Silent Wings Soaring Association

September 2014

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Soaring
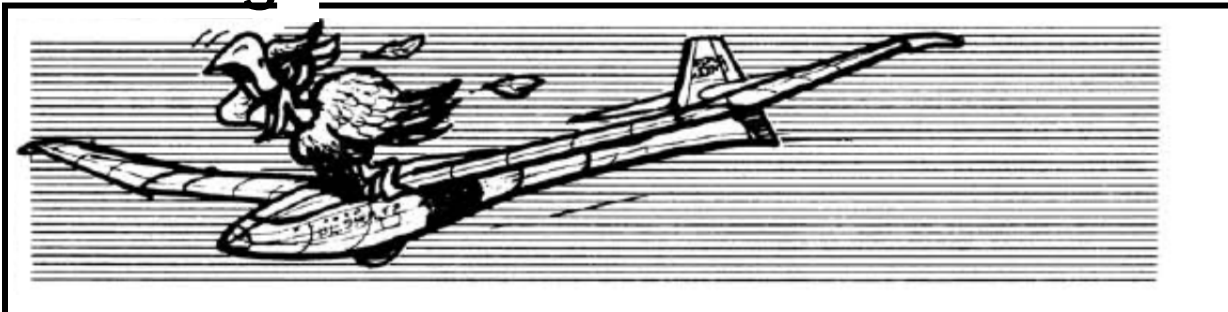
Keith **Kindrick**   **September** 2014

September Roars in with heat! We just completed the hottest club contest of the year for September. Jim Smith ordered a smoking hot event. It was 81 degrees at 7:00 in the morning! He held the rounds down to get us all out the heat ASAP which we all appreciated. We all know how hard it is to make Jim sweat about anything. During this contest he was soaking wet! When I left the field at 11:45 it was 105 degrees. At 2:00 it reached 110 degrees in La Verne. WOW

September SC2 hosted by TOSS at SWSA the heat in one week left the valley! We had the best weather ever for this event as the marine layer came in and cooled us off. Everyone had a great time with the longer flights. Our nice carpet has a few new holes in it but they are a lot smaller than they used to be with the hard core skid policy. SWSA guys flew well in this event as you can see from the pictures.

Silent Wings Soaring Association

Missing Member Found!!

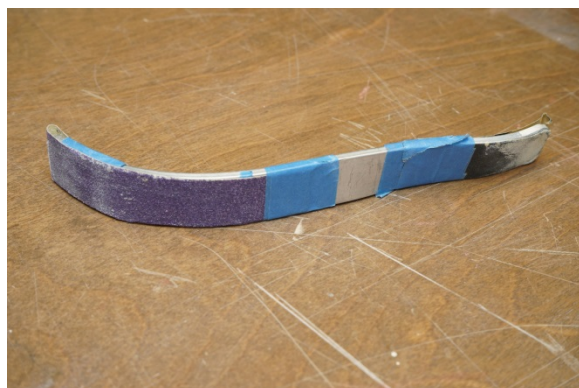Edgar Vera came back to see us at the SC2 event.

Problem Solvers

How many times have you guys been working on a model and decided to copy a program then "improve" it just a little and it goes the wrong direction? I'm sure more than one time. Here is how to solve that with a simple new approach. Why write all the values down when you need to recall what you started with? Just take a picture with your phone or tablet of the main program and use it to start a new program. This makes it impossible to lose the settings that you started with and if a friend needs to know what you're doing you can e-mail him the picture to make there program work.
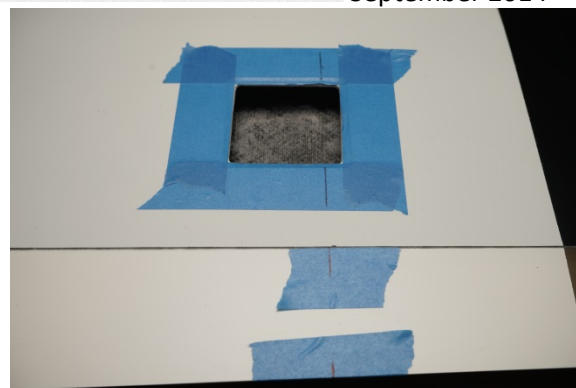
Once you are done wrap it with a paper towel then soak it with Alcohol. Wipe the area clean and you're done!

Looking for the easy way to scuff the inside of the servo pocket prior to bonding here is the tool for you!

SWSA Bird 2 meter update: Attached are pictures of the prototype "laser cut" parts. Recent activity for this is CAD has been tweaked. Additional construction is in progress for design changes. Building Instructions are back in work.

It makes getting in the servo pocket an easy task when you bend the Aluminum strip.

September 2014
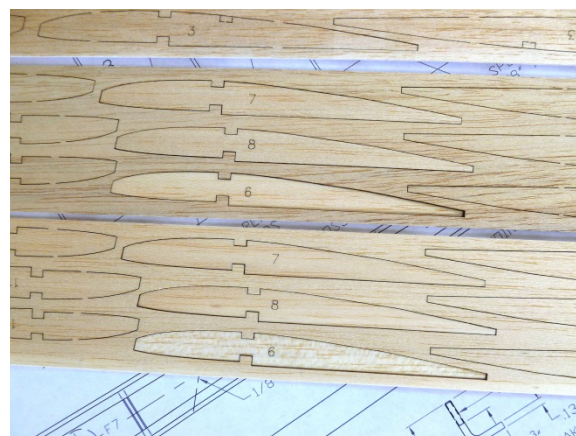
SWSA Bird 2 meter prototype "laser cut" parts
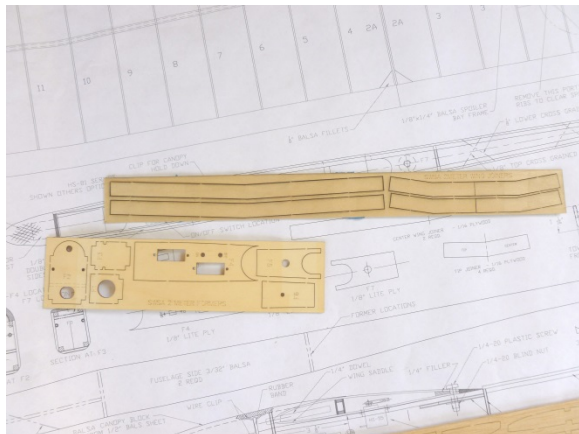
Frank was seen in the SC2 Contest walking around with the new fuselage in hand. I caught him talking with a few guys who want to build one. I took a quick shot in between his sales calls on the guys.

