Radio Controlled
Soaring Digest
June 2017
Vol. 34, No. 6

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Front cover: Steve McLaren's Panavia Tornado GR1, built from the Andy Conway PSS plans. Model spans 40" and has an AUW of ~3lb. Hand painted finish in the colour of RAF 15 Sqn the model is regularly flown with wingstores to great effect! Model is seen here soon after launch at the Bwlch, South Wales, May 2016. Photo by Phil Cooke – PSSA – more info at <http://www.pssaonline.co.uk>.
Canon EOS 7D, ISO 10, 1/1250 sec., f5, 100 mm

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Although it has a less than sparkling and some might say depressing history, slope soaring enthusiasts may find this aircraft to be well worth modelling. This would be especially true if an identically scaled B-50 could serve as "mother ship."

Panelling a Wing with Plywood 50

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Back cover: A pen and ink drawing by Julian Whittaker. Published in *Aspectivity*, the newsletter of the Victorian Association of Radio Model Soaring, Victoria Australia, February 1983.

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In the Air

The *RC Soaring Digest* FaceBook page is becoming increasingly popular, and now has nearly 2300 followers. For those on FaceBook who would like to see some of the inner workings of *RCSD* and get a notification when a new edition is available, simply go to <https://www.facebook.com/RCSoaringDigest/> and press "Like."

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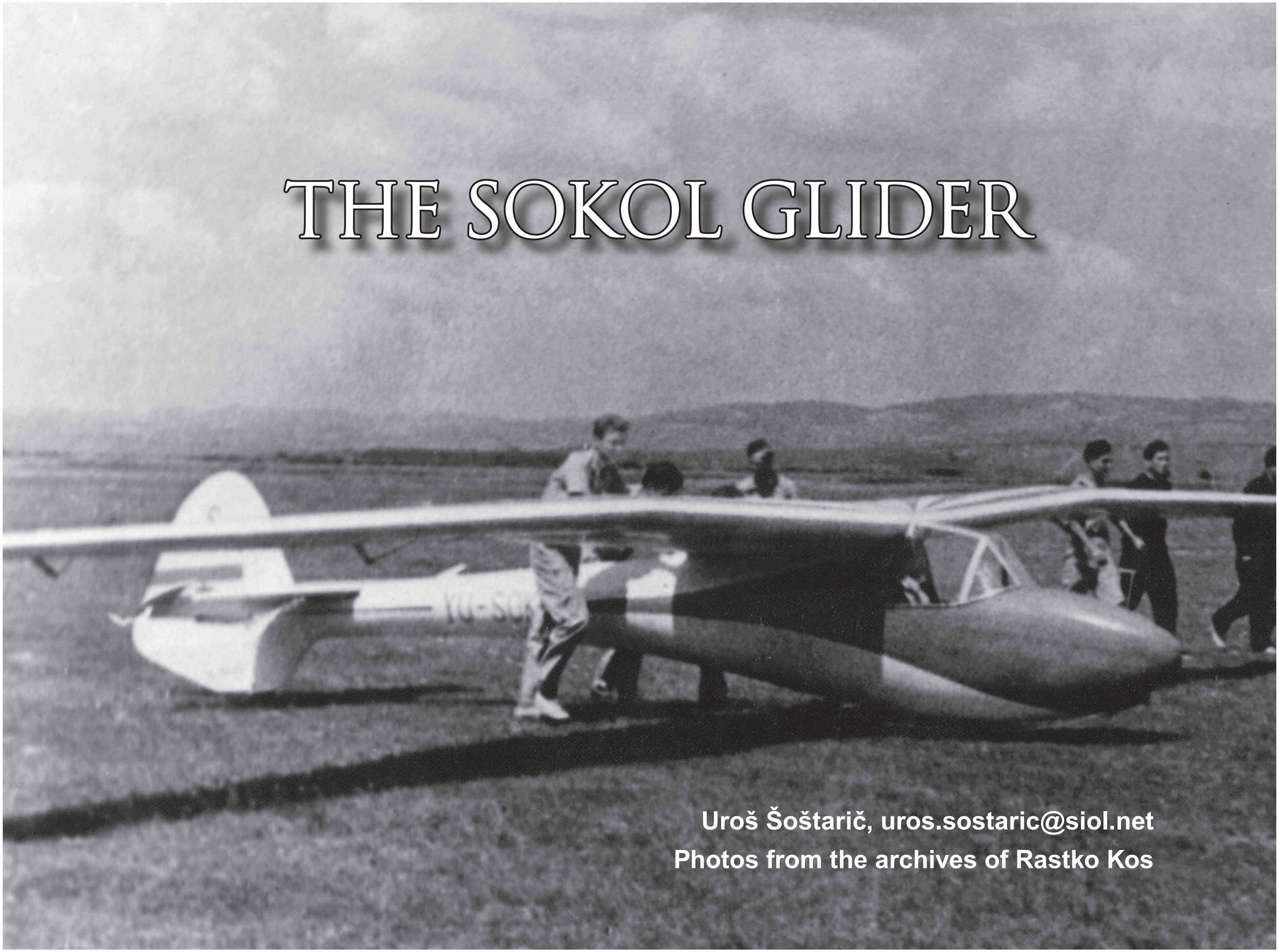
Lastly, we do have a P.O. Box where you can send printed materials, CD/DVD disks, items for review, etc. The full address is printed near the bottom of the column at the left.

That's about it for this month. Thanks to everyone who contributed to this issue, and thanks to you for your continued readership.

Time to build another sailplane!

B²



THE SOKOL GLIDER

Uroš Šoštarič, uros.sostaric@siol.net
Photos from the archives of Rastko Kos

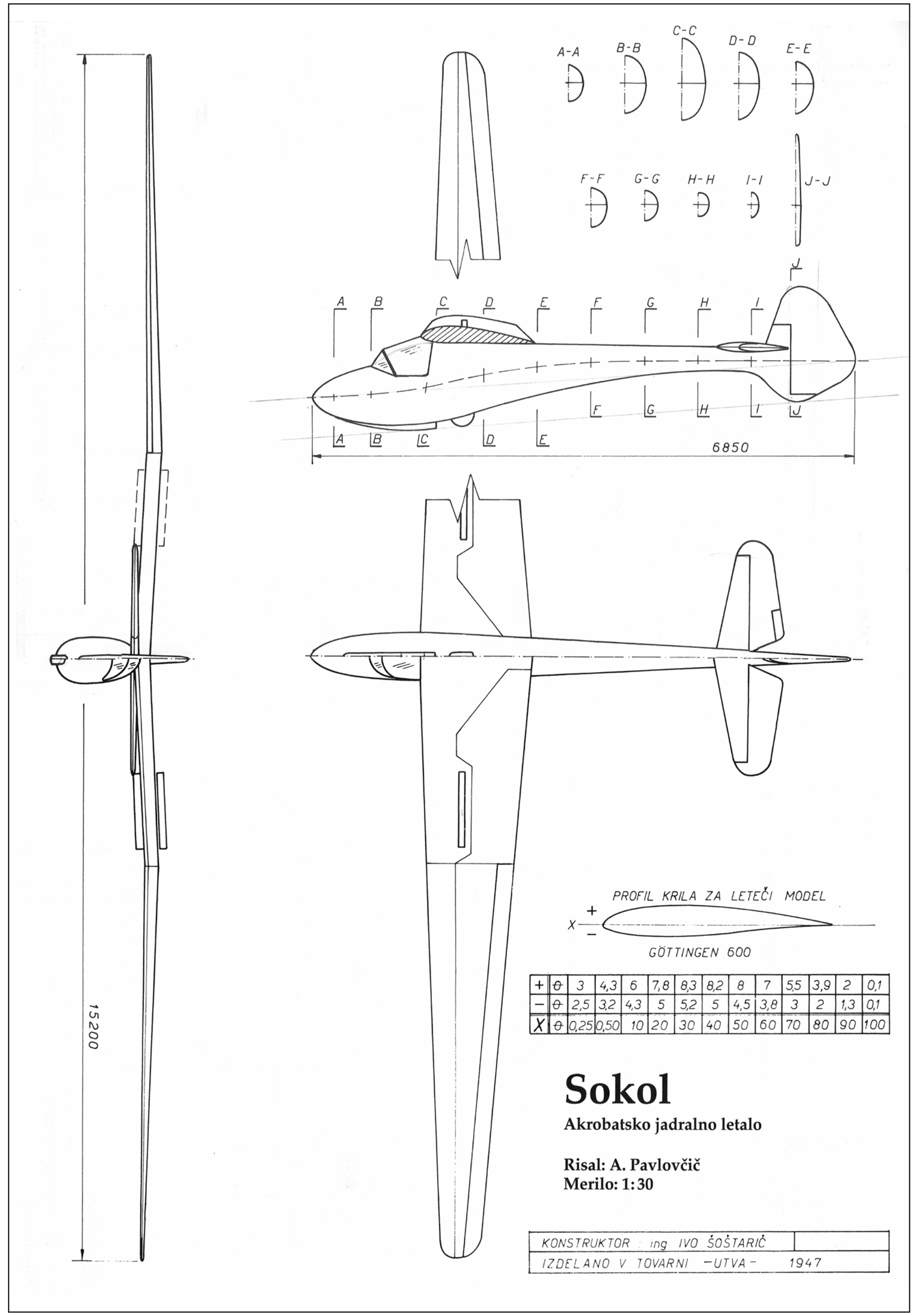
In the postwar period, Yugoslavia was one of the leading countries in designing and building glider planes. During this period, some of great glider planes for learning as well as trainer glider planes and superior racing gliders (Roda, Čavka, Jastreb, Orel, Meteor, Košava, Sokol, etc.) were built. Using these glider planes, glider pilots achieved excellent results in races of the highest level.

The Sokol glider plane was built in 1947 by a factory called Utva in Pančevo near Beograd (Serbia), based on a design by a Slovenian engineer Ivo Šoštarič from Maribor. A construction made entirely from wood was extremely demanding to build in those times, and perhaps this is the reason why only one specimen of this glider was made.

Sokol was designed primarily as a trainer and aerobatic aircraft and was therefore capable of all kinds of glider aerobatics of that time. Slovenian engineers contributed a great part to engineering then, and the time was right for the story of the Slovenian Sokol to continue with a Slovenian modeller.

Brane Volk is a Slovenian modeller known mainly for his building of wooden flying models of glider planes. After building a wooden glider model Minimoa he wanted something new, of course, again made of wood. This time he chose amongst glider planes from our Slovenian aviation history.

After a consideration, he decided to build the Sokol, designed by engineer Ivo Šoštarič in 1946, who was one of the leading Yugoslavian aircraft engineers in that time.



Opposite page: Archival photo of the Sokol glider plane in the airport of Cerklje in Slovenia

Right: Design by the engineer Anton Pavlovčič in TIM 2 magazine, Oktober 1996

The design itself and a demanding construction represented a big challenge for Brane. He asked his modeller friend Rastko Kos to prepare a construction. Rastko drew a model and ensured statics and aerodynamics.

During this time, Rastko had already gained some experience in CNC milling on a homemade machine, and therefore the technology for building was also determined: a wooden construction, covered according to function, with balsa wood (fuselage), birch plywood (wings and horizontal stabilizer) and modeller canvas (wings, elevator and rudder).

Brane's model of Minimoa has a wing span of five meters, so they chose a rather unusual scale of 1:2.53 for Sokol to achieve a larger span of six meters, which was Brane's wish for a larger model.

