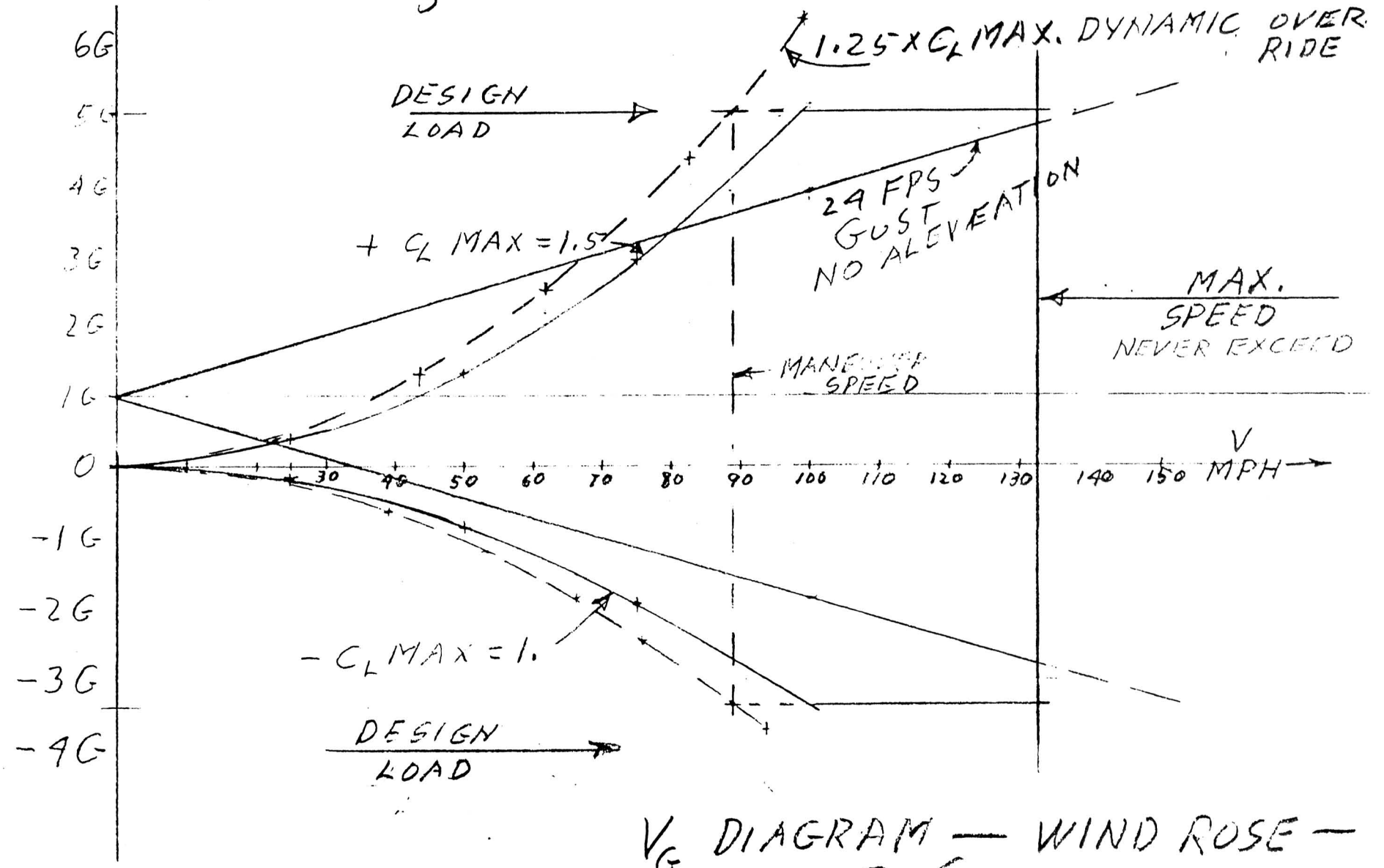
PASSENGER WARNING: THIS AIRCRAFT IS AMATEUR BUILT AND DOES NOT COMPLY WITH FEDERAL SAFETY REGULATIONS FOR STANDARD AIRCRAFT.

