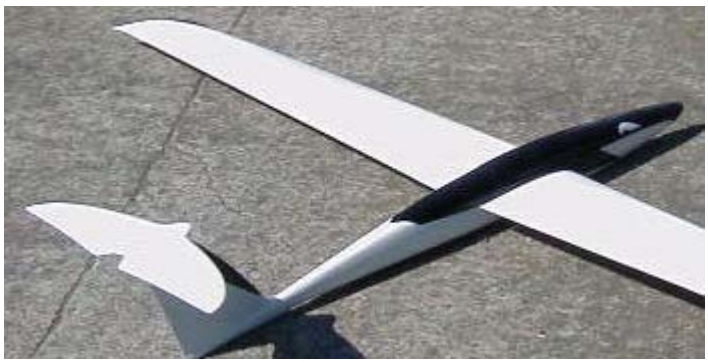
ORCA '07

This is a new version of my Orca (Nov.'89 MA) a 75" span, 2 servo, "pitcheron" sloper. Nothing on the tail moves. With no hinges, it's a slick, fast & agile airframe. The first pic below is of the '07 version ripping by 5/19/07 at Eagle Butte in the hands of Jay Decker. This was during the Six Pack event.

Employing a Tx with elevon function, panels rotate in opposite directions for turn & in the same direction for pitch to provide solid, stable, smooth, coordinated maneuvering. See setup & flying comments, pg.14. With Rx, servos, 4 cell sq. pack of AA size cells & lead to balance, the flying weight is around 45 ounces & good for most winds without ballasting.

Easily built fuse with no CF makes antenna placement a non-issue. It can run inside the fuse on a balsa stick.

This original version had 1" TE sweep shown here. It looked racy, but areas ahead & behind the pivot rod were substantially dissimilar which made hard work for servos at higher speeds.

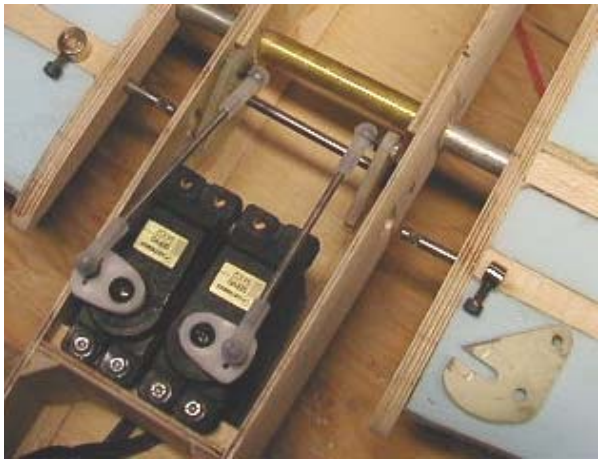


The '07 version has equal sweep along the LE & TE. The pivot point is located at 45% of chord. This aerodynamic balancing makes less work for the servos.

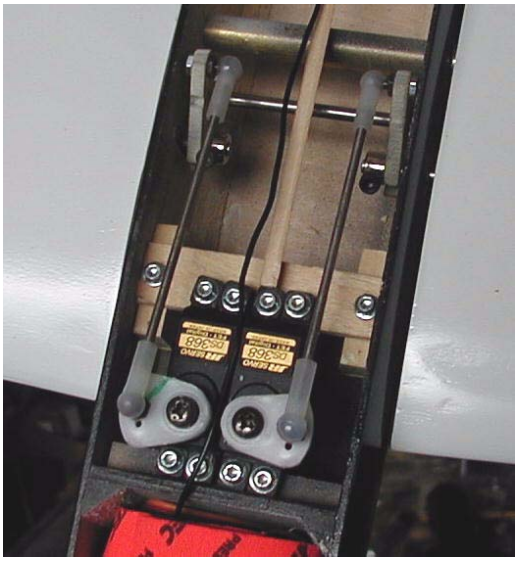
Wing panels can be built with or without vacuum bagging. The procedures to install the pitcheron system & panels in precise alignment have been refined & simplified. A new way of doing a LE with a fine finish is used.

The '07 wing has a current, dedicated sloper airfoil for greater speed. 60# CNC cut cores are available for strength & airfoil precision. See end of this article about the cores & a package that includes new plans, cams, polyester resin/glass molded canopy & construction CD. The Materials List is shown at the end of this file.

The simple pitcheron mechanics, used by Ken Stuhr in his Xica and Rotor designs, are shown below. Ken advised using servos with 50 oz/in. minimum torque. More is recommended for extreme high speed maneuvers. There's room for "standard" size servos.



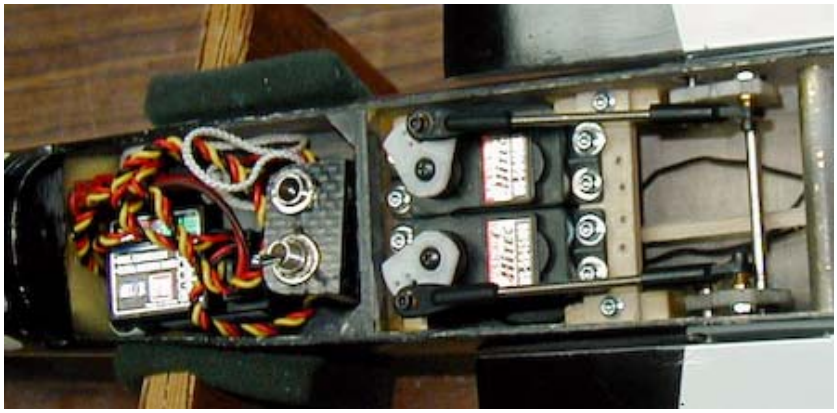
Panels, fitted with tubes, rotate on a 5/16" steel rod. 1/8" drive pins, notched for wheel collars, protrude to enter a slot in a cam (lower right). Cams pivot on a 1/8" shaft across the fuselage. Cams, shimmed with washers to clear the sides, are fitted with 2-56 threaded ball links, same as the servo output arms. Pushrods are all-thread 2-56 steel wire. At the rear, as shown in the next picture, servos mount to a 1/8" ply cross-piece secured to rails.