New News!

Rumor has it that our own Jim Smith is sporting a new plane these days. His first outing with it will be in Visalia for the Fall Soaring Festival.

With the year end in clear view for our contest season, winter brings a lot of time to each of us to try new and different things. Electric sailplanes can be a new source of fun. I've seen a few of our members master the Quad copters and Dan is going full speed with his scale helicopters. SWSA members are in a unique position to talk and discuss the electric power systems for several electric platforms with each other. This can make a simple project as we get confused over new things.

Let's look at the Xplorer2 F5j from Soaring USA. Out of the box you see the major components of the Xplorer.

Super slick tail end assembly is also on the way to the new Xplorer TD sailplanes. Fin posts through the stab then through the fuselage. Then the cam locks it all together.

Pushrod ends for quick connect.

The biggest challenge is to fit all the electronics in the fuselage and obtain the correct CG. The only ways to do this is start placing the components in the fuselage and tape them in place.
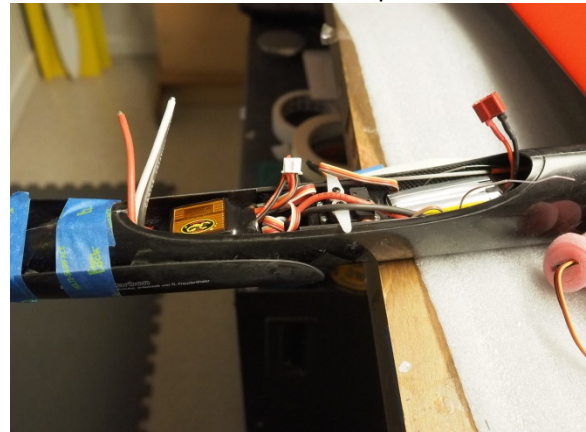
You can see the relief areas needed for the motor screws.

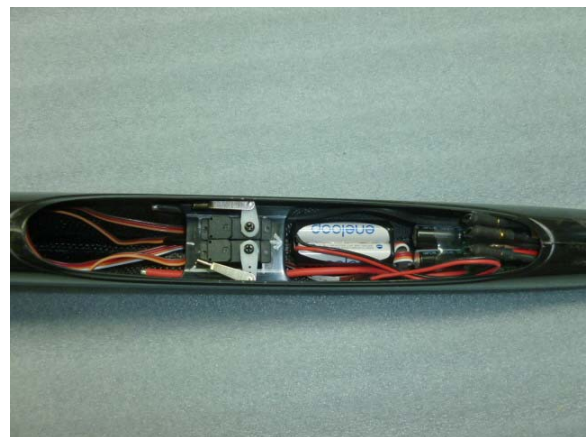Note the perfect spinner gap

Remove as much wire as possible then solder the plugs so they are facing the ESC. This saves space.

Notice how tight it all is in there! The ESC sits right behind the motor and the motor/ESC plugs are easy to get to without a lot of excess wire.

Servos or just dry fitted to check the CG. Motor battery will fit behind the servos.
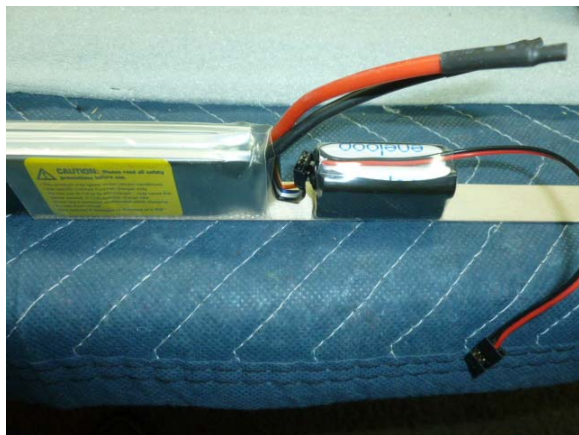
TP 3S, 1300mAh 70C motor battery and a 4 cell, 700mAh RX pack on the battery tray.
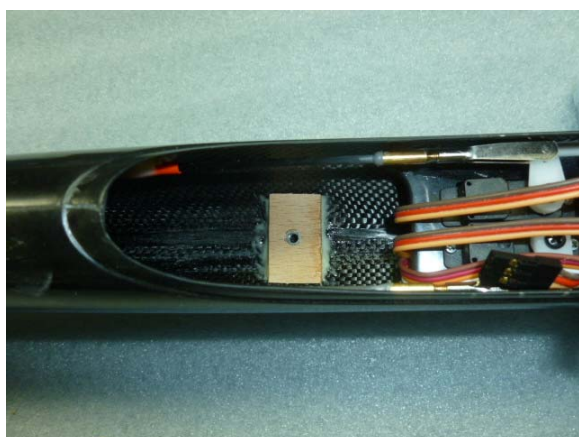
Tray hold down in the fuse behind the servos.

Batteries are easy to get in and out for charging.
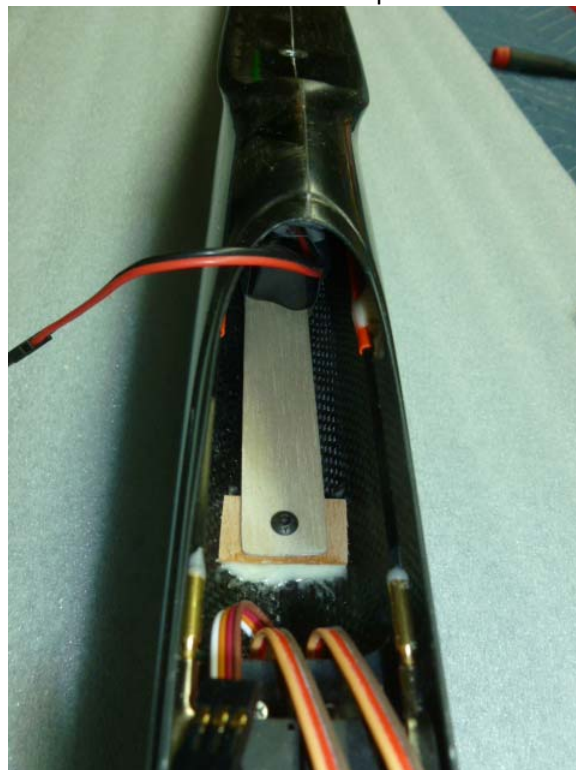
Installed and secured. The RX will use Velcro to secure the tray as well. The all carbon fuse means the antenna will be on the outside.