NO PERSON MAY EXCEED THE DESIGNERS OR BUILDERS RECOMMENDED LIMITATIONS AS FOLLOWS: MAXIMUM GROSS WEIGHT 740LBS. CENTER OF GRAVITY LIMITATIONS MAXIMUM FORWARD 24% MAC. MAXIMUM AFT. LIMIT 37% MAC. AIRPLANE TOW 84 MPH. MAXIMUM SPEED ROUGH AIR 96 MPH MAXIMUM SPEED SMOOTH AIR 127 MPH.

GROSS W = 120 LBS

$\frac{W}{S} = 7.52 \frac{LBS}{SQ\,FT.}$

$C_{L\alpha_R} = 5.087$



V_G DIAGRAM — WIND ROSE —

GUST REDUCTION FACTOR = 1.
REF. BASIC GLIDER CRITERIA.

H. Culver

WINDROSE

Parts List

Plywood:

2 sheets 1/8"x4'x8' 90° / 1 SHEET 1/8 x 4 x 8 45°		Wing & tail, tip ribs, box skins, wing spar root boxes
1 sheet	1/4"x4'x8'	Wing root ribs, instrument panel, floor spoiler, rock guard.
2 sheets	1/2"x4'x8'	Pod frames, box sides boom to skid, 3 aileron bell cranks, canopy frames cockpit combing, rudder pedals, wing root boxes, tip wheel fairings, seat mount.
1 sheet	3/4"x4'x8'	All bulkheads, skid, box sides, wing root boxes.
1 sheet	1/8"x2' x8'	Tempered masonite for all foam cutting patterns.

Wood:

4 each	3/4"x3/4"x12'	Tail boom longerons
4 each	3/4"x3/4"x 3'	Corner blocks - pylons
2 each	3/4"x2" x2'	Verticals on pylon
1 each	3/4"x2" x1'	Cross piece on pylon
2 each	1/2"x1/2"x3'	Blocks at wing root rib
7 each	3/8" x 36"	Round birch dowles
1 each	3/4"x 2 1/2"x3'	Fin spar and rudder doubler
1 each	3/4"x 2 1/2"x5'	Rudder spar
1 each	3/4"x 2 1/2"x7'	Elevator spar
2 each	3/4"x3/4"x2'	Rock -guard
10 each	3/8"x1/2"x8'	Pod stringers, corner blocks, pod to box

FOAM:

5 Blocks Dow Flotation Billets
Nominal 10" x 24" x 96"

OR EQUIVALENT 2 LB/FT³ STYROFOAM.

FIBERGLAS:

Cloth

~~20~~ 25 yds. DB170-50 Knytex(For Wing)
(From: Proform, Hwy. 46 North,
Seguin, Tedas, 78155)

10 yds. RA-5277 BID 38" 9 oz.
(From Aircraft Spruce,
Box 424, Fullerton, Ca. 92632)

Tape

360 yds. (2 each 180-yard rolls)
20 oz. unidirectional, 3" wide.
(From Aircraft Spruce)

50-yd. roll, 8.7 oz. 2" wide.
(Aircraft Spruce.)

Peel Ply

50 yds. 1 roll 2"wide

50 yds. 1 roll 3"wide

EPOXY:

7 each 1 1/4 gallon kits Safe-T-Poxy

1 Kit 5-minute epoxy (1 pint resin, 1 pint hardener)

GLASS BUBBLES (For Micro)

1 5-lb. bag

Flocked Cotton:

1 1-lb. bag

Dacron Cloth:
6 yds. 2.7 oz. 50"

Dacron Tape:

50 yds. 1 roll 2" wide

ONE ONLY, OR SPECIAL ITEMS

Wheels:

1 Main: 4.00 x 10" Go-Cart, 5/8" shaft.

4 Wingtip and Tail: 2½" skateboard, 5/16" shaft
(Trim to 1" thick) +Nosewheel

Brake:

Bicycle lever and cable

Main Flight Pins:

2 Make from 5/8" x 4" grip aircraft bolts

Aileron Push rod ends:

4 each: Ball joint: Quick disconnect type, 3/8 x 24 x 7/8" length.
(From: McMaster-Carr Supply,
9601 John St., Santa Fe Springs, CA 90670)

Seat:

1 Bucket (Aircraft Spruce) or Integral Seat-Tank

Seat Belt and Shoulder Harness:

1 Set (Aircraft Spruce, Fullerton, CA)

Canopy:

1 Sheet	.060 Lexan	48" x 54"
1 Sheet	.080 Plexiglass	18" x 24"

Springs:

2	Elevator Wire	.095" coil dia. OD .75	55 coils
2	Rudder Wire	.095" coil dia. OD .75	50 coils
2	Each Tow Hook	.032" x 2" long	
1	Spoiler Wire	.073" x .687 OD x 55 coils	
1	Trim Spring	.049" x .44" OD x 40 coils	
1	Wheel Brake Compression	.375" OD. Adjust at assembly	

Lead:

1 10-lb. block. Cut and use as necessary, for ballast.
Bob weight 2 lbs.