Here JR micro digitals were installed. Output arms need to be sturdy, so wheels are used & trimmed for clearance.

Servos could be mounted lower but space under them for ballast is reduced, in case intent is to fly in really strong winds.

Linkages need to be slop-free. Secure the 2-56 ball links with provided nuts. For clearance, snip/file excess threads even with the nuts, then apply CA glue to secure the nuts.



Jay Decker used the 150 oz./in. Hitec HS 5945 servos and Rocket City Missing Link type fittings. Servos were lowered to lower the pushrods up front.

As shown below, cams can be easily made from 1" x 3/8" pieces of 1/8" epoxy board, PC board, etc. Raise 1/8" cutting disk 3/8" for slotting. Touch up with 1/8" file.

Cams are to have holes on 5/8" centers as plans show. 2-56 ball links will self tap into a 3/64" hole. For 1/8" pivot wire, use #30 bit. Optionally, a piece of 5/32" brass tube can be seated in a 5/32" hole. Use disc sander to shape as plans show. Cams in Harley's package are slotted rectangular pieces.

CORES: Panel span is 36". Root chord is 7.75". Tip is 4.25". Cores are equally tapered along the LE & TE. There is no washout. Allowance for skin thickness is 1/64". If you cut your own cores, any of the current selection of thinner airfoils suited to slope work will do. Higher density foam is recommended. Sky King Products, Box 24745, Minneapolis, MN 55424. (ed@skykingrcproducts.com).
lists blue Dow High-Load 60 if you need a source.

FUSELAGE: Refer to the new plans, material below & the general fuselage building steps in File 1 of these Genie pages. On the slab side pattern, the top between the 14" & 22" points & that last 7" at the bottom tail end are 0-0 reference lines. The center line of the supporting pivot rod is 1" below the top one.

From 1/16" ply, cut two pieces 2-3/4" wide. Across one piece, mark the 4", 14", 22" & 29" points. Sand both pieces as needed so they align perfectly between the 4" & 14" points. On the marked piece, parallel to & 2-1/2" down from the top edge, draw a continuous line. Draw out the slab side pattern as plans show. If the ply pieces are bowed, have the bows oppose each other. Use tiny brads or tape to align the 0-0 top edges & to keep the two pieces from shifting. Stack cut a perfectly matching pair. True up the edges. Add outside 1/8" balsa & 1/16" ply doublers where plans show. Lastly add 1/16" balsa along the tail end.

HOLES THROUGH THE MATCHED SIDES: A drill press or guide is needed for accuracy. Use wood backing. Bits need to be sharp to avoid tearing the work.
Main wing pivot hole: 1" below the 14" to 22" line & parallel to it, draw a fine reference line in the wing location. This establishes the vertical location of the hole for the main 11/32" brass tube. Its horizontal location is 2-1/4" ahead of the 14" mark. With a 11/32" bit, drill a clean hole through the sides, centered where the lines intersect. **Cam pivot hole**: The hole for the 1/8" wire is centered 5/8" forward of the center of the 11/32" hole. Locate it vertically so the top of the hole will be just under the parallel reference line.

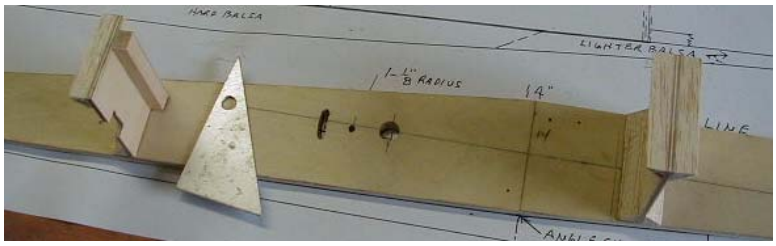
Jay has determined that the precision machined pitcheron system being offered by Doug Boyd (Winch Doctor) will nicely fit in the fuselage. Using it, make the main pivot hole 7/16" in diam. & centered 1/8" lower on the fuselage. No arced slot is needed.

<u>DRIVE PINS SLOTTING GUIDE</u>:

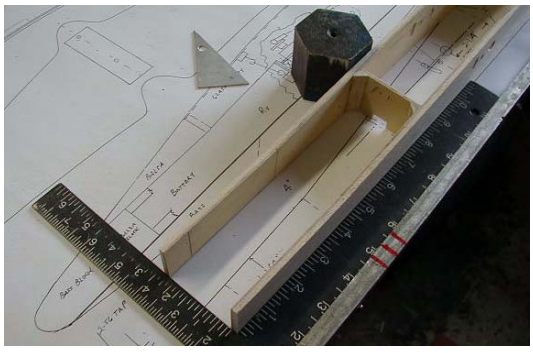
From 1/8" ply, epoxy board, etc. drill 11/32" & 5/32" holes on 1-1/8" centers. From the 11/32" tubing, cut off a piece 5/8" long. Smooth an end & run it through the stacked sides with some protruding (not shown here) to drill a series of 1/8" holes in an arc pattern.

Separate the sides. Inside up front, mark lines ¾" in where the balsa part of the nose blocking extends to.