I'll have more for you next month on this project. In the mean time you can review the power system diagram on page 9 after the contest schedule to see how to connect things.

That is it for this month.

Thermals to all ~ Keith

2014 Contest Schedule

Saturday & Sunday
Oct 4-5, 2014   **VISALIA FSF**   CVRC

Sunday,
Oct 12, 2014   **SWSA CLUB**   Keith **Kindrick**

Sunday,
Nov 09, 2014   **SWSA CLUB**   Unknown

If you have any events let me know

Electric Sailplane System Diagram

Connector

Altitude Limiter (CAM)

Receiver

Connect line for Speed control to CAM

Electric Motor

Speed Controller

Main Battery

Receiver Battery
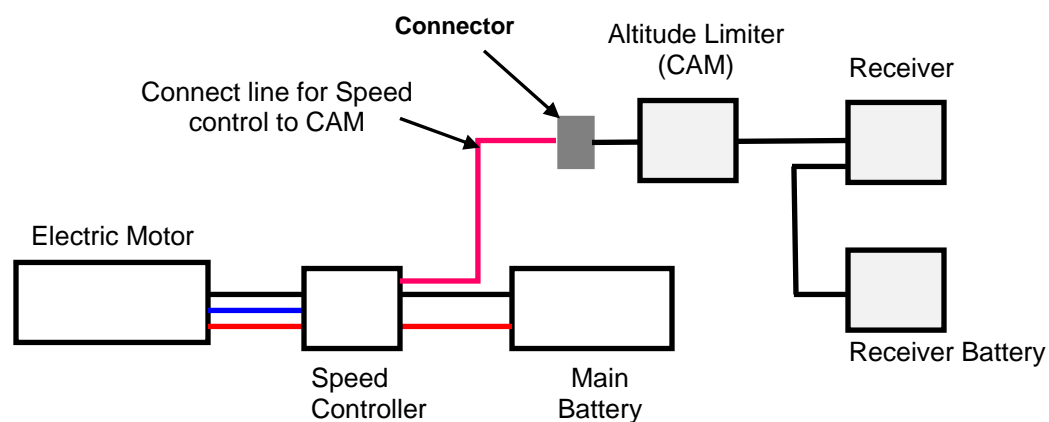
On the following pages I have attached the construction article for the Windlord high performance flying wing sailplane. This was originally published by Model Aviation (before the AMA took over operation) in 1976. It was another idea on how to maximize the wing area for the 100" Sailplane class that was so popular at the time.

WINDLORD

A high-performance flying wing sailplane that has proved competitive to conventional craft. ■ Ken Bates

THE WINDLORD is named after a king in the Tolkien Trilogy, *The Lord of the Rings.* This king of eagles is named in Elvish "Gwaiher" and translates as "Windlord" in English. I tell you this because some of the design criteria (aspect ratio, tip shape, and size) are those of the largest measured eagles.

The Windlord has a wing span of 100 in., wing area of 1400 sq. in., and an aspect ratio of 7 to 1. I have built four Windlords weighing between 50-70 oz., with wing loadings of 5 to 7 oz./sq.ft. Control is by rudder-elevator, which responds in a conventional manner, along with provisions for optional lift and drag flaps on the underside of the wing. If the ship is kept under 70 oz. unballasted, performance is comparable to most Standard Class ships being flown in competition.

The NACA 23009-75 airfoil will not tow as well as a flat bottom section. This gives the Windlord a somewhat shorter dead-air time than the best Standard Class ships

have. However, the rapid recovery and tight turning capabilities inherent in the design, produce a ship that will out thermal most conventional designs, and the high lift-to-drag ratio means that the Windlord can stay with a thermal farther down wind and still get back to land. The 1977 Contest record as of 8/22/77 is one first, two seconds, and three third places.

The Windlord project started about four years ago when I read about the Marski flying wings in Jim Marski's book. Using this information, I built a model along the lines of his Pioneer II. It flew well from a hand launch, but hi-start towing proved disastrous. As I found out later, this was through no flaw in Jim's designs, but through lack of thought on my part.

My interest in flying wings was kept alive through the next four years by the outstanding flight characteristics of small balsa and paper models thrown out of my fourth floor office window. This highly scientific research was executed by myself and my chief fellow experimental associate Keith Shaw, who usually said, "It looks funny, I wonder if it will fly."

I found in an old NACA wartime report, experiments on flying wing stability

Ken Bates with the Windlord. Sweepback not essential in a flying wing.

that indicated that I had been on the right track. A short time later, I found that my towing problem was due to using a conventional tow hook location on an unconventional design. The prototype Windlord followed shortly, and was a success right off the board.

The constant chord planform was based on my experiments (including swept planforms) and the NACA wartime reports on tailless models flown in the Langley free flight wind tunnel. These tests indicated that the non-swept center of pressure configuration offered the best longitudinal stability with the fewest drawbacks.

Swept-back wings have increased damping on the pitch and yaw axes. Since the NACA was trying to develop a stable bombing and gunnery platform, these characteristics were desirable. On models, however, the swept-back planform is highly unstable at very high angles of attack, where spanwise flow reduces tip lift, causing even higher angles of attack, resulting in violent whip stalls. Also, swept-back wings exhibit a dihedral effect at high angles of attack, which creates problems with roll axis control. Some of the Northrop wings had down-swept tips to function as rudders, and to counteract some of this dihedral effect. Swept-forward planforms (even tapered wings with straight leading edge), tend to stabilize in a nose high attitude and require wash-in at the tips to prevent this. However, the wash-in produced tip stall and spiral instability.

Now we go to the airfoil and wing shape. The airfoil is a 9% thick NACA 23009-75 (Jim Marski chose the 12%-thick 23012-75), which has sufficient reflex to produce a stable center of pressure (CP) without a large upsweep at the trailing edge (notorious for high drag). The airfoil has as good a coefficient of lift as most reflexed sections, and a higher stall angle than most. Reflexed sections have a lower coefficient of lift than conventional sections. This works out to about 70% as much lift as conventional airfoils at model Reynolds Numbers.