Steel Rod:

1 5/8 diameter x 72" long

Canopy Latches:

2 Window hold-down latches, over center type. (Local hardware store)

Hinge Stock:

9 ft. Piano MS 20257 P5 (For Aileron, Rudder Pedals, Spoiler, Canopy)

Pulleys:

9 -each AN 210-2A

Thimbles:

11 each AN 100-3

Clevis Pins:

11	AN 393 - 9	1 AN 393-15
1	AN 395-5C-43	1 AN 394-15
2	AN 394-3C-41	
2	AN 393-13	

Cotter Pins:

40	AN 380-1-3
4	AN 380-2-3

Shackles:

11 AN 115-8

Nicropress Sleeves:

12 18-2-G

Cable:

90 ft. 3/32 7 x 19 Stainless cable

Turnbuckles:

2 AN 130-16S

Aluminum Angle:

1 each 1/8" x 1" x 1 1/2" x 60"
1 each 1/8" x 1" x 1" x 72"
1 each 1/8" x 1 1/2" x 1 1/2" x 12"

Aluminum Tubing:

1 each 1/2" Dia. x .065 wall x 72"
1 each 3/4" Dia. x .049 wall x 38"
1 each 3/4" Dia. x .049 wall x 84"
1 each 3/4" Dia. x .049 wall x 50"

Steel Tubing:

1 each 7/8" OD x .049 wall x 22"
1 each 7/8" OD x .049 wall x 23"
1 each 7/8" OD x .049 wall x 50 1/2"
1 each 5/8" OD x .035 wall x 52"
1 each 5/8" OD x .035 wall x 12"
1 each 3/4" OD x .049 wall x 72"

Steel Angle:

1 each 1/8" x 3/4" x 3/4" x 13"

Steel Plate:

1 each 1/8" x 2 1/2" x 24"
1 each 3/32 x 6" x 6"
1 each 1/4" x 4" x 6"
1 each 1/8" x 1" x 24" (Skid)

Steel 4130"

1 each 1" x 3/16" x 12"
1 each 3/4" x 1/8" x 13"

Aluminum Plate and Sheet (6061-T6)

1 each 3/16" (.187) 10" x 20"
1 each 1/4" (.250) 3" x 3"
1 each 3/8" (.375) 10" x 42"

1 each .032 8" x 7"
2 each .020 25" x 38"
1 each .020 6" x 32"
1 each .090 10" x 42"
1 each .125 5" x 8"

FASTENERS:

Bolts:

4 each AN 6-12A (Seat Belts)
3 each AN 5-11A
12 each AN 5-25A (Wing Attach)
12 each AN 5-34A (Wing Attach)
1 each AN 4-24
1 each AN 4-10A
12 each AN 3-5A
6 each AN 3-6A
20 each AN 3-10A
15 each AN 3-11A
15 each AN 3-12A
36 each AN 3-13A
31 each AN 3-14A
28 each AN 3-17A
14 each AN 3-20A
16 each AN 3-15A
1 each AN 3-24A

Nuts:

4 each MS 17825-6 Lock nuts (Seat Belt)
4 each AN 315-6 Stop nuts (Rod ends)
4 each AN 364-6 Lock nuts (Rod ends)
200each AN 365-1032A
1 each AN 310-4
24 each AN 365-524
4 each AN 316-8R

Washers:

12 each AN 970-6
200each AN 970-3
2 each AN 970-4
48 each AN 960-5
7 each A 3235 -.028-24A Tinnerman

Rivets:

4 each 1/8" x 1/2" grip steel pop rivets
3 each 1/8" x 1/8" aluminum
100each 1/8" x 1/4" aluminum
56 each CR 163-4-4
140 EACH 1/8" x 3/16" ALUM (AILERON HINGES)

Screws:

6 each #4 x 1/2" sheet metal
36 each #6 x 3/4" sheet metal
12 each AN 526-832-14 (Rudder)

Machine Screws:

4 each MS 24693 - 832R4

Anchor Nuts (Seat):

4 each AN 366F22NA-048

Control Adjustment

Ailerons: The ailerons should be adjusted so at rest they droop slightly, say .15 inches at the trailing edge. In flight the air loads will bring them up even with the wing. They should have maximum possible travel, except the stops at the lower bell crank should keep the up aileron from going over center.