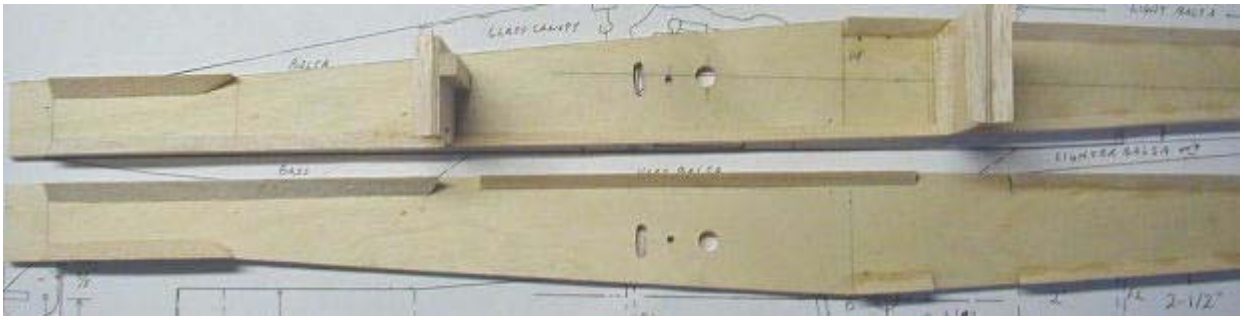
<u>1/8" PLY FORMERS</u>: These <u>must</u> be perfect rectangles. Cut 2" wide & to fit the actual sides where they go. Notch bottom of F1 to run servo leads through to the Rx. Centered in F2, drill a hole through which to pass a 1/8" sq. stick of balsa to which the Rx antenna is fastened. With standard radios it's okay to loop the excess inside back toward the nose. Ground check & if in doubt, run it outside to the fin.



To the front of F1 & both sides of F2, glue triangular stock (TS) so all is squared up to the sides. With a side down flat, glue formers to it. To glue to the other side, position sides upright with everything squared up.



Butt the front ends to the inside of a carpenter's square so they are <u>perfectly</u> aligned in top view. Press flush to the workbench so sides are aligned in profile. As shown in the next pic, TS can be glued to the edges of the sides before joining them to the formers, but leave a little space to fill in next to the TS on the formers on the unattached side.

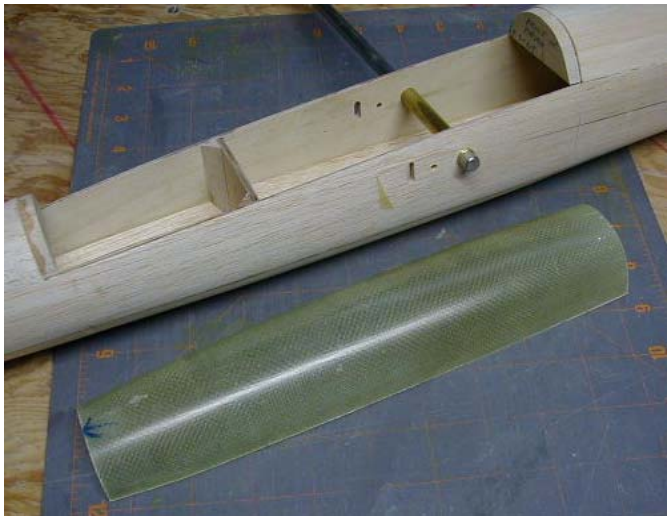


FIN of light 3/8" balsa: Splice pieces as needed to cut to profile. Cut two bass or spruce blocks into ¾" cubes. Grain vertical, use drill press to open the blocks to recess thin-walled 6-32 threaded brass inserts. Glue them in. Trim blocks 3/8" sq., inserts centered. After angling the top of the fin for the stab platform (read below) glue blocks in place. Installed blocks can be seen on page 6 if you look closely.

1/32" ply bottom back to F2: Cut this with grain crosswise. Cut a piece to go from F1 to F2 extending to the outer edges of the 1/16" ply sides. Glue this in place first to help keep the area rectangular when the sides are bent toward the nose blocking.

Cut & fit the ¾" balsa block up front between the sides. Taper it to fit the sides well. Glue it one side. Let dry, then glue to the other side, clamping as needed to keep together. Add 1/32" ply from F1 to the front edge of the ¾" block.

Fuselage bottom: Cut & attach the hard bottom piece of bass, rear end beveled to splice the hard balsa piece on. Clamp 3/8" balsa at the fin front location. Eyeball along the fuse toward the tail end. Shift sides to get alignment. Glue on lighter balsa bottom pieces to the fin location. Sand a step on the piece that overlaps the 1/32" ply. Up front, glue on the hard upper part of the nose block.



Note holes & slots made for the pitcheron hardware. Trim the canopy (Harley's pack) to the inside edges of its exterior molded-in reference lines. If too wide or too narrow, use a heat gun to make it pliable. To widen, press it down with a thick glove. To narrow, squeeze between strips of wood tacked to a board. Mark inside canopy ends to outline the ¼" plates it rests on. Tape it in place to merge top fuselage contours to it.

Thick Top Blocks: Spliced joints may be noticed, so it's best to use single blocks of wood there. Use 1" thick light balsa behind the canopy to taper toward the fin. At

the 22" & 29" break points, saw across the bottom to bend the piece. Shape the fuse with razor plane, Stanley Finishing Plane & sanding tools. See File 1. Make it pretty. Make like Michelangelo rather than Fred Flintstone.