Keeping this in mind, a 1400-sq. in. wing with aspect ratio 7 to 1, is equal to a 1000-sq. in. wing with aspect ratio 10 to 1 (Olympic II, Wind Drifter, etc.). To pack 1400 sq. in. into a 100 in. wing span requires an aspect ratio of 7 to 1. If a tapered planform were chosen, the root chord would be rather large. With this in mind, a constant chord wing was chosen, also making construction, balancing, and stability calculations vastly easier.

Since the airfoils that are stable enough for use on a model flying wing have a lower lift coefficient, the wing loading must be in the 5.5 oz./sq. ft. region, to approximate an 8 oz./sq. ft. loading on a conventional design of 1000 sq. in. Therefore, the all up weight of 50-60 oz. is indicated.

The fin, rudder and elevator areas were arrived at by experimentation. The NACA reports are of little use here, since they are applicable only at higher Reynolds Num-
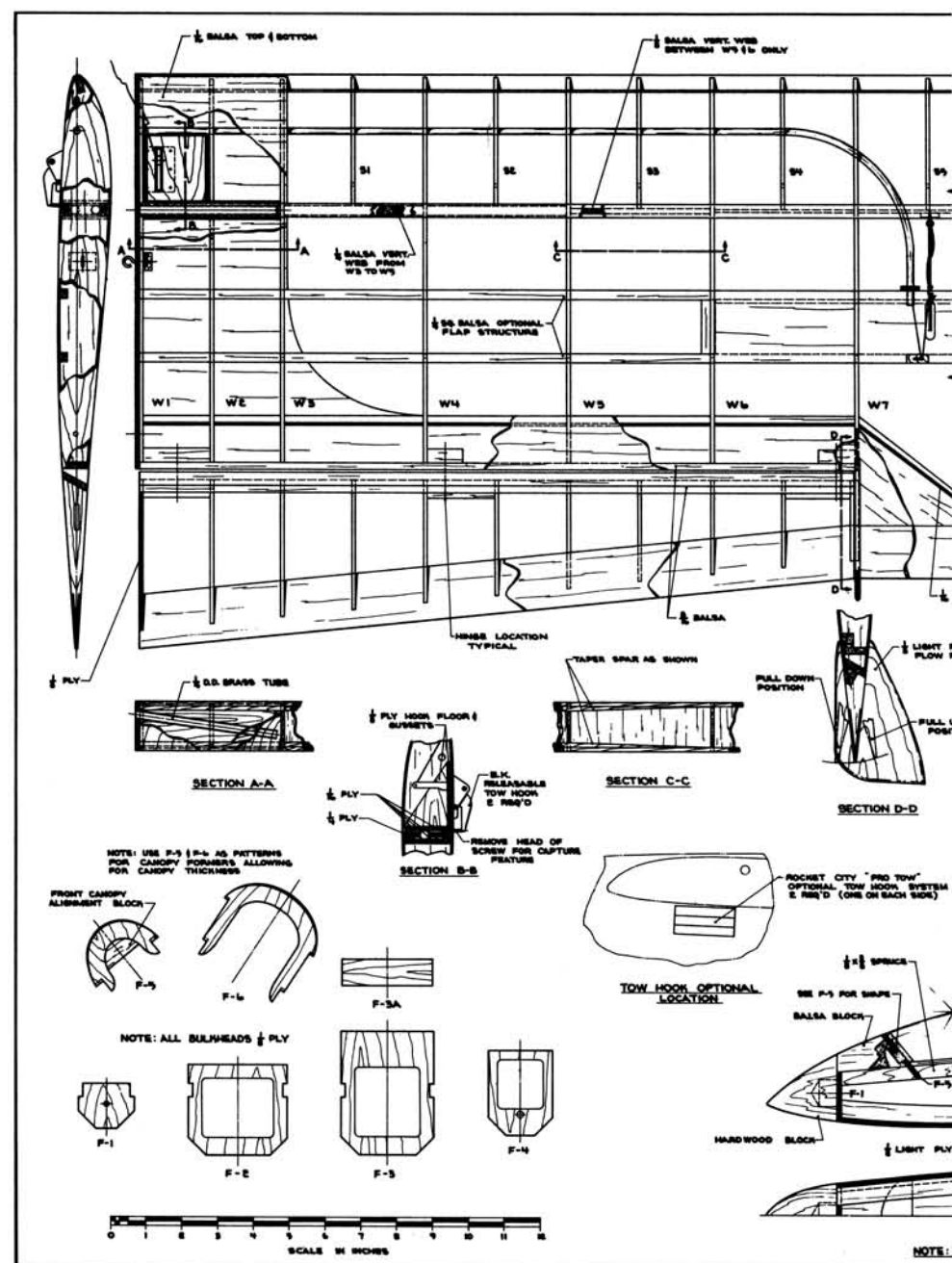
FULL-SIZE PLANS AVAILABLE .... SEE PAGE 104

bers. The tow hooks are placed under the wing to preserve normal towing forces and moments, with the short "tail" moment.

From all of these considerations, and about eight wipe outs (which I won't discuss here), evolved the Windlord. So that one may not be tempted to innocently tinker with the design in critical areas, here is how it works.

In commenting on critical aerodynamic considerations, many of these statements are much simplified, but will provide the necessary information.

The NACA 23009-75 airfoil is shown in Fig. A. The aerodynamic center, located at 25% mean aerodynamic chord, is the point about which all forces acting on the wing resolve. You can consider this to be the "aerodynamic pivot point" of the wing. The mean camber line indicates where the lift will be generated, and how much.

When the mean camber line is above the mean datum line, upward or positive lift will be generated. When it is below the mean datum line negative or downward lift will occur. It has been proven by others, and by my own experiments, that a crossover point between the mean camber line and the mean datum line, at approximately 75% MAC, is adequate for stability.