Rudder: The rudder stops, located at the rudder horn limit the rudder travel to 25° each side.

Horizontal Tail: Has a built-in trim tab 5/8" wide, and running full span. This tab, as speed increases, brings the nose of the glider up. The trim spring on the stick allows the pilot to adjust the glider to the speed desired. It is important that the hinge line of the horizontal is located exactly to the drawings. It is at the aerodynamic center of the surface. Total travel of the horizontal tail is 26°. A block of proper thickness (approx. 1/2inch) is glued to the box so that the bob weight bottoms on it. It should be arranged so that the travel is limited to 10° glider nose down, leaving 16° glider nose up.

WINDROSE

INSTRUCTIONS: Part II Engine Installations

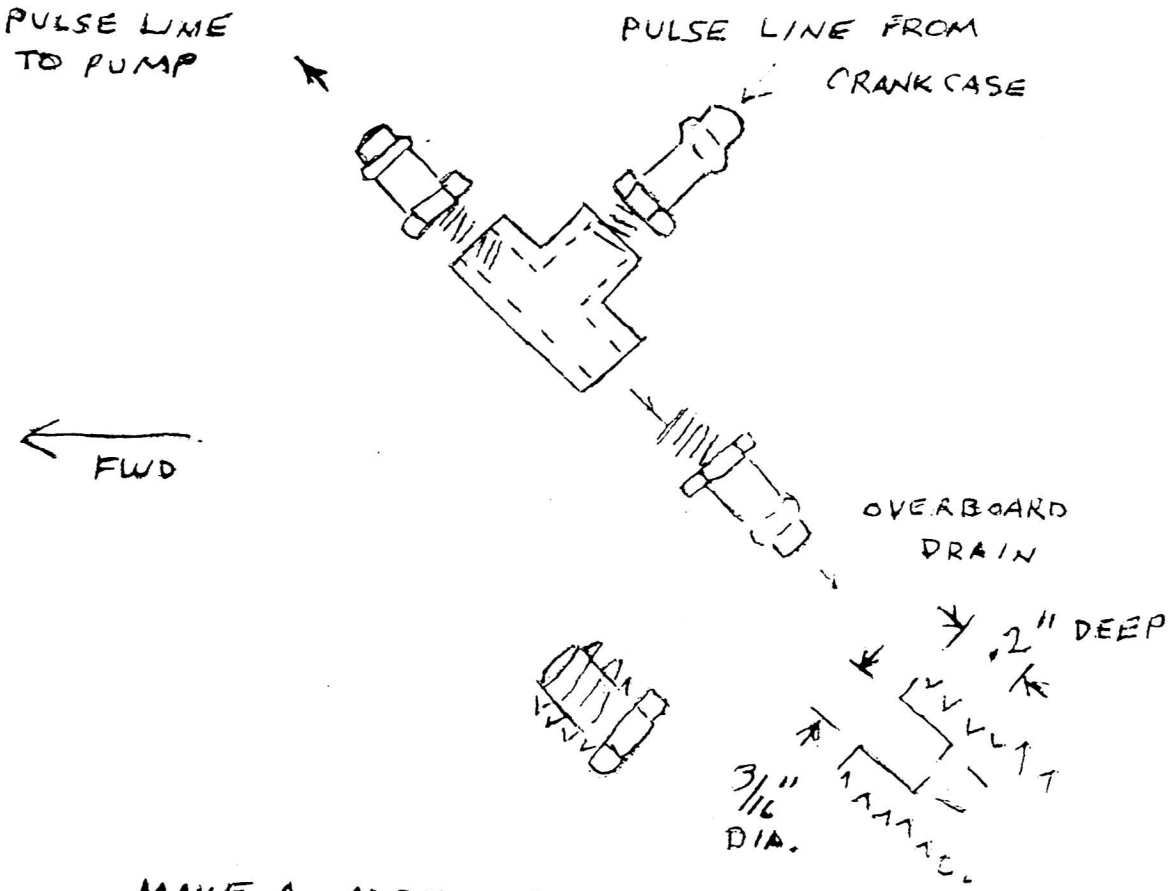
The basic Windrose configuration lends itself to a variety of engine installations. As long as you get adequate horsepower, keep the prop in the space provided, and keep the weight under control. You are free to do your own experimenting. Our engine installation including integral seat-tank, stainless steel firewall, engine and accessories added about 85 lbs. to the empty weight.