The stab is secured with nylon bolts entering threaded brass inserts seated in the top of the fin. The 2 degrees angle at the top of the fin, relative to the bottom, as plans show, worked well on the original ORCA employing the Eppler 374 thinned to 7.5% and set at zero Angle of Attack. <u>If using Les's cores, use 1 degree at the fin and set the wing at ½ degree AOA, to thus operate at 1-1/2 degrees of decalage.</u>

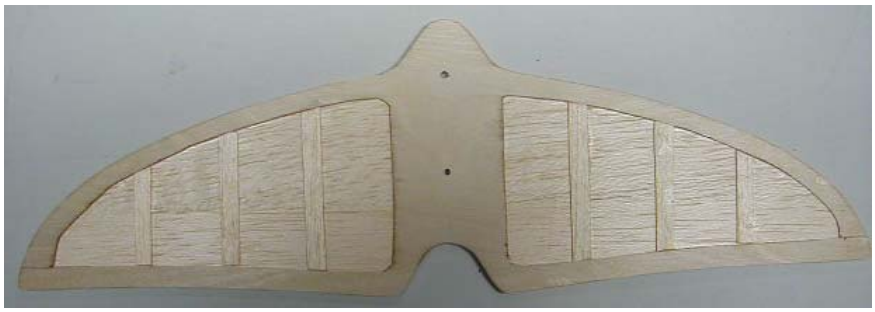
After mostly shaping the fuselage, clamp the fin blank between the sides, flush along the bottom. 1/8" above the sides, mark fillet lines. Remove fin. Along LE & TE, mark centered reference lines.

Use sanding tools to shape to a generic airfoil. Sand above the fillet lines. From a layer of 1/16" ply & 1/16" balsa, make the platform on which the stab seats. Make holes for the bolts aligned to the inserts. Epoxy platform to the top of the fin, nicely squared up, balsa side down.

The fin is to be upright between the sides without built-in turn and even with the slab side bottoms so the stab platform is properly angled. Glue it to one side first and when dry, to the other, clamping as needed to get needed alignments. Cap over the bottom. Make fillets with light spackle. Complete final sanding of the fuselage & fin, ready for glassing-over.

<u>STAB PLY CORE</u>: Place 1/32" ply under the stab plans. Run pins through the plans to outline the perimeter. Saw the exterior shape & sand the edges. Mark the openings to be made either side of the 2" center where the 1/32" balsa "ribs" go. Sawing in from either end, make the openings in the core. From light 1/8" balsa, splice sheeting as needed for tops & bottoms. Cut tops & bottoms making their perimeters about ¼" larger than the ply core. On the bottom piece, make the squared-up rectangular opening to snugly fit over the platform. Make holes in the core for the

bolts. Lay it on the bottom piece & wick join with instant CA glue. Add the balsa "ribs". Trim the assembly to the core edges. The pics below show this stage of construction. The opening to fit over the platform is hidden under the ply core.



An easy way to apply glass is to lay down a piece, smooth it out, lightly spray a stab surface with 3M77, etc. Then press the stab to the glass. Apply a little instant CA glue along the perimeter to seal the glass there. Sand off excess glass, coat the one surface with bagging epoxy & roll with toilet tissue to sop up the excess. Let it cure. Repeat on the other surface. When cured, sand smooth, apply the "slurry" mentioned in File 1, pg.16, to prime & paint. This stab weighs approx. 1.5 oz.

As a handle for painting, seat a dowel in a piece of 3/8" balsa. Secure it with double sticky foam or carpet tape. Drill a hole in a block to set it in to dry or clamp in a bench vise.

<u>11/32" Brass Support Tube Across the Fuselage</u>: Determine the length by running a stick through the fuselage to mark on. The ends should protrude 1/32" from the sides to prevent the panels from rubbing on them. Cut this piece off the 12" tube. From the remainder cut a pair of tubes 4" long. Square up & smooth all tube edges.

After glassing-over the fuselage, the tube & cam pivot wire can be secured with a little thin CA glue.

<u>GLASSING-OVER THE FIN & FUSELAGE</u>: See File 1, starting page 14. Use 1.4 oz. plain weave glass cloth. Coat where the canopy sits with a thin layer of quick epoxy only. Let this cure & sand it smooth. It's easiest to glass over the fin one side at a time with a layer of cloth & similarly bond the edges with instant CA as done on the stab. Sand edges smooth, do the other side, then brush on resin & sop up the

excess. Add a couple of more layers of glass to go around the fuselage bottom & up the sides of the fin 1"-2".

As shown in the pic below, pre-cut a pair of single pieces of the cloth to wrap half way around the fuselage plus a bit more to overlap top & bottom along the centerlines. Separately position one piece with a light coat of spray adhesive. Brush on resin & sop excess. Clean the brush. When fully cured, feather the rough edges. Do the other half.

As the resin soaks into the wood, it creates a rigid skin. The glass, when bumps & any puckers are sanded down & a "flow coat" of thinned resin applied to wet sand glass smooth, makes a good surface for filler, primer & paint. Optionally, when the single layers are on & cured enough to sand the overlaps smooth, an additional layer may be applied over the bottom to help reduce dings from landings. Let fully cure, feather edges & apply the flow coat, etc. as detailed in File 1.

<u>WING</u>: For best aerodynamic balance, LE & TE tapers should match as shown in the full left panel outline on the new plans. By pivoting 3-1/2" behind the LE there's still a bit more area aft to help prevent flutter. As a centerline reference for the tubes, mark a 9" long, precisely squared-up line across the butted panels.