Looking at sketch B, we can see that the lift, which can be thought of as a string attached to the AC, is pulling up. Balancing the lift is the weight of the ship which can be considered to be a weight hanging from the CG. With no other forces effecting the wing, it will hang nose down and dive. However, there is also a small down force from the reflexed area of the wing near the trailing edge. This lift acts through the pivot point A(AC), balancing the weight

Drawing labels

½ x ¼ SPRUCE L.E.
¼ x ⅜ SPRUCE SPAR TOP & BOTTOM
⅛ BALSA
OUTER NYROD
RUBBER BAND
1½ T.E. STOCK
1/16 PLY
⅛ BALSA FIT BETWEEN RIBS
SECTION GG
OPTIONAL FLAP INSTALLATION

S6 S7 S8 S9 SM

⅛ BALSA VERT. WEB FROM W6 TO W13
NOTE: ALL RIBS TO BE 1/16 BALSA

W8 W9 W10 W11 W12 W13

⅛ BALSA HORIZONTAL GRAIN WEB FROM W8–W13

BALSA VERT. WEB FROM W1–W8
T.E. SHEETING TOP & BOTTOM
NOTE WASHOUT IN T.E. OF TIP

USE FOAM HOT WIRED OR BAND SAWN TO FIT WING ROOT CONTOUR. COVER WITH HYPLAR GESSO OR EPOXY & FINE GLASS CLOTH.

DIA MUSIC WIRE
I.D. BRASS BUSHING
SECTION E-E
PLY
PLY
DETAIL OF FABRICATED ELEVATOR HORN

SECTION F-F
⅛ x ¼ BALSA TYPICAL
BALSA SHEET
⅛ SQ BALSA
⅛ BALSA
⅛ BALSA

AIRTRONICS CANOPY
BALSA BLOCK
BALSA CANOPY FRAME
⅛ SQ SPRUCE
O.D. BRASS
BALSA SHEET
⅛ BALSA
⅛ BALSA
⅛ SQ BALSA
⅛ BALSA
CONSTRUCTION TAB REMOVES AFTER ASSEMBLY
GLASS FUSELAGE ENDS AT THIS PLANE
E HINGE TYPICAL
PLY RUDDER HORN MOUNTING PAD
NYROD
CANOPY ALIGNMENT BLOCK
SU-PR-LINE NYROD
⅛ x ¼ BALSA
TRIANGULAR STOCK
RUBBER BAND
BOTTOM & SIDES
SIDE & BOTTOM SHEETING OMITTED FOR CLARITY
PLY ROOT RIB
DIA MUSIC WIRE
BALSA BLOCK
⅛ BALSA
CUT OUT FOR CLEARANCE OF ELEVATOR HORN

WINDLORD
DESIGNED & DRAWN BY: KENNETH D. BATES
INKED BY: Neil Liptak

| WING SPAN: 100.00 in | WEIGHT: 50.0 – 70.0 oz. |
| WING AREA: 1400.00 in² | WING LOADING 5–7 oz/ft² |

(CG), producing a statically stable system.

Dynamic stability (the tendency to return to a trimmed airspeed) is achieved by adjusting the curvature of the mean camber lines. Fortunately, this was done for us when the airfoil was designed. It remained only to pick an airfoil that exhibited a stable center of pressure throughout the normal ranges of angle of attack (negative lift-through stall).

If you can imagine this system as the simple balance described previously, you will see that moving the CG ahead requires more reflex (up elevator), and moving the CG back, requires less reflex (down elevator). But if the CG gets behind the AC, watch out! The stability is gone. With the CG behind the AC, it is possible to obtain static balance by applying large amounts of down elevator, but at this point, you will loose your dynamic stability, and have

The truncated fuselage, involving a minimum of blocks and pieces, is not a building challenge. Showing the wing root and fin mounting, the picture will make it easier to read the drawings.

It's always a thrill when the components can be eye-balled for the first time as a whole. The well-thought-out structure is robust, with an adequate frame which abstains from fancy over-kill.

The single-spar wing does not require top and bottom leading edge sheeting. Note the vertical webbing between the 1/8 x 3/8 spruce top and bottom spars. False ribs preserve airfoil contour.
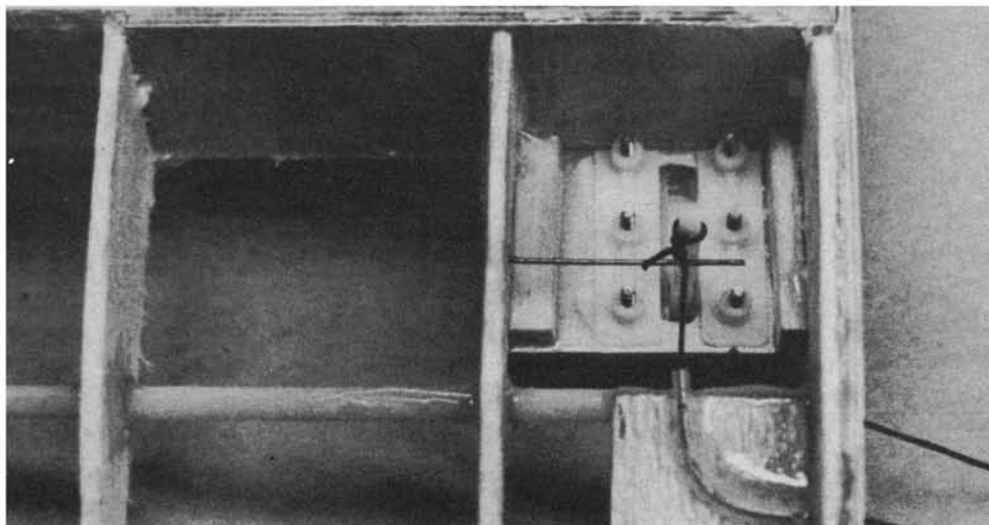
The EK releasable tow hook (2 required) installation. An optional installation using the Rocket City Pro Tow is shown on the plan—located on the fuselage sides just under the wing.