This text, photographs, and detailed drawings (Sheets E1, E2, E3, and E4) will cover the installation of the Cuyuna UL II-2 engine. It was chosen because it is in broad use in the USA, produces adequate power at an acceptable RPM, and lends itself, with minor modifications to the accessories, to tight and smooth coweling.

The fuel is carried in an integral seat-tank mounted on the standard seat mounts. Fuel is routed from the tank, through a strainer through the firewall and to the pulse driven fuel pump. The fuel pump should be mounted as low as is convenient. Below the bottom of the tank. The engine is hung inverted below the engine mount made of 4 pieces of aluminum angle.

Mounting 2 cycle engines inverted produces 2 minor problems. 1. When the engine sits idle for several days, the spark plugs fill up with oil. When we fly every day, there is no problem. Any time we leave the glider for a week or more, we remove and clean the plugs before trying to start it. We take this occasion to change the thermocouple back and forth from front to rear to front cylinder, just to keep tabs on everything. We have had no overheating at all with this engine.

The second problem, is that the pulse line from the crankcase that drives the fuel pump also filled up with oil. The sketch below shows how to eliminate this problem permanently. See Sketch A, page 2[illegible].



MAKE A METAL PLUG FROM 3/16" DIA ROD AND .2 IN. LONG. WITH A TRIANGULAR FILE, NOTCH THE PLUG ABOUT .03" DEEP ONE SIDE AND AROUND BOTH ENDS.

SO NOTCH WILL NOT BE PLUGED BY SHOULDER.

NOW, OIL WILL EXIT THROUGH THE .03" NOTCH OVERBOARD. AND ENGINE PULSES WILL STILL DRIVE THE FUEL PUMP.

INSERT IN LOWER FITTING AND STAKE WITH PUNCH.

SKETCH A

The firewall is made of .016 stainless steel, and it is bolted, riveted and screwed in place. We suggest that everywhere in the engine area you use "Locktite" on all bolts. (Available at Auto Supply Stores) and dip all wood screws in rubber cement as you install them. The last thing you need is a little wood screw going through the prop.

The engine mount itself seems self-explanatory. The engine is bolted tight and rigid by 4 bolts through steel tubing to the two "Dog Bone" washer plates, and these 4 bolts are locked with safety wire. This whole unit is "floating" in rubber where it goes through the 1/4" engine mount plates that are bolted rigid to the aluminum angle. We have found this great.

The carburetor is turned 86° and mounted almost flat against the engine. The drawings show this manifold.

The standard muffler must be shortened. Hacksaw off the exhaust (exit) end just behind the weld on the end. Saw off and discard a piece to re-weld the end in place, and have the muffler now 16 inches long. The intake must also be sawed off and a new one just welded over the hole.

That part of the exhaust that bolts to the engine is made up on a flat steel jig, so that it will fit flat on the engine. The rest of the exhaust system should be tack welded with the engine and muffler in place. Two joints are needed in the system. A ball joint near the engine and a slip joint near the muffler.

Cowling. After the new intake and exhaust systems are mounted, the engine cowling is made. The basic pieces are cut to fit from .080 artist board (cardboard). Holes are cut in these pieces where they touch against the carburetor and exhaust systems. These two pieces are glassed with 9 oz. glass while in place on the glider, then remove, and glass the inside. "Bumps" are shaped of foam scraps to fit over exhaust and intake manifolds and glassed to the cowling. The foam is removed, there is no need to glass the inside of these bumps. Just seal off any cardboard edges so they will be moisture tight.