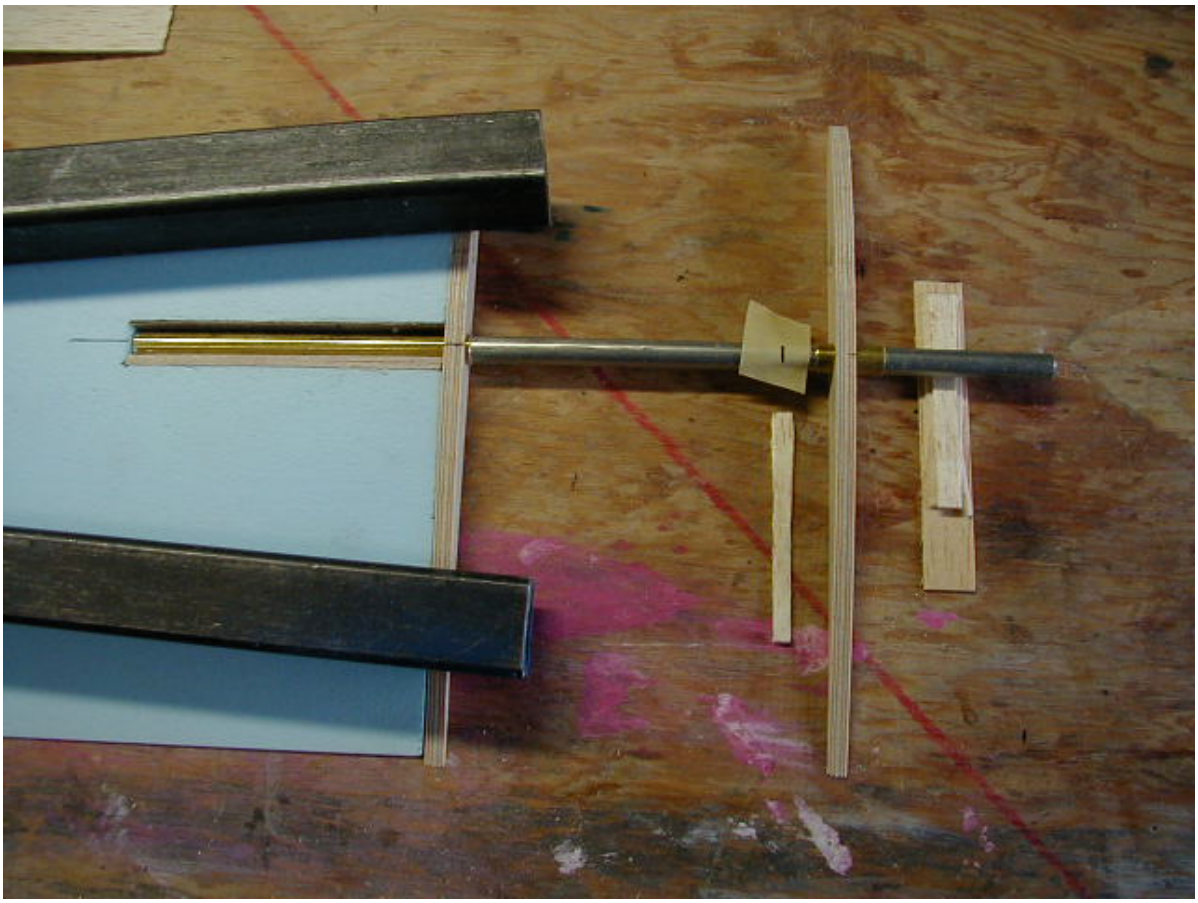
<u>Endcaps</u>: From ¼" ply or a lamination of two layers of 1/8" ply, cut two pieces about 1" x 8-1/2". On one, draw a center line in the 8-1/2" direction. Draw around a core root to mark the airfoil. 3-1/2" from the LE, mark a line intersecting the long line. 1-1/8" further forward intersect it to locate the center of the drive pin.

Some clearance will be needed to later simultaneously slip the drilled endcaps over the tubes & pins protruding from the cores. A 9MM or 23/64" bit makes a slightly larger hole. A #30 bit, used in making the cams & also needed to drill out the drive pin blocks, will work for the smaller one. Use wood backing.

For most root strength, center the holes vertically in the endcaps. Inside the airfoil outline, firmly brad them together, heads protruding to later pull out. Band saw out the caps. Fine sand them to nicely fit core ends. Slots for the 4" x 11/32" tubes are to be faced with 1/16" balsa, so are to be 15/32" wide. Tubes end flush with the ¼" endcap, so the slots are to be 3-3/4" long.

From thin ply, etc. cut a 7-1/2" x 15/32" pattern. With the cores butting, square up the pattern over the cores, mark & cut the slots. Size the facings, grain running vertical, to fit the core from top to bottom. Epoxy them in place over waxed paper.

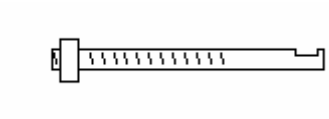
BUILDING IN 1 DEGREE OF DIHEDRAL: Study the pic below. Slip the tube in place. Build a shim, as shown on the right, to precisely fit between rod & workbench.



A rise of 1/16" over 3-1/2" is one degree. Add 1/16" to the shim. At a point 3-1/2" from the cap, mark on masking tape. Place the shim there to angle the tube down in the panel. The outer ends of the tubes should not protrude from the cores.

Run a thin bead of quick epoxy along the tube & facings, avoiding the ends where the rod or endcap may get bonded. Using the shim, repeat the procedure on the other panel. Remove & set the endcaps aside for now.

DRIVE PINS & BLOCKS: Study the drawing & pictures below. Panels are held on by wheel collars in which the set screw seats to a notch in the drive pin. Glued-in, smooth drive pins can be dislodged in hard landings. If you want them to stay put, you need something that looks like this:



Partly threaded 6-32 machine screws or other 6-32 hardware with smooth & threaded sections would work well. File the notch. You may need to file the shank down a little to get the collar on. A nut would prevent a screwed-in shaft from being pulled out of the block.

A piece of 1/8" stainless steel welding rod can easily be partially threaded with a 6-32 die. Clamp it upright in a bench vise to make threads. Notch the smooth end.

File notches just wide enough to receive the setscrew on the collar. For setscrews, use ¼" socket head machine screws that can be conveniently seated with an Allen wrench. Similarly as done in the fin & using a 1/8" bit, drill a hole in a block so the threaded section can be screwed through it. Trim the block to fit the endcap.