a moving AC, as there no longer is any reflex to the section. A moving AC will not allow the system to return to a balanced condition, because the fulcrum is moving with every deviation in trimmed air speed. Thus, moving the "elevators" on the Windlord changes the amount of average reflex for the wing as a whole, without eliminating it entirely.
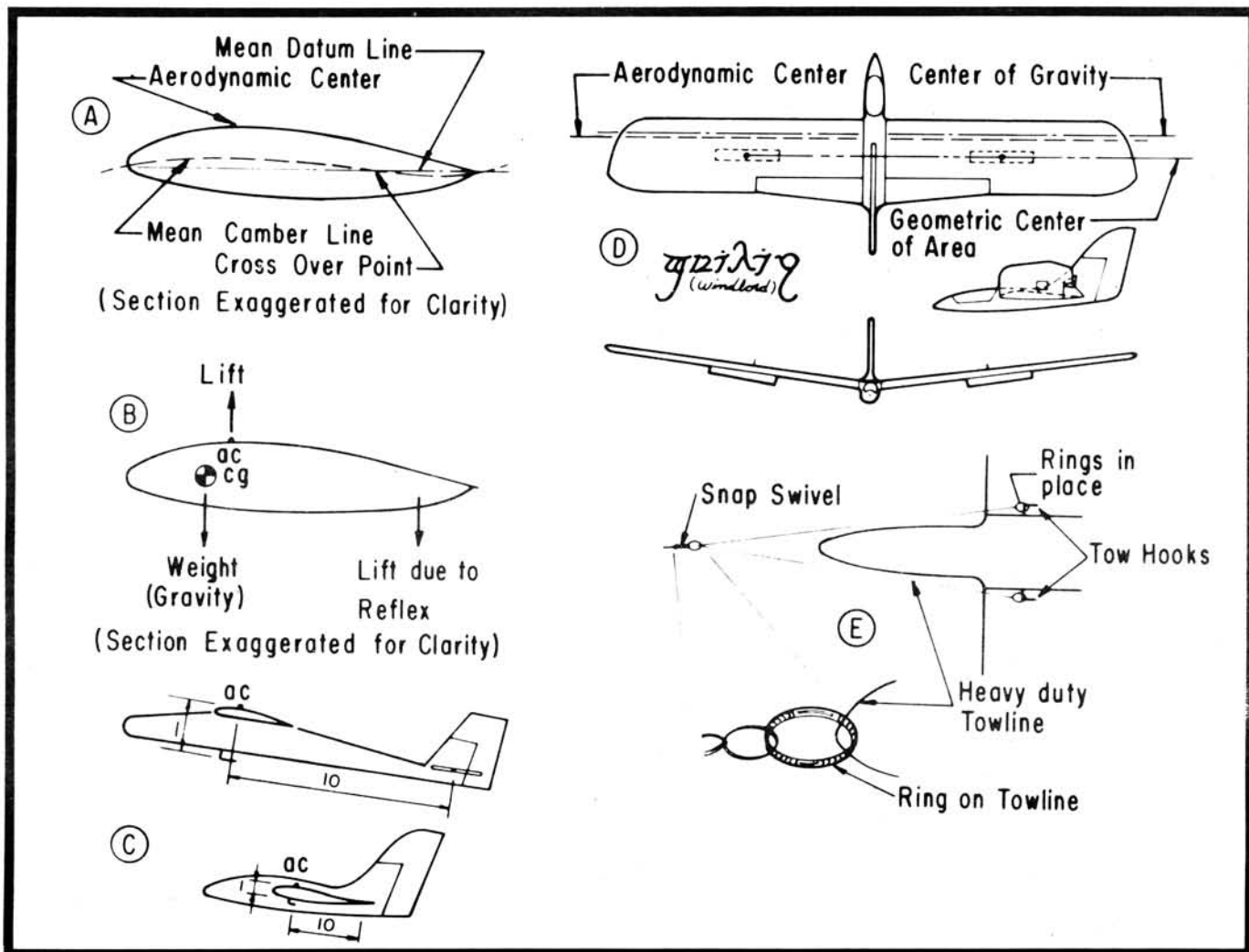
If you stall the ship, what then? The lift is gone and so is our stability. Wrong! Looking at sketch D, we see a top view of the Windlord with CG, CP and geometric center of area shown. Since the CG is ahead of the geometric center of area, a stall will eliminate the lift. The center of pressure is no longer the wing's pivot point, leaving us with an object that has more weight on one side than the other. If we drop (stall) this object, it will fall heavy side down (nose down), until lift is re-established, like a conventional design.

All of the stabilizing influences found on a conventional design are present on the Windlord. It's just so close coupled that there isn't any gap between the wing and the stab. The stab is there on the rear of the wing. The low moments of inertia inherent in this arrangement means that there isn't any need for a long tail moment. So much for the mystery of "tailess" designs.

Remember my tow problem? Keeping the previous explanation in mind, consider sketch C. The aerodynamic center on the wing of a conventional design is still the aerodynamic pivot point. On a design of normal fuselage depth and tail moment, the ratio of distances from the center of the horizontal stab to the AC, and the tow attachment point to the AC, is about 10 to 1. In order to preserve this moment ratio on the Windlord, the tow hooks have to be approximately 1 in. from the AC.

All of my earlier tow troubles came from putting a tow hook on the bottom of the fuselage. The fuselage was of normal depth below the wing—approximately 2 in. Now, assuming that the elevators are capable of exerting about 1 lb. of force, and are about 10 in. from the AC, we have an available torque of 10 in. lbs. If the tow attachment point (tow hook) is 3 in. from the AC on top of the wing, and we have a tow line pull of 10 lbs., there is a torque of 30 in. lbs. (*three times the available torque from the elevators!*).

At launch, this torque from the tow hook snaps the nose up before there is sufficient air speed and the ship stalls. In a stall, the torque from the tow hook continues to overpower both the elevators and the geometric center of area, preventing stall recovery. In this stalled condition, any touch of rudder will produce a pinwheel-like spin. This is why the tow hooks on the Windlord are on the bottom of the wing. You may want to substitute conventional hoods for the releasable hooks but *leave them where they are!* At this location, small fore and aft adjustments of the tow hook locations are not as effective as ele-

Figure A: Mean Datum Line, Aerodynamic Center, Mean Camber Line, Cross Over Point (Section Exaggerated for Clarity)

Figure B: Lift, ac, cg, Weight (Gravity), Lift due to Reflex (Section Exaggerated for Clarity)

Figure C: ac, 1, 10, ac, 1, 10

Figure D: Aerodynamic Center, Center of Gravity, Geometric Center of Area, gality (windlord)

Figure E: Snap Swivel, Rings in place, Tow Hooks, Heavy duty Towline, Ring on Towline

vator trim for adjusting tow climb angle.

The rudder area was derived from a small 6-ft. model that would occasionally spin, if stalled in a turn. I just added enough area to eliminate the spin.

Construction

Before starting to build, decide whether you want to use the wing- or fuselage-mounted tow hooks. The wing-mounted hooks provide more freedom and a better tow. They also release easier, but they are another linkage to hook up when assembling the ship. If you use the fuselage hooks, you can install a ballast tube in the wing for the wing hooks. A ballast box in the fuselage is necessary. Keep the ballast as close to the CG as possible. (About 20 oz. is max.) The optional flaps do help the tow somewhat and are useful as a landing and dethermalizing aid.