The propeller page seems self explanatory. You can make the prop yourself in about 2 days, or perhaps we will find a prop shop to make them for us. The Cuyuna engine has a tapered shaft. Our prop hub fits tightly to the shaft at 2 concentric locations. There is a wooden tool to hold the hub from rotating while you torque down the hub bolt. We watched where the prop stopped on each run, and in about 3 adjustments, we got the prop to stop directly behind the deadwood (vertically) if we shut the engine off at 60 mph indicated. There is an aluminum hub puller. You back off at the hub bolt about 3 turns, then use the hub puller to bring the hub loose from the shaft.

Starting: The prototype is now flown as a self-launching glider, which means the engine is started from outside the glider. Take off and catch the first thermal, and shut the power off. Now you are a glider. Some of you may want air re-starts. It is easy to arrange. You will need to route the choke (start setting) into the cockpit. The starter is mounted on the engine by 6 bolts, and can be rotated in 60° increments.

In the right location, the pull direction will be vertical (straight up). Route the rope over a big pulley (4 inch) and into the cockpit. You will have to make up a mount for the pulley, and probably another to hold the pull handle at a convenient location for the pilot. The pull will be over your right shoulder. You may have to install a longer rope in the system.

FLYING

Windrose is a normal glider in every respect. Some half a dozen pilots have flown it. The roll rate is excellent. The spoiler is just that. It is for glide path control, not speed control. It dramatically changes the sink rate on approach, and can be opened and closed with no appreciable change in speed, which makes it excellent for low time pilots. The sailplane has been flown by auto-tow, airplane tow, and of course self launching. It's wing loading gives good penetration (at least compared to Woodstock!) and the new brake will skid the wheel at about 35 mph rolling. Follow the drawings and instructions and Windrose should give you many hours of good soaring.

Jim Maupin

Parts List

Windrose Engine Installation

Engine: One Cuyuna UL II-2 Engine with Carburetor, CDI ignition, exhaust fittings and muffler.

Instruments: One CDI operated tach, one cylinder head temp gage.
Seat-tank - See drawings.

Aluminum Angle

1 ea	1.5" x .75" x .125" x 6"	6061-T6 al	(Prop Brakes)
2 ea	1.5" x 1.5" x .125" x 20.5"	6061-T6 al	(Engine Mount)
2 ea	1.5" x 1.0" x .125" x 16"	6061-T6 al	(Engine Mount)

Aluminum Plate

2 ea	2 1/4" x 5" x .080		(Nose Wheel Mount)
1 ea	2" x 16" x .032		(Wheel Brake)
1 ea	2" x 1 3/4" x .125		(Aft Brake Mount)
2 ea	1 1/2" x 6 1/4" x .125	6061-T6 al	(Safety Plates)
2 ea	2 3/4" x 9" x .25	6061-T6 al	(Engine Mounts)
2 ea	1 3/8" x 4 1/4" x .125	6061-T6 al	(Engine Mount Gussets)
1 ea	2 3/4" x 2 3/4" x .125		(Prop Plate)

Steel Plate

1 ea	1/16" x 1 3/8" x 3"	mild steel	(Intake Baffle)
2 ea	3/16" x 2" x 6 1/8"	wrought iron or low carbon steel	(Brake Shoes)

Steel Tubing

4 ea	.5" OD x .049 Wall x 2.5" long	4130 steel	(Engine Mount)
1 ea	1.5" OD x .049 Wall x 6." long	4130 steel	(Intake Manifold)
1 ea	2.0" OD steel tubing 1' long	(from Muffler Shop)	
1 ea	1.75" OD steel tubing 1' long	(from Muffler Shop)	

Bolts, Nuts and Washers

4 ea	AN3-20A	(Nose Wheel Mount)
1 ea	AN5-20A	(Nose Wheel)
2 ea	AN3-4A	(Aft Brake Mount)
2 ea	MS 24694-S17 machine screws	(Brake Plate Mount)
5 ea	MS 24694-S11 machine screws	(Brake Shoe)
1 ea	MS 24694-S28 machine screws	(Brake Shoe)
4 ea	3/8" coarse thread bolts, length 3.25" from under head to end of bolt	(Engine Mount)
22 ea	AN3-10A bolts	(Mount to Pylon)
16 ea	AN3-5A bolts	(Gussets)
12 ea	AN3-6A bolts	(Mount to Angle)
1 ea	1/2" coarse thread bolt approx. 2 1/2" long	
1 ea	AN365-5	(Nose Wheel)
4 ea	AN365-3	(Nose Wheel Mount)
2 ea	AN365-3	(Brake Aft Mount)
2 ea	AN365-3	(Brake Aft Mount)
6 ea	AN365-3	(Brake Shoe Mount)
22 ea	AN365-3	(Engine Mount to Pylon)
16 ea	AN365-3	(Gussets)
12 ea	AN365-3	(Mount to angle)
22 ea	AN960-3 washers	(Engine Mount to Pylon)
2 ea	AN960-3 washers	(Brake Plate Mount)
4 ea	AN960-6 washers	(Engine Mount)