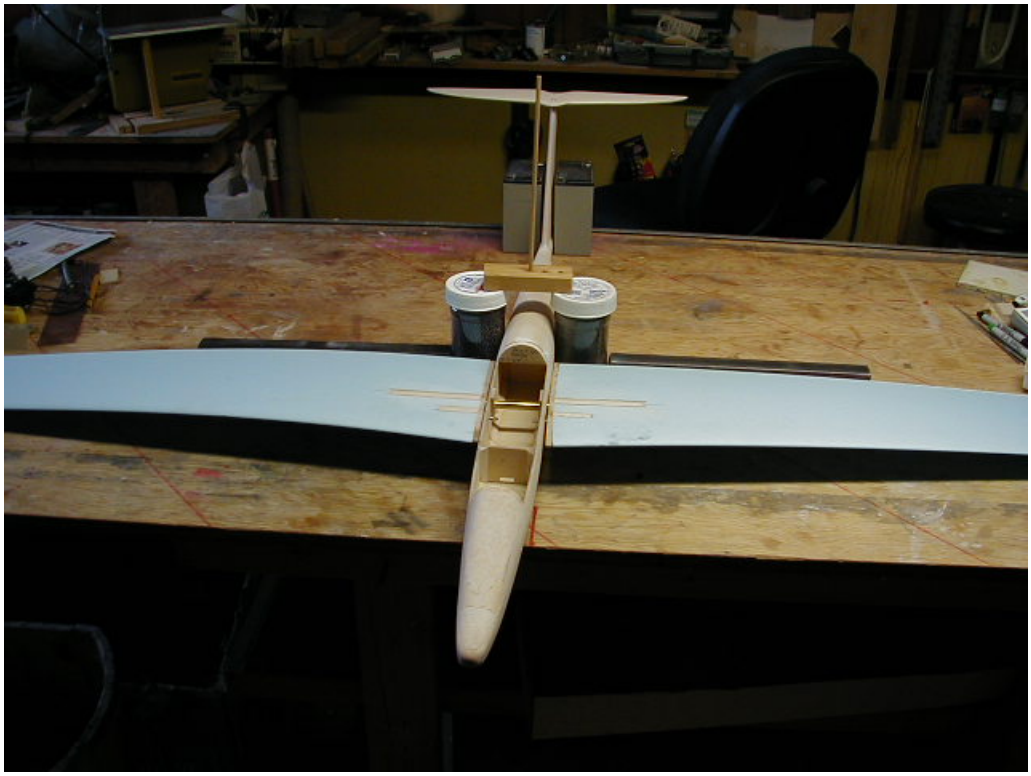
To get all clearances just right, seat the 2-56 ball links in the cams. Slide the 1/8" pivot wire through one side, slip on washers for clearance, then both cams & the other washers. Slide the pivot wire into the other side. Rotate the notch so the setscrew will be accessible. Run a stud into the collar as a handle to easily screw the threaded pin into the block. Determine how much of it should protrude to eliminate play between a panel and the fuselage. Take a measurement to the center of the

notch. Unscrew the pin to get glue into the hole in the block and screw the pin in place. This will likely hold well enough, but a nut can be threaded on if preferred. Use a thin coat of epoxy to secure the block in the slot in the core.

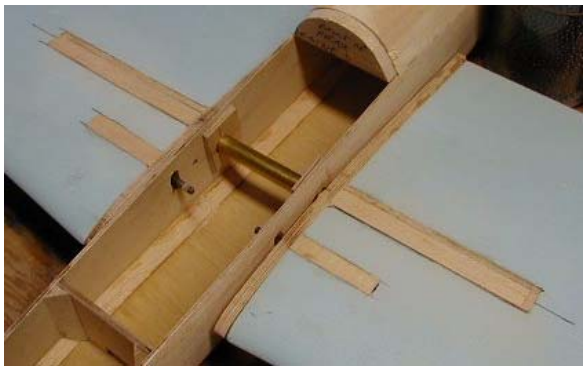
Panel alignments can be checked with a couple of intersecting lines drawn on the workbench, kitchen floor or on a large sheet of paper to lie on the floor. Draw one line to represent the fuselage center line. At the tail end, make a little mark ½" either side of it. Up front near the nose, make marks 1" or so either side of it. 20" from the tail end, draw a long line across & at right angle to the fuse line. The TE ends of the wing can be viewed relative to this long line. If the wing is cockeyed, the tube holes in the fuselage must be enlarged & the tube shifted to allow alignment. This may require enlarging the drive pin slots to prevent jamming.

Also check to see how the panels align with the tail from head on. If a panel is low, then one hole will have to be enlarged upwards & maybe the other one downward as well. The ¼" round Permagrit sanding tool is useful here. Work with it only outwards so as not to splinter the ply inside. Sort it all out so good alignments are possible.

Here are pictures of things set up on my workbench over lines drawn on it.



Weights (dry battery cells & lead shot in jars) were used to keep the fuselage upright & centered over its line. The tips of the cores were also weighted down flat to the bench to stabilize things. The block with the dowel in it is used to check alignment of fin to fuselage.



Internal reinforcing plates can go on the brass tube. I drilled 9MM holes in them over wood backing & sized them to not interfere with cam motion. With panels aligned, the plates were slid inward to coat with epoxy. When cured, remove the panels & fill the gaps around the tube ends.

WING SUB-LE: Remove 5/16" of core along the LE's. Attach & shape a sub-LE of 1/8" balsa. After the ply skins are attached & trimmed back to the sub-LE, a LE is attached. This is discussed in more detail later.

Epoxy the endcaps to the cores, tubes & drive pins. Remove what extends beyond the sub-LE. Fill over/under the tubes & the drive pin blocks with balsa & epoxy.