Begin by building up the sub-assemblies. Build the fin and rudder, but do not add ⅛ balsa cap sheeting to fin. Cut out ¼ ply wing rod-tube holder, and epoxy ¼-diameter brass tube in place. Epoxy inner 1/16 ply shear webs to tube holder and tube holder and tube.

Cut out elevator bellcrank parts, and tack glue them together. Drill the holes in the bellcrank, disassemble and epoxy together, trapping bearing tube in place.
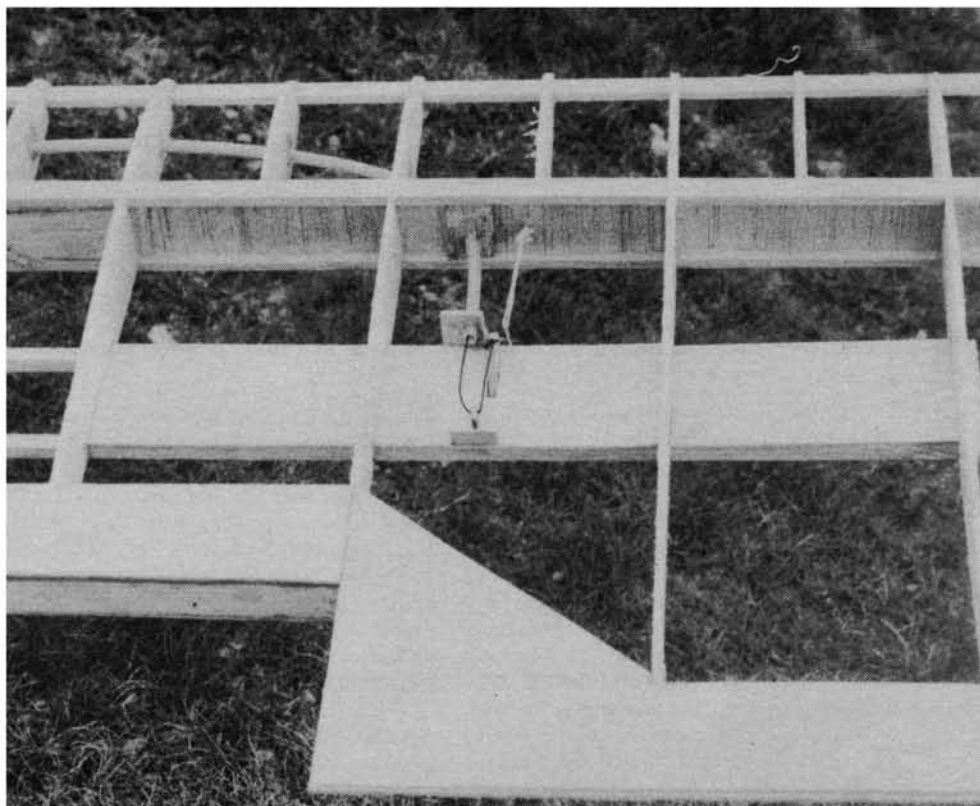
The method of operation, and installation details of flaps, are clearly seen in this photo. Pullcord runs through Nyrod, the rubberband provides the tension to retract the T.E.-stock flap.

Wax the 1/8 piano wire rods and insert them in the bellcrank, twisting, etc., until alignment is perfect. After the epoxy has set up, the rods can be removed. While these assemblies are drying, cut out the rest of the parts.

Start the fuselage by gluing the spruce strips and corner stock to the fuselage sides. Glue F4 and F5 and the two sides together over the plans, and let dry. Next, pull the nose and tail together, substituting a piece of 1/4-sq. spruce for the fin. Add the rest of the bulkheads, block, and bottom sheeting. Do not add the top sheeting at this time.

ready to glue to the basic fuselage box.

Glue on the wing root fairings but do not add the cap ribs at this time.

Before starting the wing construction, borrow a wing jib (if you don't have one), otherwise use the tabs on the lower rear surface of the ribs, as shown on the plans.

Pin down the trailing edge sheeting and carefully Zap or Jet (or use your favorite instant sticky) the ribs to the trailing edge sheeting, *up side down* (there is a flat spot on the top rear of the ribs). Maintaining the proper spacing and keeping the ribs parallel, slide in the leading edge and bottom spar. Glue or X-30 in place (do not

hole for the rear wing rod. Separate the pieces and add the 1/8 hole and slot for the elevator control horn to the fuselage fairing cap ribs. Glue the cap ribs in their respective locations, and drill, or cut out, the holes that are now blocked.