Hose

1 ea	.5" ID x .8" OD x 12"	NAPA hose
1 ea	.8" ID x 1.1" OD x 12"	NAPA hose

Prop

7 ea	1/4" x 3 1/2" x 36"	maple	
1 ea	3" x 3" x 2 3/8"	any aluminum	(Hub Puller)
1 ea	2.5" dia. x 3" long	mild steel (1018)	(for Prop Hub)

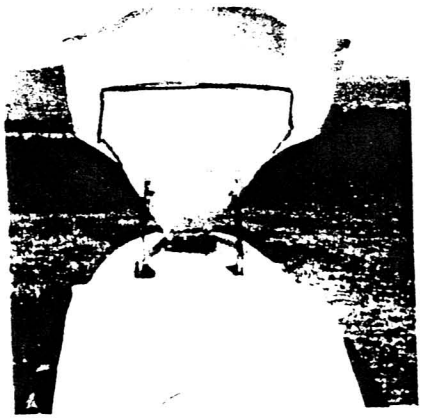
Firewall

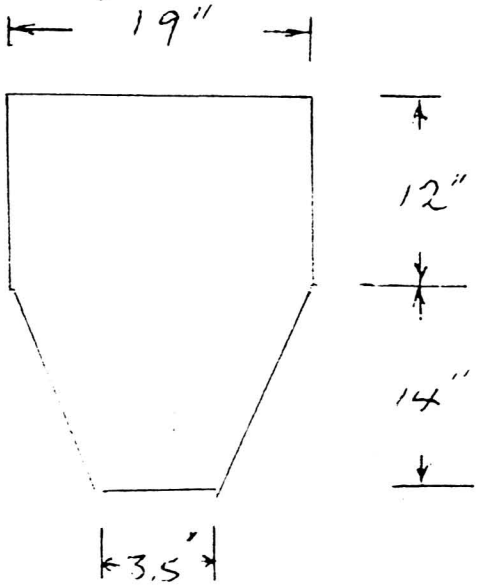
1 ea Fiberfray 1/16" x 24" x 5 ft.
1 ea 301 Stainless Steel Sheet .016 thick
3 ft. wide x 4 ft. long

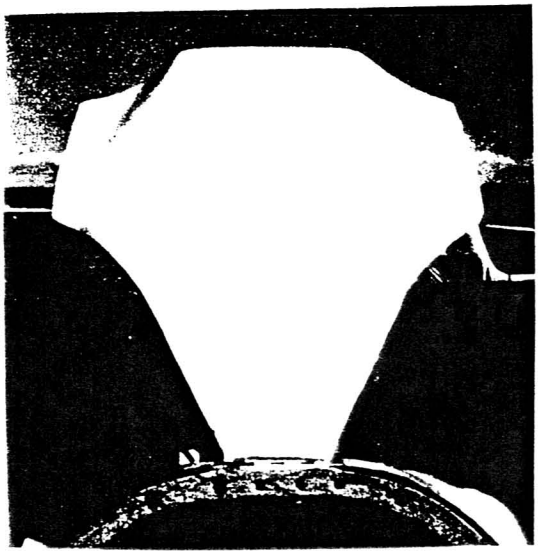
WIND ROSE

ENLARGED SPOILER

THE SPOILER OF THE WINDROSE PROTOTYPE WAS ENLARGED ABOUT 100% BY LAYING UP 4 LAYERS OF 9 OZ FIBERGLASS OVER THE ORIGINAL SPOILER. THE LAYUP IS MADE DIRECTLY ON THE GLIDER WITH PLASTIC UNDER THE LAYUP. THE DIMENSIONS OF THE NEW SPOILER ARE SHOWN BELOW.







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