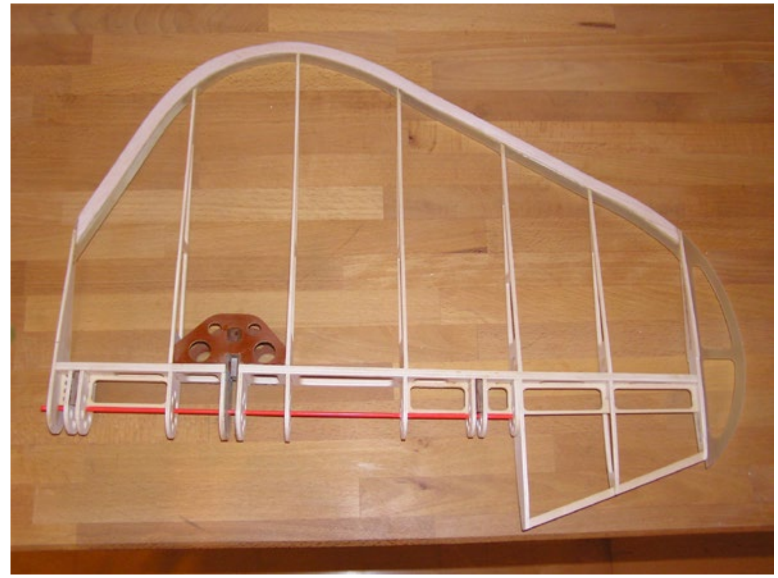
In construction of a flying model it is helpful to have as much documentation and designs as possible; however, for Sokol only a few archive photos and a not very reliable design by its engineer Anton Pavlovčič containing three views (plan view, side view and front view with some typical cross-sections) were available.

It took a lot of improvisation in designing a 3D model in the Autodesk Inventor software. For example, using only your feeling to select the dihedral angles of M-shaped wings, and the incline of wing profile according to the fuselage and elevator. Aerodynamic calculation was done using the XFLR program; for wing profile he chose HQ-ACRO by Dr. Helmut Quabeck, known for quality profiles, developed specially for modelling needs.

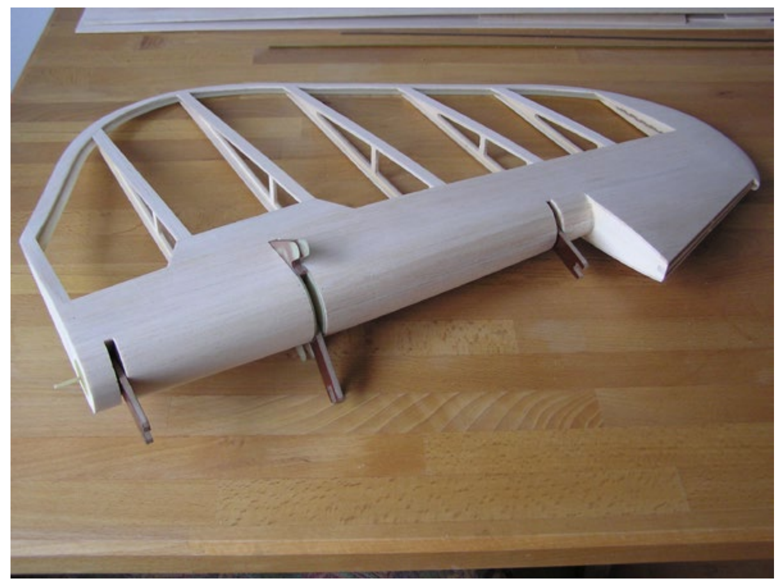
For a project as large as Brane and Rastko's Sokol, a lot of unknown variables and open questions understandably arise in the beginning. They approached the issue by beginning with the smallest part, the rudder. Although this is a rather independent part, all the details had to be designed in the beginning.

A rudder contains a specific drive system, where the drive lever with steel braided wires remains bearing on the vertical stabilizer, and a built-in drive element enables de-installation of the rudder for safer transportation.

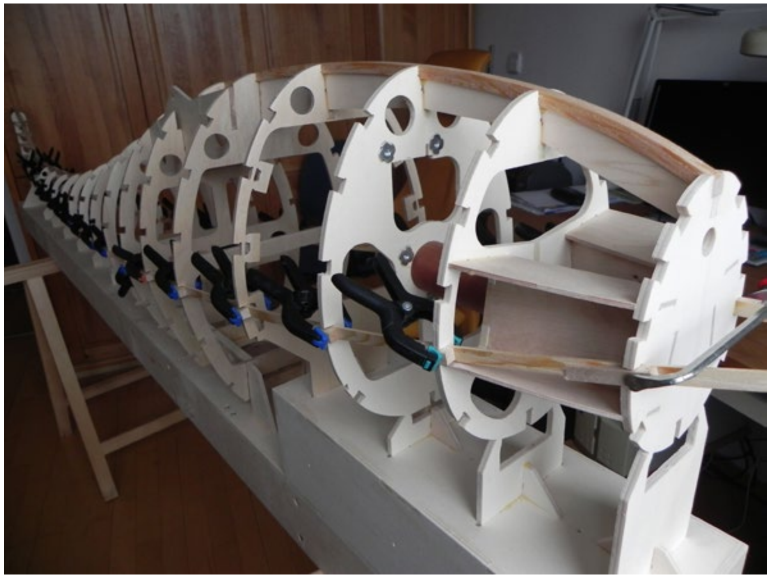
Upon completion of a construction of all parts, Rastko prepared milling programs (using Vectric Cut2d software), and milling of parts began. Once



Rudder with the drive element in construction



Rudder with skin made of balsa, pivots and drive



Above left: Fuselage in the making – gluing multilayer longitudinal battens

Above: Fuselage is separated from assembly preparation

Left: The fuselage is covered and it is beginning to get its true shape, but the room ceiling is getting too low

the parts made of poplar plywood with thickness of 3 mm, textolite and vitroplast of various thickness were milled, Brane began building the glider.

This broke the ice.

Then came the hardest part – the fuselage rounded in all directions. The only reasonable choice to cover such demanding shapes are balsa strips. A solution was also needed for an extremely demanding shape of longitudinal battens, which are heavily arched in several planes. Because of this, during their construction Rastko suggested to make larch wood battens with a cross-section of approximately 10 x 8 mm out of multiple layers, which would be glued during laying on the fuselage frame.

Feet are added to the fuselage frame for gluing to assembly preparation, which means less work was needed for precise laying out of battens along the fuselage. The milling machine did a lot of work.

Parts of the wing with bayonets and their bushings

Wings finishing is milled three-dimensionally from Styrodur

Brane glued the frame onto the assembly preparation and began straining the longitudinal battens. The idea of gluing multiple layers proved to be a great decision, because this produced a very solid construction, without even mentioning valuable internal tensions, and Brane could finish the less strained battens with balsa strips to avoid unnecessary weight. Brane carried out covering with balsa strips in his well-known professional style, and the fuselage started to look more and more like the original.

While working on the Sokol project, Rastko designed a much larger and faster CNC milling machine. This was really useful in further construction of Brane's model, because this made milling of the elevator and particularly of the wings much faster and gave results of higher quality.

Rastko paid special attention to details in every step. Therefore, he also developed a dedicated lever for the elevator drive, which is assembled and disassembled by tightening and releasing a single M4 screw. It also provides drive without any ventilation whatsoever.

For easier transportation, the wing with a beautiful M-shaped dihedral is divided into four parts, which are assembled using special arched bayonets.

Middle part of the wing is already free from its assembly preparation, and the lower part still needs to be covered

Bushings on the wings are made from vitroplast of various thickness and using carbon fibre clamps. Bayonets consist of a multilayer core made of poplar plywood and larger side-plates made of vitroplast with thickness of 1.5 mm.

Here come the colours – the elevator

In a resulting channel, the carbon fibres wound on a coil are impregnated in epoxy resin. Wound bayonets of course had to be compressed into prepared moulds, to prevent fibres from lifting on the arched part and disrupting the shape. The procedure probably seems rather demanding and must be started with a lot of patience and precision. But a seemingly endless winding of carbon fibres was going surprisingly fast. This resulted in strong and not too heavy bayonets that fit perfectly into bushings on the wings. A few more carbon fibres than are necessary for the function itself were used, but this significantly simplified the construction.
A special feature of Sokol's wing are rudders, spreading throughout the entire outer section and continuing into elliptic finishing. This meant that in constructing the finishing, local profiles had to be arranged in a way that the pivot of the rudder in height was always exactly in their centre. The finishing was milled three-dimensionally and made of Styrodur. After mounting on the wing and the rudder, all our efforts in construction were rewarded by perfectly functional rudders.

Three-dimensional milling of supporting battens for all wing parts made Brane's work a lot easier in precise profiling of the battens.

When Brane continued the construction and had almost completed the model, Rastko used the XFLR program to repeat all aerodynamic calculations multiple times and designed a device to determine the centre of gravity. Like most old-time models, Sokol has a very short front part of the fuselage, therefore in designing the glider a large ballast tube in the nose was already planned. This turned out to be a great decision

View into the cabin

And the great day has arrived – waiting for the first flight at the model airport in Vipava

After a successful first landing – Brane Volk, the builder, in the front, and the designer Rastko Kos in the back

for determining the centre of gravity, since only 300 grams of extra lead had to be added. Lead had to be specially moulded according to the area between the battery compartments, where it had to be placed for gluing using a special dedicated device.

Construction is naturally followed by flying, but a lot of conditions had to be fulfilled before that. We had to wait from late spring all the way to a beautiful November day, when we gathered at the model airport in Vipava. The weather was excellent and calm, and the tow pilot Boris Sekirnik was ready with his Citabria. Sokol was assembled, mandatory photos before the first start had been taken and Brane had no more excuses for the first flight.

The builder Brane Volk is justifiably proud of his great model

Take-off was done without any problems, and aero towing soaring was calm. As early as during this phase, Brane noticed a very strong functioning of ailerons (spread over two meters of the outer parts of wings). Towing quickly reached the necessary altitude and this was the beginning of a true independent maiden flight. During the first cautious turning, a little altitude trim upwards had to be added.

The model flies, as it is suitable for such an old-timer – majestically and calmly. A cautious test of tailspin showed no surprises; the model only drops on the nose and calmly continues the flight using an increased velocity.

In conditions with no thermal, the model obviously steadily loses altitude and it is time for landing. After a wide approach and levelling with the direction of the track Brane pulled out the air brakes and once again the model exhibited excellent qualities. There is no dangerous reaction in altitude, landing continues in the same direction, only the velocity begins to decrease.

Of course, there is no need to add, what a relief Brane and Rastko felt. After years of building, the model proved itself in its best light, even in flight.

The second flight after a break to calm the nerves was also done without any problems, and the landing was even nicer and softer.

So, another old-time glider plane came to life in the form of a model.

SOKOL original and model information:

	Original	Model
Wing span	15.2 m	6.0 m
Length	6.85 m	2.74 m
Wing surface	15.3 m^2	2.3 m^2
Weight	210 kg	20 kg

Egret V

Kite V

Tony Beck, t_cbeck@att.net
Additional photos by Tom Cassem and Keven Downs

These models — Egret V 2M and Kite V 100" — are the latest in a long line of high performance wooden sailplanes. Early on, my designs tended to sacrifice handling for improved performance. In real life, that rarely worked out well. When a pilot must stir the sticks and constantly fight his plane, any theoretical performance advantage quickly disappears in real life. These models benefit from those hard learned lessons. Performance is always a design goal, but more importantly, that performance must be realizable without super-human pilot skills. In addition, as sailplane pilots, we tend to fly in rough, windy conditions, which put a premium on responsive, predictable handling.

The original idea for these planes was to build a "mix-and-match" model that could be flown with either 2 Meter or 100" span. After much analysis, that just wouldn't work. There are too many aerodynamic complications involved with such a large span change. That said, the two models are almost identical in construction. They use the same wing rib set, almost the same tail rib set, and the fuselages are the same except for the bigger plane's lengthened tail boom.

You could probably fly the 100" wing and tail on the short fuselage. It would have rather sporty handling though. You definitely can fly the 2M wing and tail on the long fuselage, but the resulting plane is a bit heavy.

The wing design for these ships is off the beaten path. Polyhedral wings pay an efficiency penalty at the dihedral break. This is due to interference between the wing panels, and the tip dihedral's effect on the outer wing panel's angle of attack. These aerodynamic facts of life cause a loss of lift over the outer wing, which gets worse as the model slows to work thermals. One way to compensate for this is by increasing the tip panel's chord.

A 2 meter span test model was built to try out the idea. While it is hard to measure performance, the new plane had a distinct advantage over my previous favorite 2M model, and handled reasonably well. After a lot more testing, fiddling, modifying and rebuilding, these models are the result.