Install the elevator control horn with the front 1/8 diameter rod. Use the spaces to keep the horn centered in the fuselage. Add linkages, etc., and sheet top of fuselage. Make cut outs for fin spars and glue fin in place, checking alignment by plugging in the wing. Putty, sand, and carve fuselage to shape. Build canopy frame and add canopy cut from a Cox Airtronics
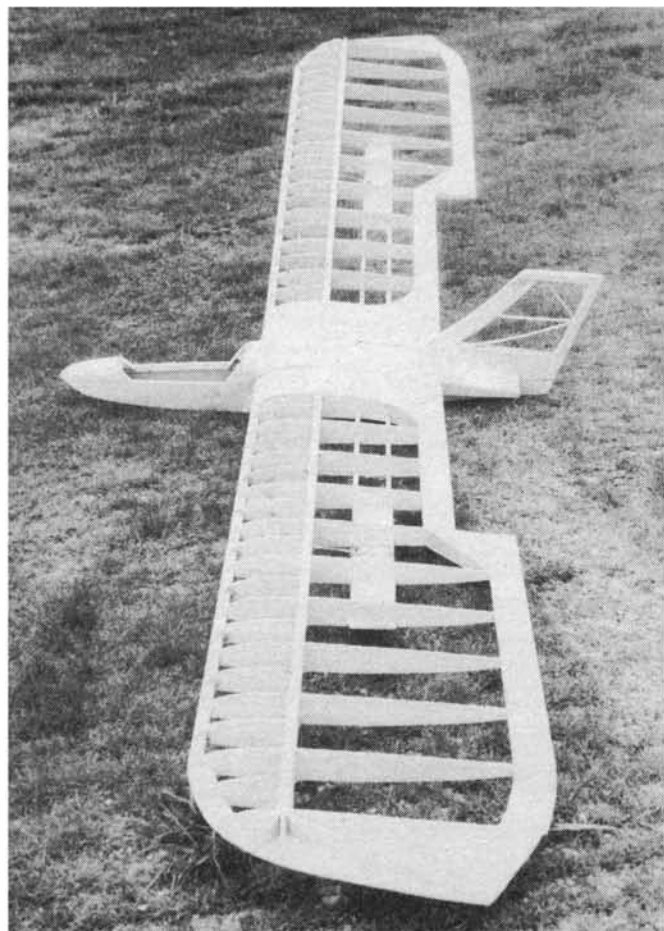
The completed frame. Span of wing is 100 inches, which yields 1400 squares. Wing loading works out to 5-7 oz./sq. ft. at 50-70 oz. gross.
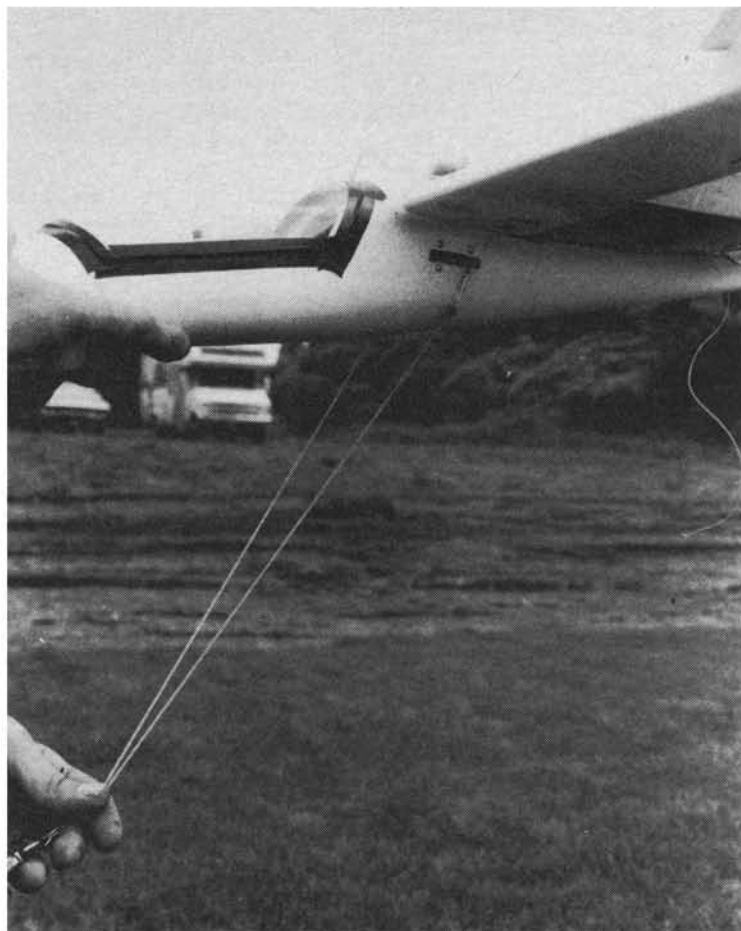
How the tow line is affixed to the two side-mounted hooks in the optional installation. Rationale of towing setup is discussed in text.

The wing root fairing is band sawn or jig sawn from a balsa block. Foam may be substituted and hot wired to shape, if spruce anti-crash braces are inserted at the leading edge, and at the elevator cut out area. Ideally, the balsa block should be 4½ wide, and longer and higher than the root fairing. Laminate a block, if none this size is available. Transfer the airfoil shape of the root fairing to the side of the block and cut out. You should now have a stubby "wing." Next, spot glue the scrap back on the "wing." Measure the correct width, and bevel the sides to match the dihedral angle (14° total, 7° each side). Transfer the fuselage box side lines from plan top view to the "block" and cut out. You will have a pair of wing root fairings, shaped and

Zap). Add flap stringers, elevator cut-out spar, and root bottom sheeting. When dry, unpin and turn over. The wing should sit on the tab and the bottom spar. If not, shim the trailing edge with scrap wood, etc. Next, install all shear webs and wing rod holder assembly, add the top spar, and epoxy the 1/16 ply, root shear webs in place. Add linkages, tow hook mounts, ballast chamber, and sub ribs, etc. Finish wing but do not add the root cap ribs yet.

The elevators are built right side up on a flat surface. This produces a twist, which is intentional. Drill the 1/4 hole for the wing rod in the wing and fuselage fairing cap ribs. Spot glue, or clamp, the ribs together, using a dowel, etc. through the 1/4 hole to help alignment and drill the 1/8-diameter

Aquila canopy. Install radio and finish personal preferences.

Flying

The center of gravity should be 3⅛ in. back from the wing leading edge. Balance the ship on a pair of pencil points or any similar device (finger tips are too broad!). The elevator control throw should be ½ in. up and ½ in. down. The rudder should have about 30° throw, each side.

There is no washout in the wing. Do not put any in. It will cause the ship to lose some pitch stability. Trimming is accomplished by aligning the outboard end of the elevators with the wing trailing edge, and

adjusting the CG in small increments until a stable floating glide is achieved with this setting.

Towing is accomplished with a bridle as shown in Figure. E. Do not tie the bridle to the snap swivel. Pass it through the ring on the snap-swivel, and use large enough tow rings so that they cannot pass through to one side of the bridle. The ring will stop at the snap swivel and allow you to complete the tow. One-side tows are possible, requiring about 10° of rudder deflection to correct the yaw.

You may substitute conventional hooks for the releasable capture hooks. It may be necessary when launching with a winch to continuously pulse the winch rapidly through the early portion of the tow, including tensioning of the line and launch. This will maintain a constant tension on tow, like that of a hi-start. If you run the winch continuously until the ship has started to rotate and climb, and then suddenly release pressure on the line, you may experience a slight pitch up, releasing the tow bridle.

Efficient, thermaling turns can be made quite tightly, and penetration with down elevator trim is excellent. Inverted flight is almost as good as upright and the Windlord can be made to outside loop. When inverted, the rudder does not reverse. Right is still right! (Don't ask why!) Dethermalizing is done with the flaps, or a shallow inverted dive, since an upright dive builds speed rapidly, and this speed does not bleed off quickly.

Orientation has not been a problem. But, it looks so much like a hawk at a distance I don't recommend using a dark color scheme.

Enjoy your Windlord, and don't lose it in a gaggle of hawks!