1/64" ply skins: To retain airfoil accuracy, the cores are cut with 1/64" allowance for skin thickness. Skins for each panel can be cut from a 1' x 4' sheet by placing the capped core roots near either end, TE's on a diagonal. There is enough material to shape the raked tip as plans show. Mark & scissor the pieces so 1/8" extends beyond the core TE's & about 1/32" beyond the attached sub-LE's. The top skin will be a little wider, chord-wise, than the bottom. Due to stresses released in cutting, the LE and TE lines may not be perfectly straight. If the LE lines are bowed, mark the ply to fit them. Trim the TE's to a straight line. Mark ID on each piece so you know what goes where.

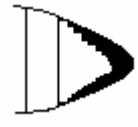
ATTACHING THE PLY SKINS: If you don't have vacuum bagging gear, skins can be attached with a contact cement such as Dave Brown Products "Southern's Sorghum". Google "Dave Brown Products". One 7 oz. bottle will do.

You get one shot with contact cements. With care you can align & lower the core to the bottom skin. If unsure about getting it right, place dowels or strips 2"-3" wide cut from manila folders, etc. on the bottom skin, position the core and, one by one, pull them out to just tack the skin in place. To avoid building in unwanted twist, lay the top bed over a flat plane work surface, invert the work & rub on the bottom skin to bond it to the core. Trim off skin beyond the sub-LE. Then repeat with the top skin, working in the bottom bed. Clean up the TE.

If you have bagging equipment, lay the skins inside out over newsprint. Mix 5-6 drams of bagging epoxy & with a credit card, etc. smear a thin coat overall on the skins. Position core and tape skins over it. Use the beds outside of the bag, weighted

down to avoid unwanted twist being built in. Such panels have a much more solid sound when rapped than if contact cement is used. When well cured, trim skins back to the sub-LE. Clean up the TE.

LEADING EDGES: Using CA +, attach 3/16" x ¼" strips of balsa to the sub LE.



The drawing is exaggerated to illustrate how the balsa strips (forward white area) can be shaped to make a base to coat with Icing Putty (black area). See the Fine Finishing File.

Note here how one balsa strip has been worked down to a triangular-like shape & feathered back level with the skins.

This shows the puttied LE, smoothed & ready for slurry, priming & painting.

ROUNDED TIPS: See page 16, File 3 about forming the tips with epoxy putty. Protect the bare skin surfaces with masking tape. The Icing putty, at least when fresh, is too runny.

SLURRY APPLICATION: Coat panels overall with the "slurry" mentioned on page 16 in file 1.When fully dry, sand it down with progressively finer grits used dry to avoid raising the grain in the ply skins. This will help fill the grain, cracks & crevices.

PAINTING: Using the 5/16" steel rod as a handle, apply a white, sandable spray primer & when dry, work it down with progressively finer grits used dry or lightly dampened. 3M has a 2000 grit paper found at auto supply outlets. For the top coat, apply many light coats to get uniform coverage & finally, apply a "wet" coat to dry to a high gloss. Support a panel horizontally to help avoid runs in the paint.

This is a section of the puttied LE after painting. Ratty looking LE's need not be accepted.

If you go with basic white overall, imaginative black "Orca" accents can be subsequently painted on with careful masking.

INITIAL SETUP FOR FLIGHT: Plan to secure the canopy with tape, so it doesn't blow off at high speeds.

In a 2 stick Tx programmed to provide the elevon function, usually you will get turn & pitch on the right stick. Set the trim tabs for rudder (yes), aileron & elevator at neutral. Set the servos at their neutrals. Position and program the output arms (trimmed wheels) so the ball links point straight sideways. See that the pushrods go deeply into the threads of the nylon sockets.

If using Les's proprietary cores, set the pushrods to lengths that put both panels at 1/2 degree positive Angle Of Attack relative to the 0-0 line segments of the fuselage. If you cut your own cores you will have to sort out balance, AOA and decalage that work best.

If the rudder trim tab effects the panels & if the Tx has the capability, program out the rudder trim tab authority, so it does not matter if it gets jostled from its neutral position. Otherwise tape it in neutral.

You want the aileron trim tab to allow fine trimming in the turn axis. You want the elevator trim tab to allow fine trimming in the pitch axis.

A useful trick is to program the Tx for a little "flap-down elevator" compensation, so down positioning the normal flap stick or lever in flight will keep the nose from ballooning up as airspeed increases. This is an alternative to holding needed down pressure on the self-centering elevator stick or fussing with the elevator trim tab.

BALANCING: For starters, if using Les's cores, balance 2-7/8" from the panels LE at their roots. Depending on the weight of the tail, you may need to add 4-6 oz. of lead up front. This gets the ship to around 45 oz. unballasted flying weight. For initial hand glides and preferably over tall weeds, toss the ship straight & level with plenty of airspeed so it can fly. As needed, use the elevator trim tab to get something that resembles level flight.

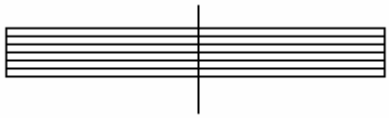
Experiment to find an amount of deflection that gives a comfortable turn & pitch action. Use your dual rate switch or "alternate aircraft switch" to set different amounts to observe effect. Final preferences will have to be determined by trial & error at the slope. Each modeler's ship will be a bit different & have to be individually sorted out.

15 MPH wind at a slope is about the minimum needed to stay airborne. Things begin to really get interesting at about 25 MPH. I flew a 45 oz. original ORCA

unballasted in winds of 50 MPH at Eagle Butte in the Tri-Cities, WA. I could barely stand, but the ship remained solid as a rock & extremely responsive.