Neither ship is an ultra-light European style RES plane. The prototype 2M Egret V came in at 32oz. It could be built around 30oz. with careful wood selection and lightweight covering. The prototype 100 Kite flies at 40oz. These weights are light enough to slow down and work weak lift, but still have sufficient speed capability to get back home on breezy days.

Construction

Your build will go smoothly if you proceed in the following order:

- Tail V tube and tail panels
- Main wing panels up to joining the panel halves
- Wing tip panels
- Fuselage up to installing the bottom nose blocks (before installing the tail boom bottom panel)
- Wing installation on fuselage
- Tail V tube installation on fuselage
- Radio system installation
- Tail boom bottom panel installation
- Fuselage shaping and glassing
- Hatch cover ("canopy")
- Paint and cover

Tail:

Start construction here! The techniques used are similar to the wing, but the tail ribs are designed so that the panels can be built on a flat surface. Since the tail panels are washed out (twisted ~1/2 degree), and the airfoils are not symmetrical, be careful to build a left and right side. Build light! Use just enough glue for a strong joint, and no more.

Start by cutting out all the parts. The root rib is a composite of 1/64" ply and 1/16" balsa. Glue the balsa rib to a sheet of 1/64 ply and then cut out the ply using the balsa rib as a guide. Next install the 3/16" hard balsa control horn mounting wedge on the opposite side from the 1/64" ply. Taper the wedge so that it has zero thickness at the bottom, and the full 3/16" thickness at the top. Cut out the tail pivot tube hole in the wedge to match the rib. See figure T1 below. Rib 3 also has a 1/64" ply doubler, but only on the forward part.

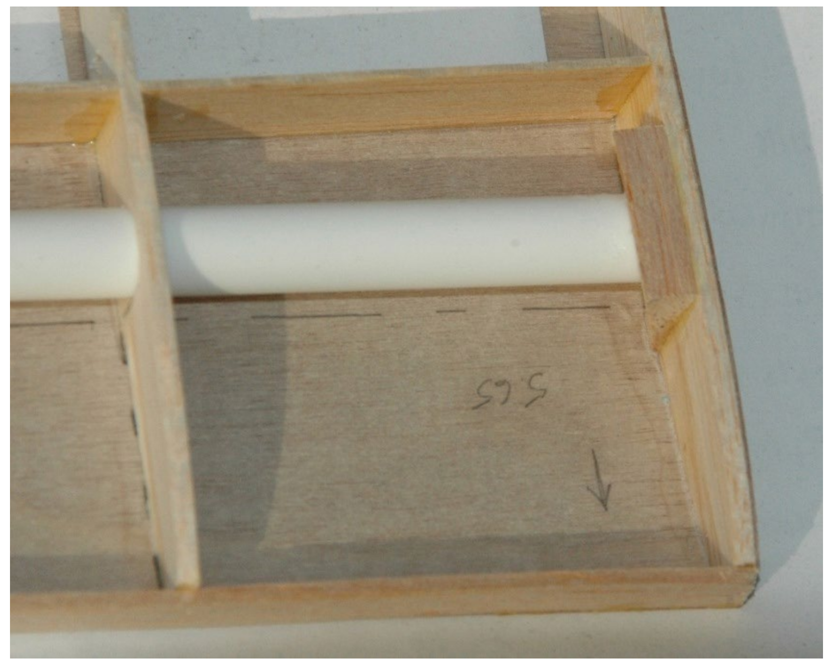


Figure T1: Tail root rib with control horn wedge.

Glue the ribs to the bottom D-box skin, glue the bottom trailing edge skin to the ribs and glue the 1/16 balsa leading edge doubler to the front of the D-box skin, and to the front faces of all the ribs. Next slide the plastic tail pivot tube into place in ribs 1 through 3. Don't glue it yet.

Place the panel on a flat building surface and install the 1/32" hard balsa shear webs along the back edge of the D-box and front of the trailing edge panel. Next, glue the plastic tail pivot tube in place. Your tail panel should now look like Figure T2, below.

Figure T2: Tail frame ready to install control horn and top D-box skin.

Cut a slot for the control horn in the bottom D-box skin and install the 1/16 ply control horn as shown in figures T3 and T4. Use a gap filling glue that gives you time to work. Titebond III works well.

Next install the trailing edge top skin and D-box top skin. To do this, place the tail frame on the corner of a flat building board with the control horn and trailing edge hanging off the edges of the board. Put weights on the frame to hold it in place.

Figure T3: Control horn installation

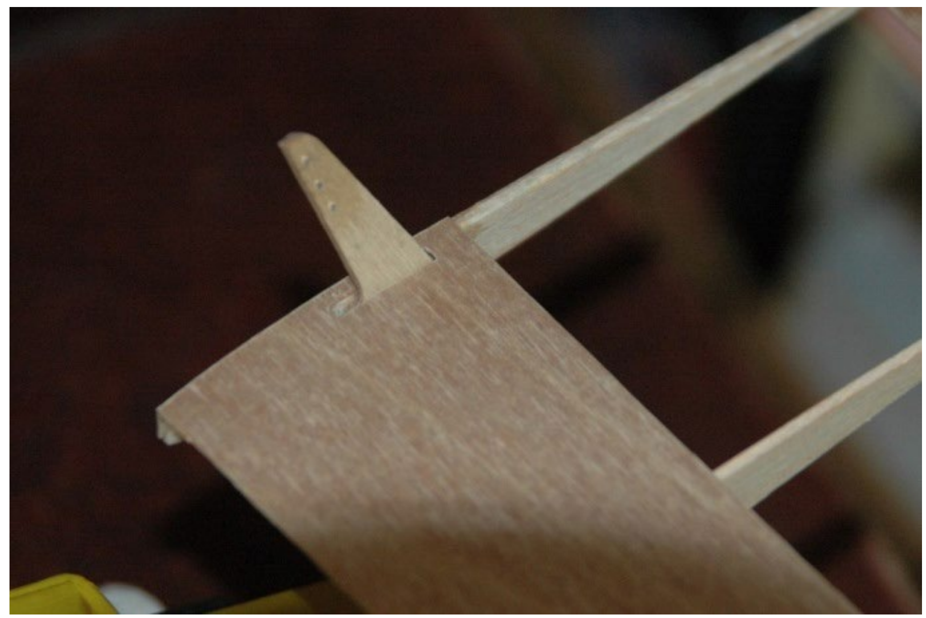


Figure T4: installed control horn

Note: I used a jig for this step the first time, but you really don't need to. Subsequent tails made without the jig have turned out fine.

Apply a high strength wood glue to the top of each trailing edge rib, along the back of the trailing edge and along the tops of the TE shear webs. Don't use too much here! Put the top trailing edge panel in position. Place a section of scrap spar under the back edge of the TE, and another over the TE. Clamp in place with clothes pins, as shown in Figure T5, below. Place weights on the front area of the TE.

Once the trailing edge is dry, glue the D-box top skin in place.

Figure T5: Closing the stab trailing edge

Just like the TE assembly, start by gathering several lengths of scrap spruce spar or hard balsa square stock, and some weights. You won't need the clothes pins this time. Instead, you will need a couple dozen straight pins.

Put the tail panel back on the flat building board and tape in place.

Apply glue to the leading edge of the tail panel, D-box shear web and the ribs, then put the top D-box skin in place. Align the back of the D-box skin along the top of the shear web. Place a square stick along the back edge of the D-box skin, and another an inch or so forward. Add weights to hold the skin in position. Be sure that the skin is pressed into contact with the ribs. At the leading edge, pin the sheeting down to make good contact with the LE stringer. Gaps or thick glue joints here will make shaping the LE more difficult.

Once the glue has set, remove the weights, trim the front of the surface and install the balsa leading edge stick.

Build the tail pivot tube V assembly:

Start by cutting a piece of ¼" Outside Diameter Hard Brass tubing to 9". At the middle of the tube, cut a V notch so it can be bent to the 100° tail angle. Don't cut the tube into two pieces! Just cut it enough to bend.

Bend the tube and tape to the template as shown in Figure T6.

Cut a ½ round section of ¼" Hard Brass tubing, about ½" long, to form the center reinforcement.

Using needle nose pliers, shape the center reinforcement to fit into the V as shown in Figure T7.

Solder the Tail Pivot Tube joint using a high strength solder, such as Dyna-Grip Kit No. 430, or Grobet Stay-Brite High Strength Silver Solder Kit. After soldering, clean off residual flux with HOT water, both inside and outside of the tubes. The flux is very corrosive and it will rot out your tail tubes if not thoroughly cleaned. The good news is that the flux washes off easily.

If you plan to do any lawn dart landings, cut two 1.5" long 7/32" Hard Brass tube sections. Carefully smooth off the sharp edges at the ends of the tubes, then slide one into each of the tail tubes and push it to the bottom of the V. Drip a few drops of

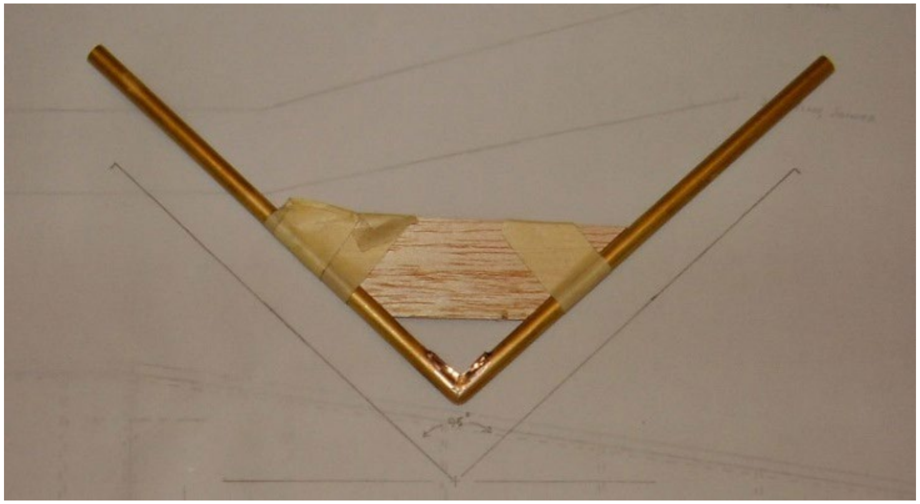


Figure T6: Tail pivot tube assembly template

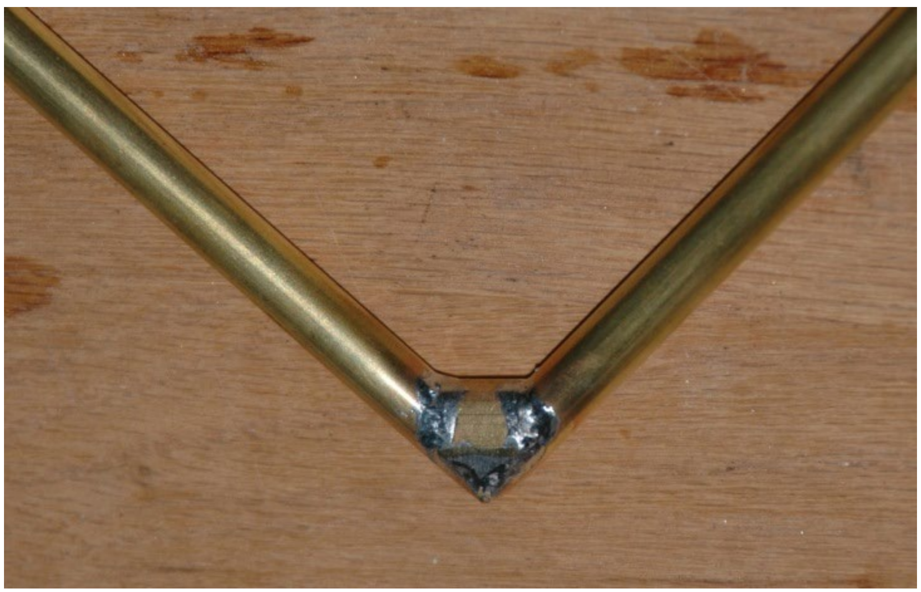


Figure T7: Tail tube reinforcement

thin CA glue down the inside of the tail pivot tubes to hold the reinforcement tubes in place. This strengthens the tail in case of (very) hard landings, but adds weight where you'd rather not have extra heft.

Trim the tubes so each side is exactly 4" long. It is important to get both sides the same length.

Main Wing Panel:

The wing main panel should be built next. Both the tip panels and the fuselage are fitted to it.

The wing's structural design spreads stresses through the spar, D-box and trailing edge. The spruce spar may look wimpy. That's because it's not carrying all the flight loads. If you plan on winch launching, carbon caps can be added to the spars. Prototypes have been built with and without carbon in the spars. The no carbon wings launch on an unlimited highstart with no problem.

The overall wing design is rather complex. Airfoils change continuously across the span, with each section optimized to its location. Wing twist (washout) also changes across the span. There are several advantages to this. Stall characteristics are mild, span efficiency is high and the spar is nearly a straight taper from root to tip, easing construction.

Start by making all the wing parts.

The wing tip to main panel joiner is laminated from birch aircraft plywood (NOT lite ply!). The tip joiners are laminated from two layers of 1/16" ply and one of 1/32" ply. Tip panel dihedral angles are different for the 2 Meter and 100" wings. Be sure to build the joiner you need. Figure W1 shows the tip joiner clamped for the glue to dry.

The wing main panel joiner is made the same way as the tip joiner, but from three layers of 1/16" birch aircraft plywood.

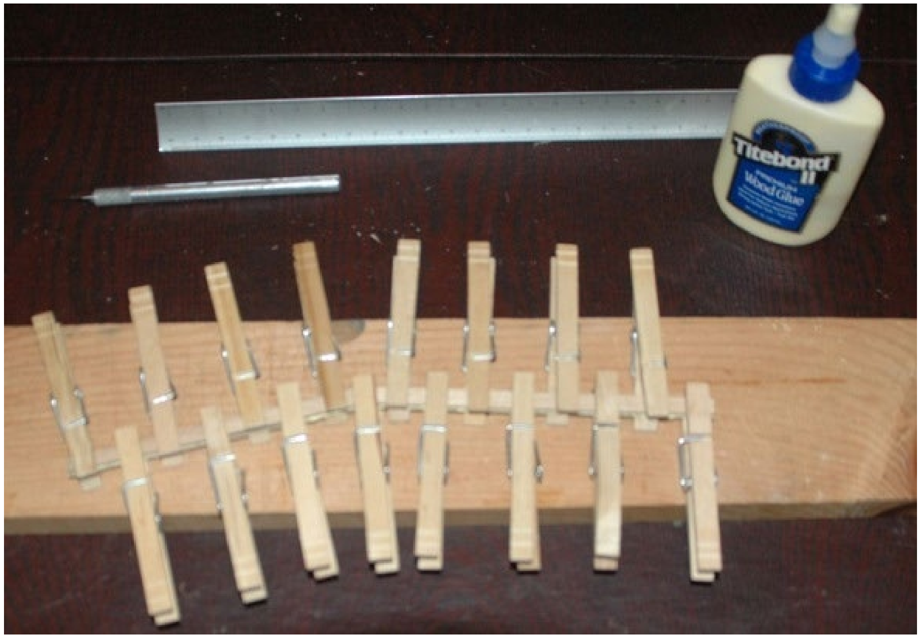


Figure W1: Laminating the tip joiner

Wing Ribs:

If you decide to make wing ribs the old fashioned way, by stacking rib blanks between masters and carving them to shape, there is an excellent article in the October 2015 RCSD by Chuck Anderson on how to make a rib set. I suggest a couple modifications to Chuck's procedure for this wing.

1/16" birch ply works well for master ribs, and you will have that on hand for the wing tip joiners anyway. Coat the edges of each master with thin CA to prevent nicks while carving.

Master ribs are 1, 6, 12, 13, 17 and 21. These need to be as exact as possible! You will build stacks between these.

To keep taper of the rib stack reasonable, I put a 1/16" balsa filler rib between each rib in the stack in the main panel stack. To make the elliptical tip ribs (17 through 21), the filler rib thickness is adjusted to get the right chords while carving a straight taper stack. The filler rib between ribs 17 and 18 has to be sanded thinner from 3/16" balsa stock. All the rest are standard thicknesses. The filler rib thicknesses are shown in Figure W2 below.

To fasten the rib stack together, I use either long pins or 2-56 threaded rod rather than the 4-40 bolts that Chuck recommends. Figure W3 below shows pinned stacks and W4

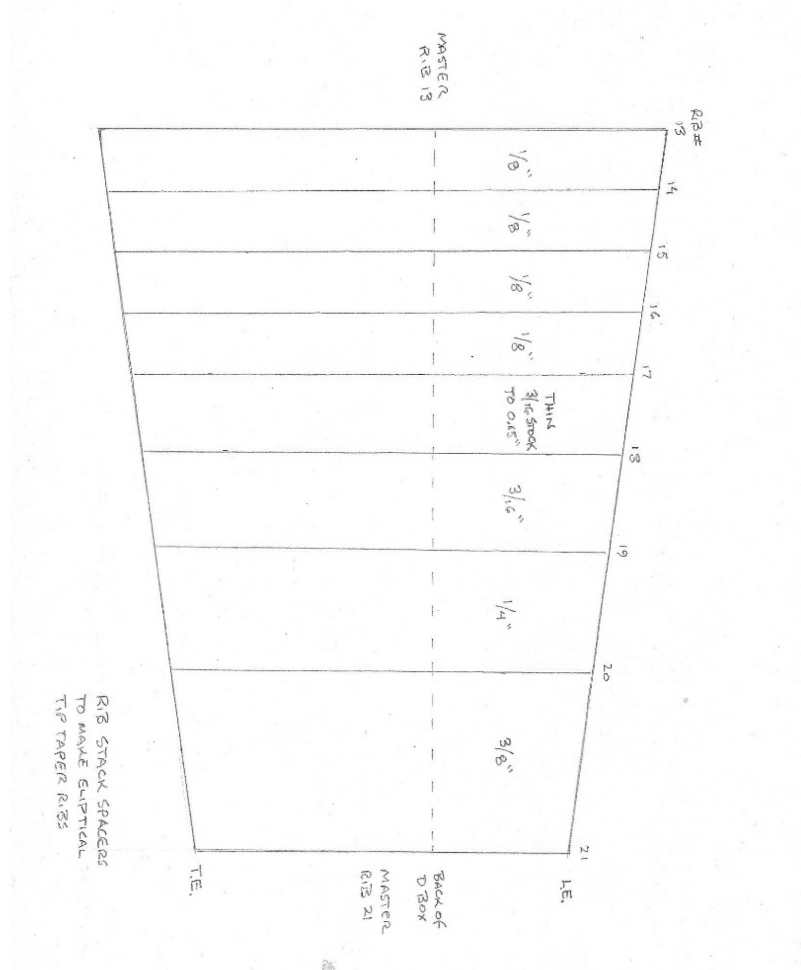


Figure W2: Rib stack dimensions to make elliptical taper tip ribs shows a competed tail rib set. These are for an early wing version, your set won't look quite the same.

Chuck uses power tools, but this can all be done with hand tools as well.

Root Rib 1a is laminated from 3/16" hard balsa and 1/32" ply.

Figure W3: Wing rib stacks between master ribs

Figure W4: Tail rib set

Ribs 1b and 2 are 3/32" or 1/8" balsa. The rest of the ribs are 1/16" balsa.

The dihedral break ribs, numbers 13a and 13b, are shown in Figure W5. These are laminated using 1/32" birch ply and 1/16" balsa. Cutouts for the wing joiner, locating pins and locating pin bushings must line up exactly between ribs "a" and "b". The nose area of Rib 15 is laminated with 1/16" balsa and 1/64" ply to support the joiner. Rib 15 reinforcement is shown in Figure W22.

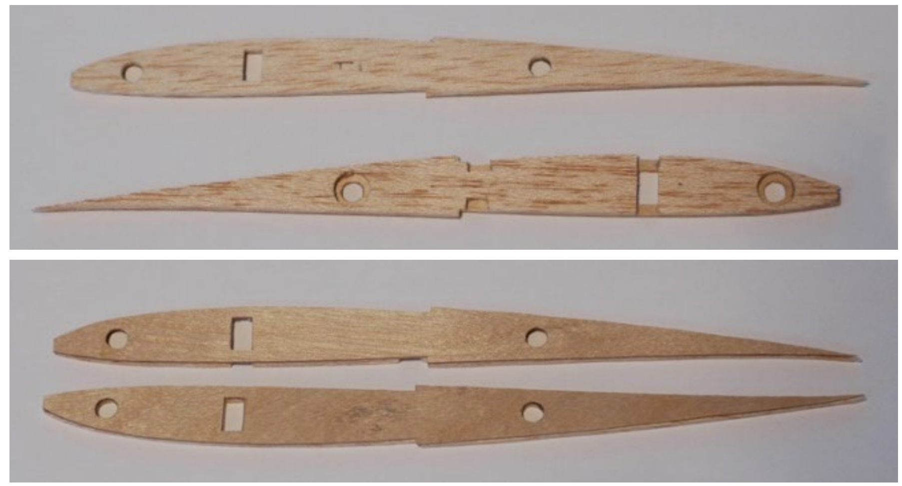


Figure W5: Dihedral break ribs

In order to get everything put together as designed, this wing must be built using jigs. If you build it the easy way, on a flat building board, you will pay a significant performance penalty.

Each wing panel is built on the bottom D-box skin. The main panels are built first, then the tips are fitted to the main panel.

Start by assembling the main panel wing jig. The spanwise legs are made a little tall and trimmed to match the rib jig plates on initial assembly. Once trimmed, tape the jig to a flat building board. Figure W6 shows the right 2M wing jig ready to be taped to the building board.

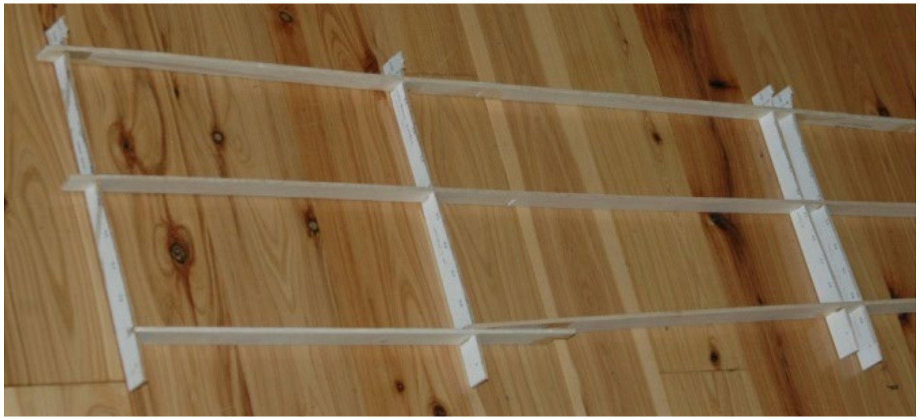


Figure W6: Wing jig assembly

Glue the bottom spar (3/16" X 1/8" spruce) and D-box rear corner brace (1/16" X 1/16" hard balsa, basswood or spruce) to the bottom D-box skin. Be very careful to get these located properly as the ribs have to lock in to these spars.

Glue a 1/32” ply shear web between ribs 1A and 1B to the spar, doesn’t matter if it’s front or back side. You need it to set the 3^{o} dihedral angle of rib 1A.

Glue all the ribs to the bottom D-box skin, starting with Rib 1A and working out toward the dihedral break. Thick CA (super glue) works well.

Trim the front edge of the D-box skin so that the wing frame seats correctly in the jig.

Place the wing panel in the jig using weights to hold it in position. Secure the wing to the jig using blue painters tape.

Cut the leading edge doubler from 1/8” sheet balsa and glue in place at the front of the D-box skin.

Install the lower trailing edge skin using the jig trailing edge marks for alignment. Thin CA works well.

Install the trailing edge shear webs and T.E reinforcement wedges (both cut from 1/16” sheet balsa), then trim the reinforcements to match the rib contour as shown in Figures W7 and W8.