Tremendous chunks of sky can be quickly covered, so keep your eyes on the ship. Towering 200 ft. loops can be made by diving in slope lift to gain airspeed. With enough deflection, continuous rolls in high rate at high speed are too fast to count. A daring maneuver is to race with the wind toward your eyeballs, tuck the ship inverted & do continuous rolls heading back out. However, at safe altitude, first make sure you have enough "down elevator" deflection in the panels to readily tuck under.

BALLASTING: If, after settling on a balance point you like, you want a heavier ship for really high wind work, the fuselage floor under & behind the servos provides space for layers or lead sheet. These could be divided for easy insertion either side of the main support tube. Drill a hole through the layers to run a retaining screw through them & into the fuse bottom. A ply plate(s) with T-nut could be glued to the fuselage bottom for the screw(s) to enter.



Lead weighs 6.6 oz/cubic in. A stack (or block) equivalent to 3/8" x 1-1/2" x 6" weighs approximately 30 oz. That would increase the wing loading another 10 oz./sq. ft.

PRE-CUT WING CORES: These are available from Les Horvath who cuts my Genie line cores. They are precision CNC cut from blue Dow High-Load 60. When skinned with glassed-over 1/64" ply, they are particularly strong, especially if the skins are attached with bagging epoxy in a vacuum bag. The airfoil is one designed for him to use. He says it is "proprietary". It comes with an intact LE in case a builder wants to bag overall glass cloth and overall CF cloth to the cores in pre-painted Mylar carriers. Core price is $45, plus shipping. Order from Les at foamcore@earthlink.net. Just ask for Harley's ORCA cores.

HARLEY'S PARTS PACK: Available in US only. Includes (1) a rolled, machine copy of hand drawn new plans. Nothing is built on the plans. Along with above text & pictures or those in the CD, this is all that is needed to build the ship. (2) a molded polyester resin/glass canopy to be trimmed to reference lines, (3) a pair of rectangular, slotted cams made from 1/8" epoxy/glass board. Builder has to drill the holes in matching locations if I haven't done it and shape the exterior & (4) a current CD-R with latest version of this file & all the 20 other files in the Genie web pages. Price, including postage, is $26. If you want to make your own

cams, knock off $5. Order from Harley Michaelis, 26 S. Roosevelt, Walla Walla, WA. 99362. Cash, check or M.O. Not set up for Paypal.

MATERIALS LIST

HARDWARE: 12" of 11/32" OD brass tube. All-thread 2-56 steel rod for pushrods. Optional 1/8" brass tube as stiffeners over it. A 10-1/2" piece of 5/16" steel rod. About 9" of 1/8" music wire. Four of the Dubro #181 package or you could use the Rocket City Missing Link hardware.

Two 1/8" wheel collars. Two 6-32 x ¼" socket head machine screws to use as setscrews. Better get some spares. Allen or ball socket wrench for those. Two 6-32 thin-walled threaded brass inserts. Some 6-32 x ½" pan head nylon bolts. Besides common drill bits, you'll need a #30, 11/32" & a 9MM or 23/64".

WOODS: In birch ply, two 1' x 4' sheets of 1/64" ply for wing skins. ¼" x 6" x 12" ply for the endcaps or enough 5 ply, 1/8" ply to make those & the two formers. A 12" x 24" sheet of 1/32" for the stab core & fuse bottom sub-decking. ¾ sq. x 48" stick of basswood. Use to make drilled blocks for the threaded inserts in the fin & the drive pins in the wing. Also cut three pieces to join side by side for the hard contoured bottom front end of the fuselage. Also cut four pieces to join to cut the hard nose block. Scrap of 1/16" ply for the platform the stab fits over. Scrap of 1/16" balsa for that platform & the facings in the panels the main brass tubes glue between.

Two 3/16" x 3/8" x 36" strips of spruce, bass or hard balsa for the LE's.

IN BALSA: Lone Star AAA, graded light, medium & hard is just fine. For the bottom behind the bass block, get a hard block ¾" x 3" x 12". Behind that use light balsa. For it & the fin, get a 3/8" x 3" x 36" piece.

For the doublers over the slab sides, get two medium sheets of 1/8" x 3" x 36". From those, cut strips needed for the sub-LE's or order a pair of 1/8" x 3/8" strips.

The top of the fuselage should be light balsa. Get a 1" x 3" x 36" plank.

For the stab top & bottom, get one 1/8" x 4" x 48" in light balsa. You'll need to do some splicing to get 6" width needed at the stab center.

TRIANGULAR STOCK: The stock stuff is usually the wrong size or density. See page 6, File 1 about making a tool to hold square strips to cut into triangular stock with a band saw. Get a sheet of both light & medium 5/16" x 3 x 36" balsa. Rip into 5/16" square strips to inexpensively make a supply of triangular stock. Use lighter stock behind the rear former.

MISCELLANEOUS: Get a couple of linear yards of 1.4 oz. plain weave glass cloth for the fuselage & wing. It's okay for fin & stab, but something lighter would be preferred. If you have bagging equipment you probably have the thin epoxy. If not, & if you can handle the odor, the Sig Polyester Finishing resin can be used to glass the fuselage. Useful adhesives would include instant CA & CA Plus, 5 minute epoxy, aliphatic resin wood glue, 3M77, etc.

I get most of what I need from Lone Star Models in Lancaster, Tx. See ad in the magazines or do a web search for "Lone Star Balsa". They carry balsa, ply, bass, the Dubro line, glass cloth, quick epoxy, CA glues, K & S tubing, music wire, etc. Small Parts, Inc. is a source for steel rods, brass tubing, drill bits, music wire, etc. Local home building supply/hardware outlets are other sources. I locally found a 3' piece of 5/16" steel rod for $3. I could cut it with a hacksaw.

Questions? E-mail me at harleym@bmi.net.