Gather a bunch of clothes pins, several lengths of scrap spruce spar or hard balsa 3/16" X 1/8", and some weights (I like 1 pound lead ingots).

Apply a small bead of high strength wood glue to the top of

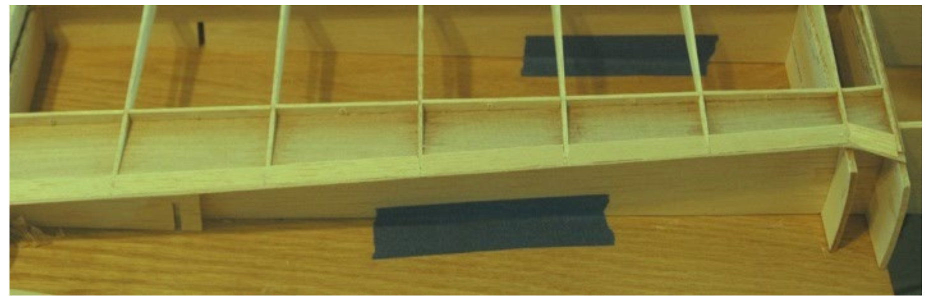


Figure W7: Trailing edge construction

Figure W8: Trailing edge reinforcement — wedges on the left are shaped, on the right are as installed each trailing edge rib, along the back of the trailing edge and along the tops of the TE shear webs. Don't use too much here! Place the top trailing edge panel in position. Place a section of scrap spar under the back edge of the TE, and another over the TE. Clamp down with clothes pins. Place weights on the front area of the TE. Figure W9 shows how the assembly should look. I like to leave it overnight, but you can remove the weights and clothes pins in a couple hours. This method results in a straight, light and strong trailing edge, with a correctly curved undersurface.

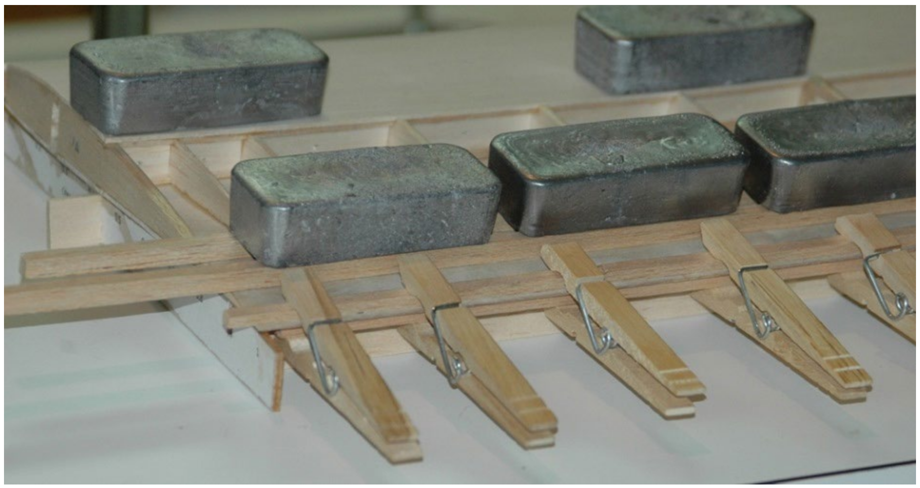


Figure W9: Clamping the trailing edge top skin

With the wing frame in the jig, install the spar and D-box shear webs. Spar webs are 1/32 and 1/64 ply. Webs at the back of the D-box are 1/16" balsa. On the spar, install one side completely (front or back) before installing the other. After installing the first side, remove the rib material between the spar caps of ribs 1A, 1B, 11 and 12 to allow for installation of the wing tip and main panel joiners. Figure W10 shows shear web installation.

Figure W10: Installing shear webs at the back of the D-box

Figure W11 shows installation of the tip joiner pin bushings in rib 13a. Glue in place using JB Weld or a similar epoxy.

Remove the wing from the jig.

Trim the wing main and tip panel joiners so they are a sliding fit into the spar. Since the main spar tapers in depth, a small wedge is placed under the top spar stick between ribs 10 and 11 to take up clearance between the tip joiner and the spar. It should be a snug sliding fit. Looseness here can result in wing flutter. Figures W12 and W13 show the wedge before and after installation.

Notch the wing root for the mounting bolt as shown in figure W14. This will make drilling the mount hole a lot easier, and more accurate, once the wing halves are joined.

Reinstall the wing panel in the jig and install the last sections of spar shear web.

The next step is to install the top D-box Panel.

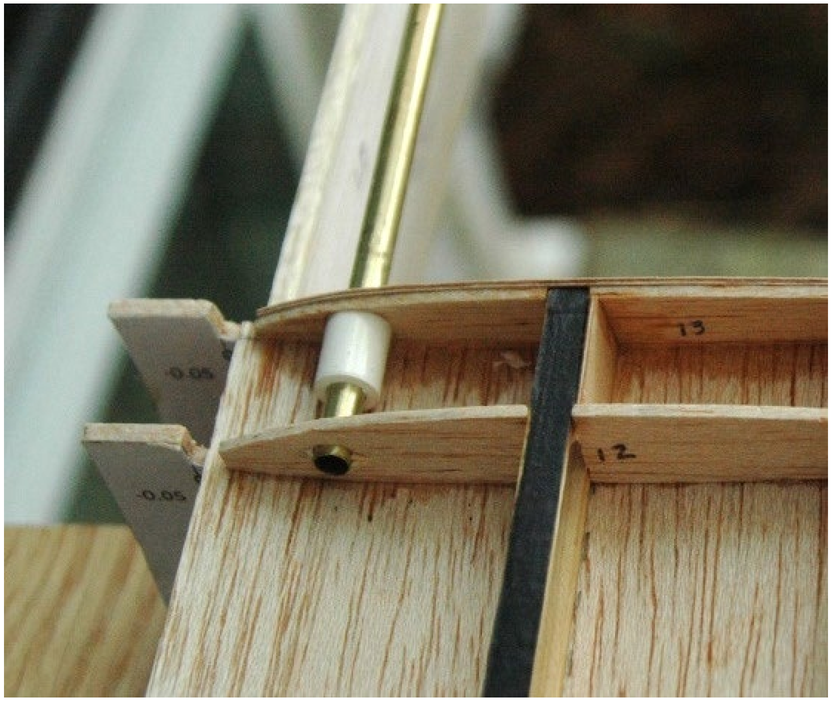


Figure W11: Installation of the wing tip locating pin bushings — carbon spar caps are optional

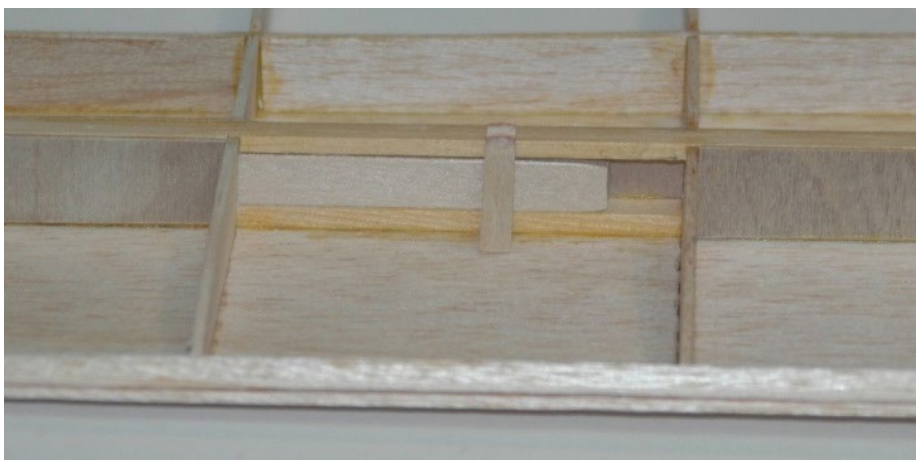


Figure W12: Tip Joiner in the wing spar with the spacer wedge in front

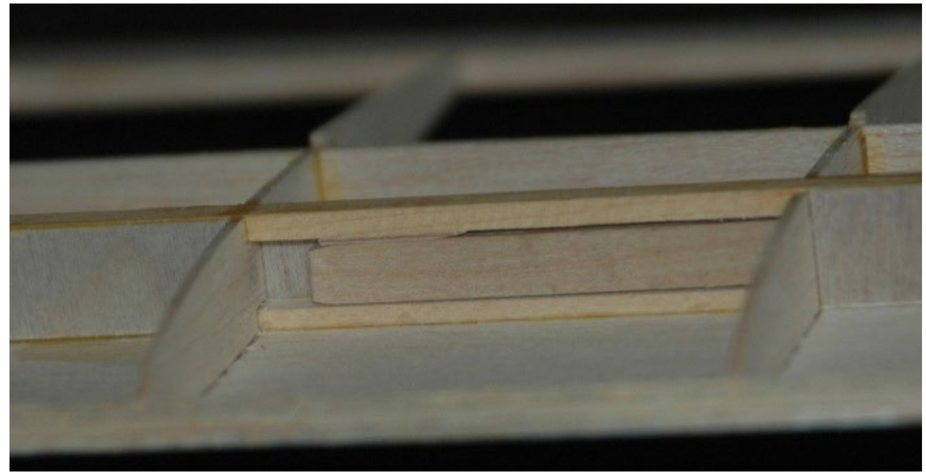


Figure W13: Tip joiner spacer wedge installed

Figure W14: Wing mounting bolt notches at the front of the root ribs

Just like the TE assembly, start by gathering several lengths of scrap spruce spar or hard balsa square stock, and some weights. You won't need the clothes pins this time. Instead, you will need a couple dozen straight pins.

The 1/16" sheet balsa D-box skin has a lot of curve near the leading edge. That can be a problem if you don't pre-bend the skin. To do this, wet the skin on the outer surface only. The skin will bend around the LE curve and take on the look of a potato chip. Place the skin on the wing frame (wet side up) and weigh it into position with square sticks and weights, as shown in Figure W15. Don't glue it now, just let it dry in position.

Figure W15: Clamping the top D-box skin in place

<u>CAUTION:</u> If you glue the top panel down while it is wet, the wing will probably warp as the panel dries.

Once the top D-box skin has dried overnight, it can be glued in position.

NOTE: This skin contributes a lot of the wing's strength. It is very important that it be well bonded to all of the ribs, the spar, leading edge and D-box shear webs. Do not use CA glue here! Use Titebond III or a similar gap filling glue that allows plenty of working time.

Apply glue to the leading edge, D-box shear web and the ribs, then put the top D-box skin in place. Align the back the D-box skin along the top of the shear web and add weights to hold it in position. Work towards the LE, applying sticks and weights to press the skin into contact with the ribs. At the leading edge, pin the sheeting down to make good contact with the LE stringer. Gaps or thick glue joints here will make shaping the LE more difficult.

Once the glue is completely set (overnight is good), remove the wing panel from the jig.

Slide the tip joiner onto the main wing panel, slide Rib 13b on to the joiner, slide the locating pins into Ribs 13 a & b. Using high strength epoxy, glue Rib 13b to the joiner, and the locating pins to Rib 13b. Figure W16 shows how the assembly should look. Once the glue has set, carefully remove the joiner assembly from the main wing panel.

Figure W16: Assembling the tip joiner, first tip rib and guide pins

Build the main wing joiner out of 3 layers of 1/16" birch plywood. Use aircraft grade, not Lite Ply! The center wing panel joiner is shown slightly oversize on the plans. Trim it to a snug fit in the left and right spars. Figure W17 shows the wing roots and joiner.

Install the spoilers and rib cap strips. Figures W18 through W20 show the prototype spoiler installation using 1" balsa trailing edge stock, nylon hinges and KST DS245H servos.

Figure W17: Wing panels with plywood center joiner

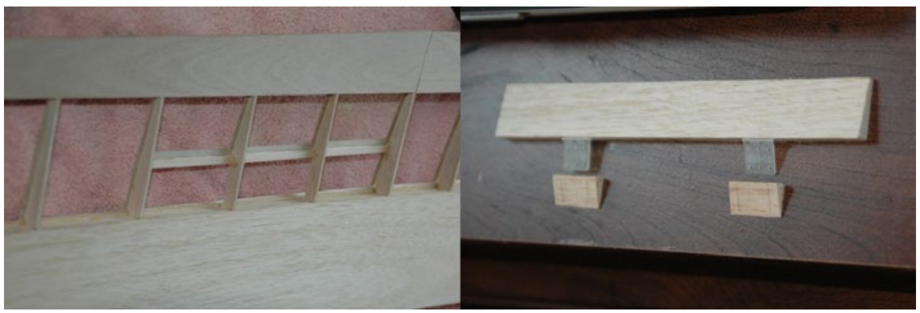


Figure W18: Spoiler frame, spoiler panel and hinge blocks

Figure W19: Spoiler installation details

Figure W20: Installed spoiler with rubber band closing spring. Note that the servo wire is sealed with RTV where it enters the spoiler box.

There are as many opinions on spoiler installs as there are builders, so I will leave this detail up to you. Be very careful to minimize air leakage through the spoilers. In addition, no air should be able to enter the space between ribs 6 through 9 from any other part of the wing. Air leaks can be a real performance killer. A full size sailplane from the early 1960s had a measured glide ratio in the mid 30s with the leaky factory spoilers, which immediately improved to the low 40s once the spoilers were sealed!

Once the spoilers wires are routed through the wing, the 1/16" balsa sheet panels at the wing root between the D-box and trailing edge can be installed.

The next step is to mate the wing halves. Apply high strength epoxy to the inside of the wing spar where the joiner will fit, and to the mating ends of the wing panels. Fit everything together. Clamp the TE with a clothes pin and pin the wing halves in alignment. Set the assembly aside for the epoxy to harden.

Wing Tip Panels:

The tip panels build just like the main panels, except there is no spar. The tip panel D-box has more than adequate strength. In addition, light wing tips improve maneuverability a lot! The traditional spar is eliminated to save weight. If you plan to winch, the tip joiners can be reinforced with carbon tape, but resist the urge to put in a spar!

Assemble the tip panel jig as shown in Figure W21 below.

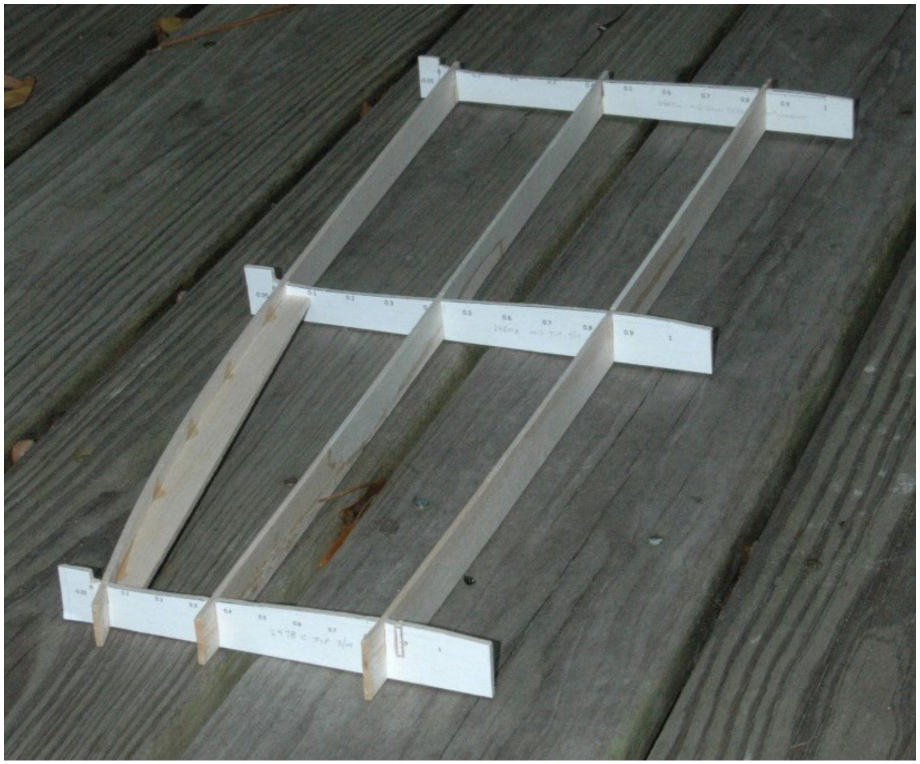


Figure W21: Tip panel jig

Glue the leading edge doubler in place on the lower D-box skin.

Slide ribs 14 and 15 on to the tip joiner, position the ribs and glue them to the lower D-box skin as an assembly, as shown in figure W22, below.

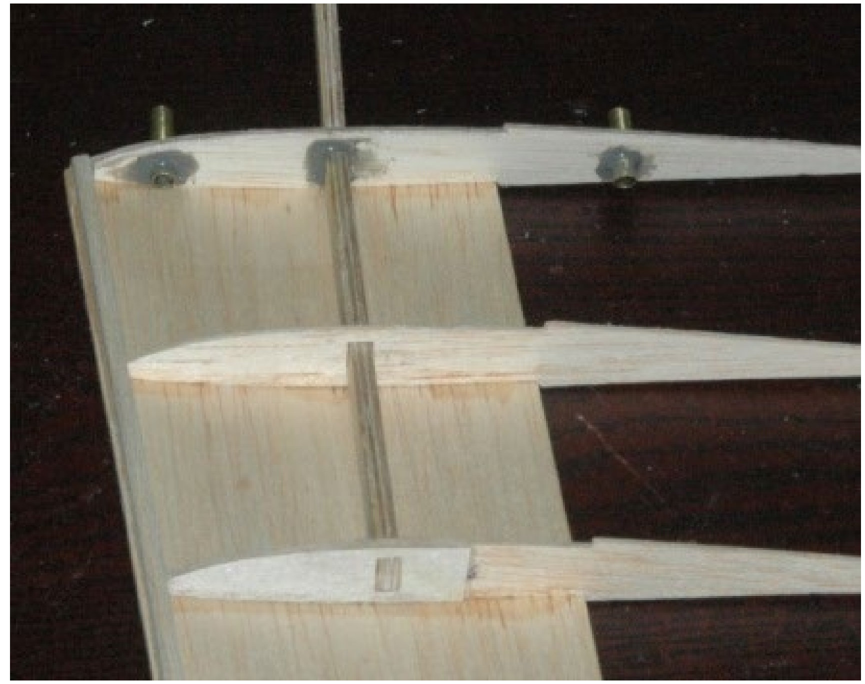


Figure W22: Installing the spar joiner and first three ribs

Glue the rest of the ribs in place.

Put the tip panel in its jig, weigh it in place and tape down with blue painter's tape.

Slide the bottom trailing edge skin into position and glue.

Install the D-box and trailing edge shear webs, the trailing edge wedge reinforcements and the LE doubler. Shape the TE reinforcements and LE doubler the same as the main wing panel. Your tip panels should look like Figure W23.

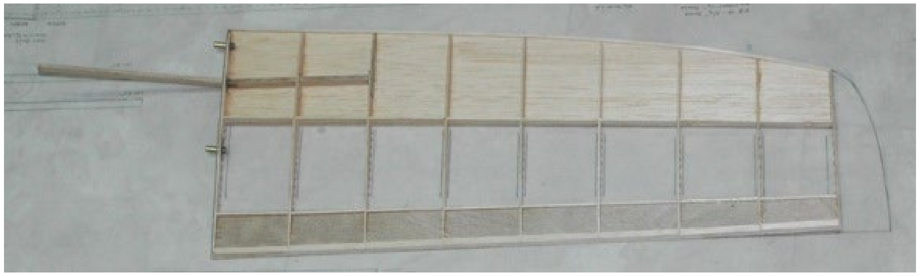


Figure W23: Tip panel frame ready for top D-box and trailing edge skins

Install the trailing edge top panels using the same method as the main wing panel.

Wet the top D-box panel and place it in position to dry using the same procedure as the main wing panel. Once it has dried in place (usually overnight), glue it down.

Once the top D-box skin glue has set, remove it from the jig. Install the 1/64 plywood rib cap strips.

Cut out the tip blocks from soft 5/8” balsa sheet (or 1/8” balsa sheet glued to ½” balsa sheet, as shown in Figure W24 below). Rough shape before installing on the wing tip. The tips shown are more complicated than they need to be, but I like the way they look. It is a lot easier to make the trailing edge flat instead of upward curved, and that change probably has no measurable effect on drag.

Figure W24: Wing tip blocks

Once the tip blocks are installed and shaped, coat them with thin CA. The tips tend to get whacked and CA hardens them without adding a lot of weight.

At this point, switch to fuselage construction.

Fuselage:

Cut out all the fuselage parts. Select light wood for the tailboom parts. This will save a lot of nose weight.

Laminate bulkhead F5 with 1/64" ply.

Build the ply/spruce wing bolt mounting plate. The plywood top and bottom panels can be either 1/8" ply or laminated from thinner pieces of plywood to form a 1/8" inch thick ply. The plate is made from a top panel of 1/8" ply, middle layer of ¼" spruce spar stock and bottom panel on 1/8" ply.

Glue the 1/32" ply doubler to the front underside of the tailboom top panel.

Shape the front of the upper tailboom corner braces as shown in Figure F1 and F2.

Taper the back section of all four tail boom corner braces between bulkheads F7 and F8.

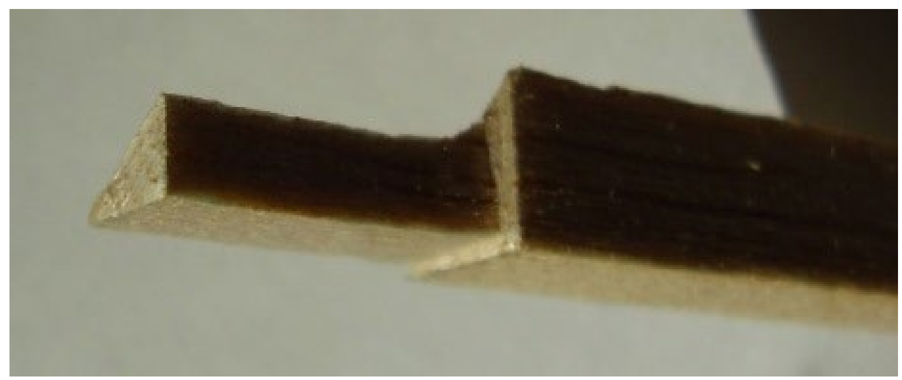


Figure F1: Upper tailboom corner brace shaping detail

Mate the front and back fuselage sides at the splice joint under the wing, then laminate the 1/64 ply doubler panels to the forward fuselage sides. Thin laminating epoxy works best. Carpenter's glue is more convenient, but the fuselage sides will warp if not held flat with weights for a couple days after gluing. Thick CA bonds too fast to wet out the entire bond area, so you end up with the doubler bonded over less than half of the actual contact area. Don't use too much glue here. Extra glue is extra weight, and it makes the joint brittle. Be sure to make a left and right side!

Once the sides are laminated, install the triangle corner braces on the tailboom. Do not install the nose corner braces now. See Figure F2.

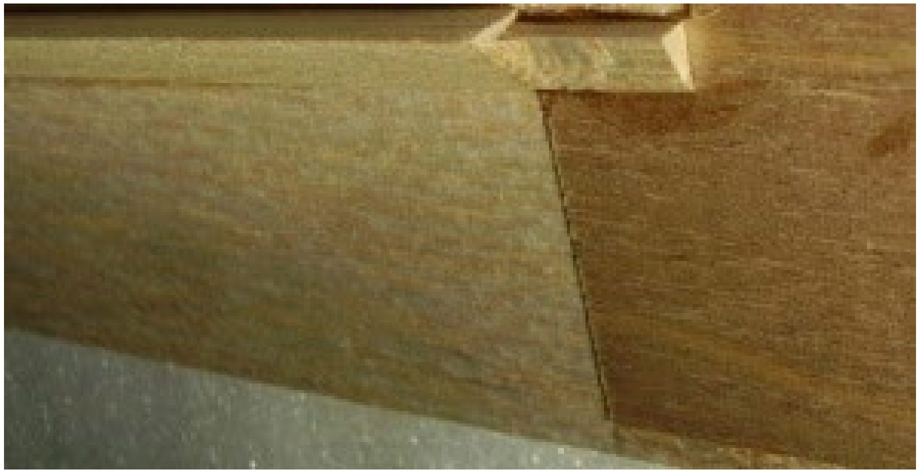


Figure F2. Upper tailboom corner brace installation.

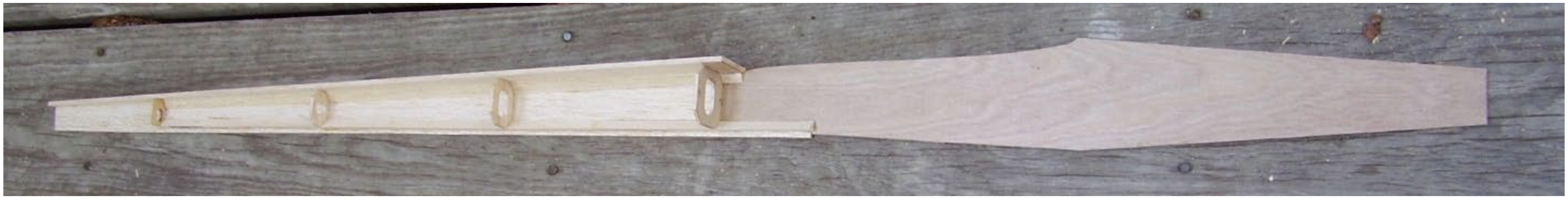


Figure F3: Initial fuselage assembly

Install the bulkheads between the wing trailing edge and the tail tube mount on either the left or right fuselage side.

Install the tailboom top panel.

Your fuselage should look like figure F3 above. (Note, an early prototype is shown. The nose shape is slightly different and the last tail bulkhead is not yet installed.)

Install the opposite fuselage side.

Figure F4 shows the rear wing mount area. This part of the fuselage takes loads from the rear wing mounting tab, so strength is important here.

Figure F4: Rear wing mount area of fuselage, view from underneath

Set the fuselage on the plans, or another straight line reference on your building table, align the tailboom with the reference center line and tape the fuselage to the table using blue painters tape.

Wrap a rubber band around the nose to pull the two sides together. Place the nose bulkhead (F1) between the two sides using the rubber band to clamp it in place. Do not glue it at this point. Insure than the nose is aligned with the plan reference center line.

Install the two front wing mount bulkheads, the wing mount screw plate and the towhook bulkhead. These can be tacked in place using CA before gluing with a high strength epoxy, such as JB Weld.

Once the epoxy has set on the mid-fuselage bulkheads, the nose bulkhead can be glued in place.

Make the nose block. Hollow the center and put in the biggest chunk of lead that will fit. If you can get some tungsten crankshaft weights they are even better, since they are twice as dense as lead.

Install the fuselage nose corner braces, the nose block and the nose bottom panels. Do not install the tailboom bottom panel yet!

Figure F5: Mid-fuselage bulkhead installation

Your fuselage should look like Figure F5. Note that only the towhook bulkhead has been epoxied in place in this photo. Also shown is a mechanical V tail mixer, which was replaced when I upgraded to a modern computer radio.

Shape the bottom of the fuselage nose to the plans contour. A sanding block with 120 grit sandpaper works well to rough in the shape. Once it is close, finish with finer sandpaper. Don't round the corners yet.

NOTE: You may want to do this outside. There's going to be a lot of balsa dust!

Install the tail pushrods. The prototype models use Sullivan S-508 cable pushrods, which have worked well. A small amount of friction in the pushrods is a good thing, as it tends to damp out tail flutter (which has not been a problem in these ships).

Apply a layer of ~3oz. fiberglass to reinforce the rear wing mount area, as shown in Figure F6 below.

Figure F6: Applying fiberglass to the rear wing mount

Fitting the wing to the fuselage:

CAUTION: For the following steps, use a drill press, or very carefully, a hand drill. Motorized drills can get away from you quickly and fixing a drill mistake isn't easy.

Install the wing hold down bolt block between formers 2 and 3 using high strength epoxy.

Place the wing on the fuselage and measure that the wing is centered (left and rights tips are the same distance from the fuselage), then measure from the wingtips to the tip of the tailboom. Align the wing so that the left and right measurements match. Tape the wing in position with blue painters tape. Mark the wing trailing edge on the bottom surface at the fuselage sides as an alignment reference.

Using the wing as a guide, drill a 1/4” hole for the hold down bolt down through the wing and fuselage bolt plate. Remove the wing from the fuselage. Drill the fuselage bolt plate to the correct size for a ¼-20 Tee Nut or threaded insert and install the Tee nut or insert in the fuselage bolt plate.

Install the trailing edge wing hold down tab block as shown in Figure F7 below. Use the alignment marks to locate the block.

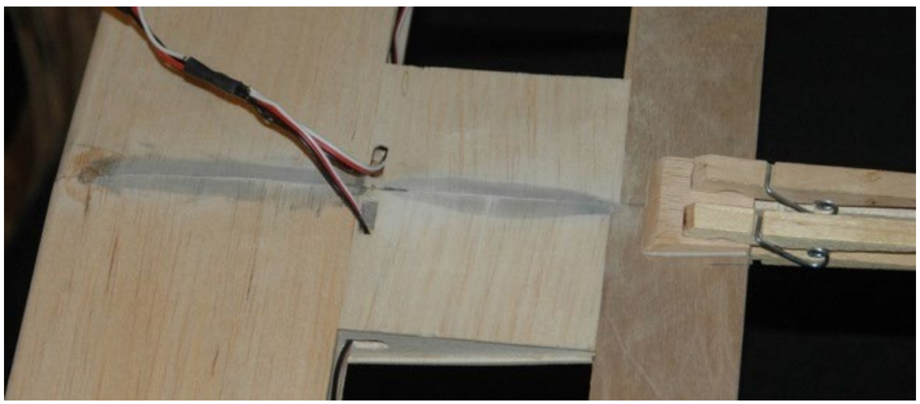


Figure F7: Rear wing mount clamped with clothes pins

After the glue dries, place the wing on the fuselage. Working from inside the fuselage, mark the wing hold down block so it can be trimmed to the required thickness. Trim carefully. It is best to do this in several small steps rather than one big one that goes a little too far.

Glue the wing mounting tab in place on the block. Epoxy or Titebond III works better than CA. The joint will be less brittle.

The mount should look like Figure F8 below.

Figure F8: Rear wing mount tab

The tab and block should fit into the rear of the fuselage with no slop.

Note: The wing mount is designed to allow the rear tab to fail in the event of a really hard landing. This reduces damage to the fuselage and wing structure.

Next fiberglass the wing center joint. I used uni-directional carbon on the 100" wing. If you have it, use it, otherwise 3-5 oz. glass will work fine. See Figures 9 and 10 on the next page.

Note the black spoiler cable guides. These were later removed and servos installed under the spoilers. That worked a lot better.

The servo is for cable operated spoilers, which didn’t work very well.

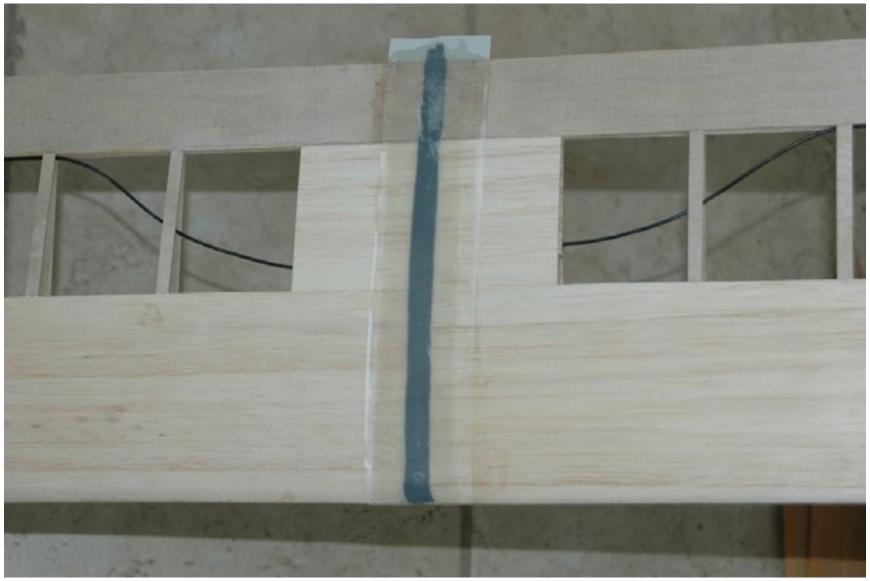


Figure F9: Reinforcing the wing panel joint with carbon fiber tape, fiberglass and peel ply.

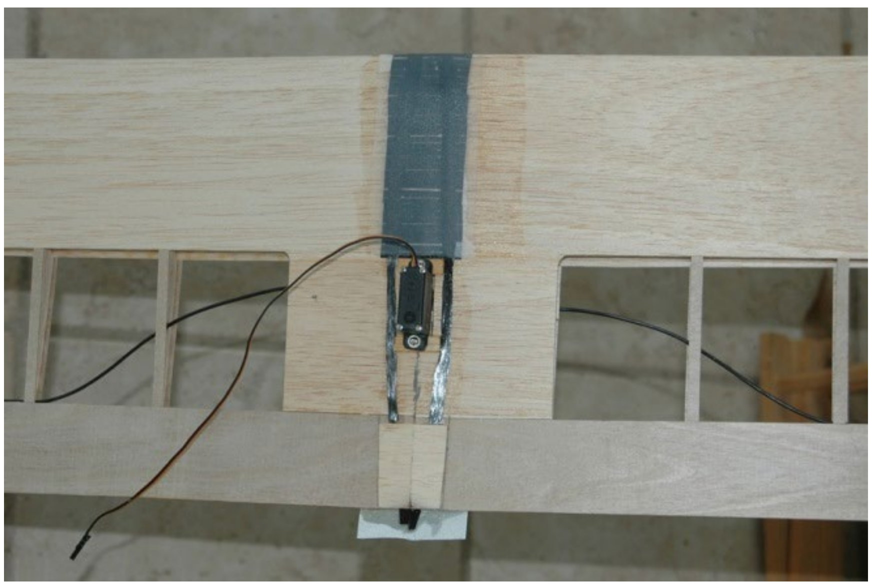


Figure F10: Bottom side of the wing with unidirectional carbon reinforcement being applied.

Leading Edge Templates:

The single most critical step in building a high performance sailplane is getting the wing and tail leading edges shaped correctly. If you get this wrong, your speed range will be narrowed, and you may end up with nasty stall characteristics. In the worst case, your plane will perform poorly at all speeds.

Figure W25 shows a wing half with the templates installed. This can be done either before or after the wing halves are mated. It's your choice.

Figure W25: Wing with lots of leading edge templates

Using a sanding block and 180-220 grit sandpaper, shape the leading edge at the templates first, then work away from them until the entire wing is shaped. A good way to see how you are doing is to hold the wing with the leading edge towards a strong light (like the sun), and slowly rotate the leading edge up and down. Any areas that do not conform to the templates can be seen easily.

Installing the Tail Pivot Tubes:

Cut out the fuselage tail boom between the two plywood tail support bulkheads to allow the tail pivot tube assembly to fit between the bulkheads. The pivot tubes should fit low enough in the tailboom to be fully supported by the bulkheads

CAUTION: Alignment of the Tail Pivot Tubes is critical. By getting this right now, you save yourself a lot of trouble later.

Install the main wing panel on the fuselage and set the model on a flat surface. Put blocks under the wings to level them.

Tape spacers near the trailing and leading edges of the tail surface panels so that the surfaces will be spaced away from the fuselage when the panels are on the pivot tubes. These spacers set the sweep back of the tail, which should be zero. Adjust the front and back spacer thickness to hold the tail and pivot tube at the right angle. See Figure F11. Be sure you have EXACTLY the same space on both the left and right panels!

Apply JB Weld, or other high strength epoxy to the tail pivot tube V joint and the tail support bulkheads.

Set the tail pivot tube in place on the fuselage and slide the tail surfaces (with spacers) on to the tube. Using masking tape, or blue painters tape, tape the tail surfaces to the fuselage near the trailing edge. Using paint cans, wood blocks, or whatever else is handy, prop the tail in position. Measure the height of the tail panel tips off the flat surface to be sure the tail is straight, as shown in Figure F12.

Figure F11: Tail spacers taped to the tail panels

Figure F12: Gluing the tail pivot tubes to the fuselage

Once the epoxy has set, install the tail fairing blocks. Use JB Weld to fasten the tail pivot tube securely to the fairing blocks. The blocks add a lot of support and require a good bond to the tube. Use Titebond III to secure the fairing blocks to the fuselage in all areas except near the pivot tubes. Do NOT final shape the blocks now. Once initial flight tests have established the correct CG and tail panel incidence, then go back and trim the tail fairing blocks to match the tail surface position. Figure F13 shows the blocks installed on the fuselage, and figure F14 shows the final shaped fairing being covered with light glass cloth, which is the last building step.

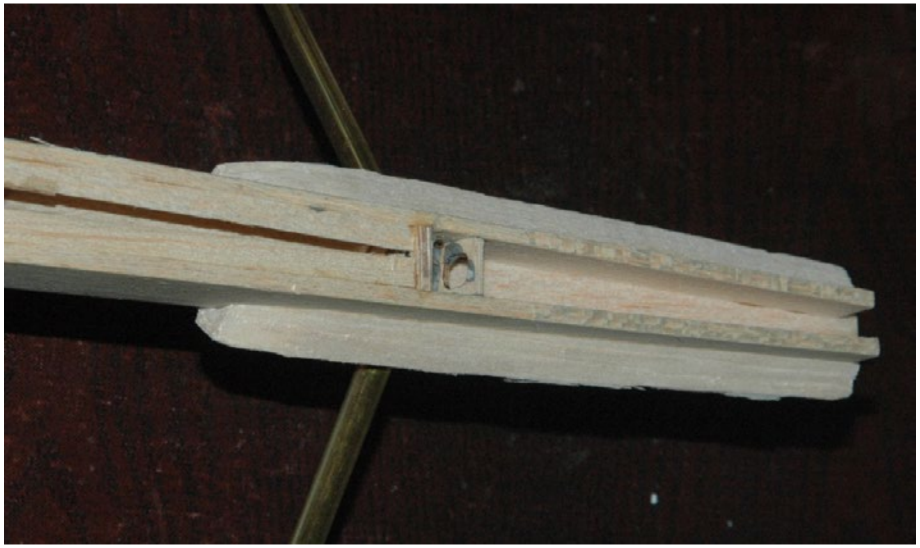


Figure F13: Tail Fairing blocks in position

Figure F14: Tail Fairing Final Shaping and Glassing

Install the bottom tail boom panel using the method below.

With the main wing panel bolted to the fuselage, set the plane upside down on a flat building surface. The plane should be resting on the ends of the main wing panel, and the tips of the tail pivot tube. This assures proper wing-tail alignment (as long as you trimmed your pivot tubes to exactly the same length on both sides). Using Titebond III, glue and pin the 1/8" balsa bottom tail boom panel in place.

Build the hatch cover/canopy.

If you have a really big piece of balsa laying around, the hatch cover can be made in one piece. Otherwise, piece it together from 1/2" soft balsa sheet.

Fit the hatch to the fuselage nose without the wing installed. Once the nose fit is right, put the wing root airfoil template in position on the wing saddle and mark the wing cutout. Once the wing cut is roughed in, install the wing and shape the inside of the hatch cover to clear the wing bolt head. Finish shape the hatch and install the rubber band hook.

Do not be tempted to omit the hold down pin at the front of the hatch. Without it, the hatch can lift open on hard launches, which results in it coming off in flight. The second time this happened to me, the receiver battery came out and hung over the fuselage side by the wires. Luckily, the wires held and the flight ended uneventfully.

Finish the fuselage.

Round all the fuselage corners, then glass the fuselage. The lightest glass cloth you can find will work. The main purpose is to prevent cracks developing from heavy landings and ground loops. Paint on the glass with clear dope. It adds a lot less weight than thinned epoxy, and is plenty strong enough.

Install the radio.

There are no special tricks to the radio installation. Be sure that there is no slop or lost motion in the controls. Solid mount your

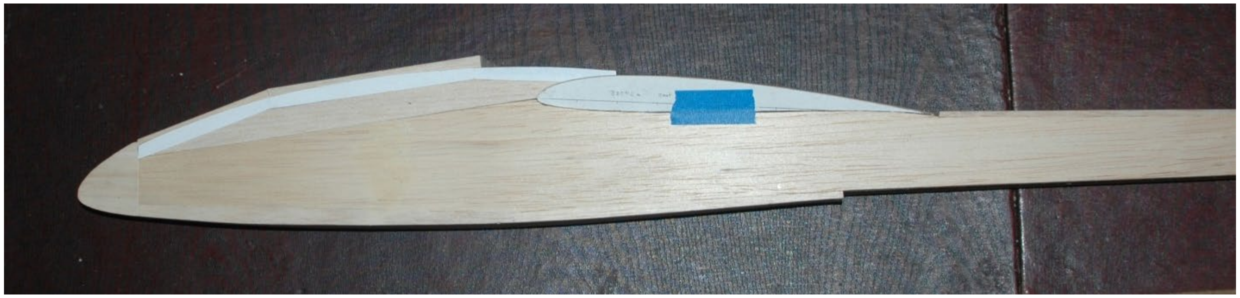


Figure F15: Marking the hatch cover for wing fit

Figure F16: Fitting hatch cover to wing

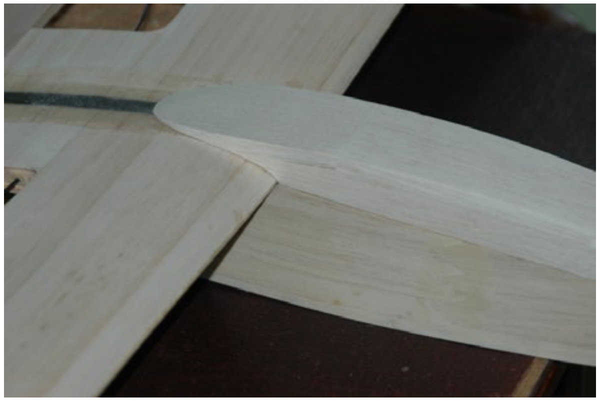


Figure F17: Hatch cover rough shaped

Figure 18: Hatch cover underside

Figure F19: Hatch cover retaining pin

servos. Velcro tape is easy, but it allows the servos to move. A small amount of friction in the tail surface pushrods helps prevent flutter. Too much can cause centering problems.

Setup:

It's difficult to over emphasize the importance of setup. You have worked hard to get this far. Now the difference between a sweet handling, nice flying ship and an annoying, poor performing ship, is a good setup.

Start by adjusting control deflections:

- Elevator: 0.5" up/down, measured at the trailing edge root.
- Rudder: 0.6" up/down

Set these as medium rates, set high rates 25% greater and low 25% less. The initial control deflections will get you through your first flights with a minimum of drama. Check full up elevator on high rate to be sure that the tail surfaces don't collide. Don't be afraid to do some tweaking as you gain experience with your new plane.

As usual, the CG shown on the plans is safely forward of optimum. I like to balance models at the calculated neutral point with a lead slug glued into the nose. This sets the aft CG limit since a Dremel is required to move the CG any further back. On both ships the calculated neutral point is 3.88" aft of the wing root leading edge. To move the CG forward to where you actually want it, tape weights in the nose. The CG “sweet spot” is between 3.5" and 3.7" aft of the wing root leading edge. Pitch stability falls off very rapidly as the CG moves aft of 3.7". These planes become decidedly unfriendly in pitch with very aft CG settings. Working lift with the CG so far back requires large and rapid elevator inputs to keep the model from stalling on every gust. The 100" ship is more sensitive to CG position and control throw. A half ounce change in nose weight makes a big difference. Too nose heavy and turns require a lot of nose up stick to keep speed under control, and the models tend to ignore lift. Too nose light and the plane stalls very easily, especially when working lift. Reduced elevator throw will help with aft CG sensitivity, but then push overs at the top of launch become a problem.

Be sure your spoilers open all the way. The second half of spoiler opening is much more effective than the first.

One particularly helpful option is to mix in a slider for pitch trim. This allows quick elevator adjustments without having to click away on a push button trim. I find it especially helpful for trimming to a faster cruise speed for working back upwind, or quickly changing trim on launch. Additionally, you can put a finger on the slider and know exactly where your trim is set.

Turbulators: The back edge of the tail surface D-box is at 35% chord. This position was chosen because the tail airfoil works well with a turbulator between 35 and 40%. The edge of the D-box forms a small step in the airfoil that serves as a turbulator. At least it did on the first two tails. However, the third tail was built more accurately, in the hope of achieving the lowest possible drag. That ship turned out to have some strange handling issues. The elevator and rudder responded OK at higher speeds, but acted as if there was a lot of exponential programmed in when working lift. Some flights would trim easily while on others the model was impossible to trim. Landing flairs were particularly challenging. The model wouldn’t respond to small elevator inputs when it came time to flair out. Then, as the stick was pulled back the plane would suddenly pitch up and try to stall. Moving the CG and fiddling with control mixes didn’t help at all. After a lot of fruitless experimenting, turbulator strips were installed on the tail panels at 40% chord, just behind the back edge of the D-box. The model was transformed! It suddenly handled great. On its first outing after the fix, it put up an 8 minute flight on an overcast day when every soaring bird in the sky was flapping, even the Mississippi Kites. Better yet, the pilot workload flying that weak, wispy lift was not high.

I would strongly encourage you to install turbulator strips on the stabilizer panels, as shown above. If you decide not to, and experience these handling quirks, get out the pinking shears and electrical tape, and make zig-zag turbulators for the tail!

Making Turbulators:

Most hardware stores stock PVC electrical tape in several colors, so you can pick a color that matches or contrasts with your tail panels, as you like.

Stick a length of the tape to a sheet of waxed paper and cut out the turbulator strip using pinking shears (available from sewing shops or your significant other’s stash of sewing supplies). The exact dimensions of the turbulator strip are not critical.

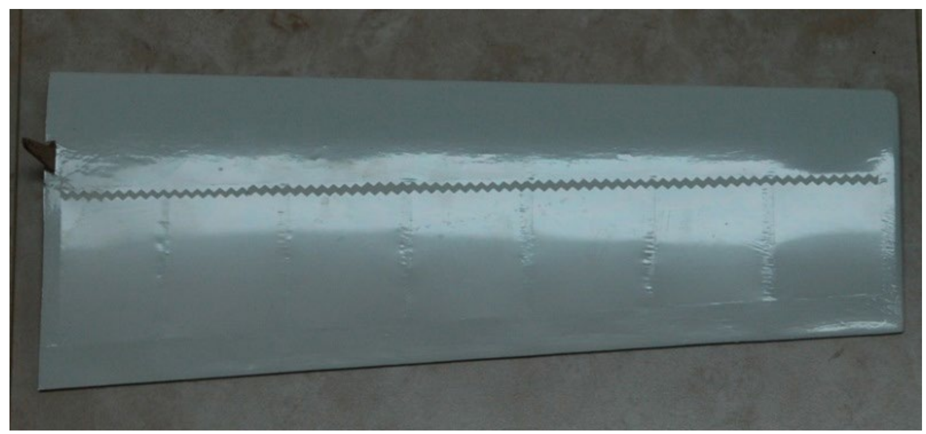


Figure T8: Tail panel with turbulator tape

The most stressful part of building a sailplane – First Flight!

Once the strips are cut, remove the wax paper and place them on to the tail panel as shown in Figure T8. Put strips on both top and bottom surfaces.

NOTE: If you leave the turbulator strip on wax paper more than a few hours, it can get really hard to peel off.

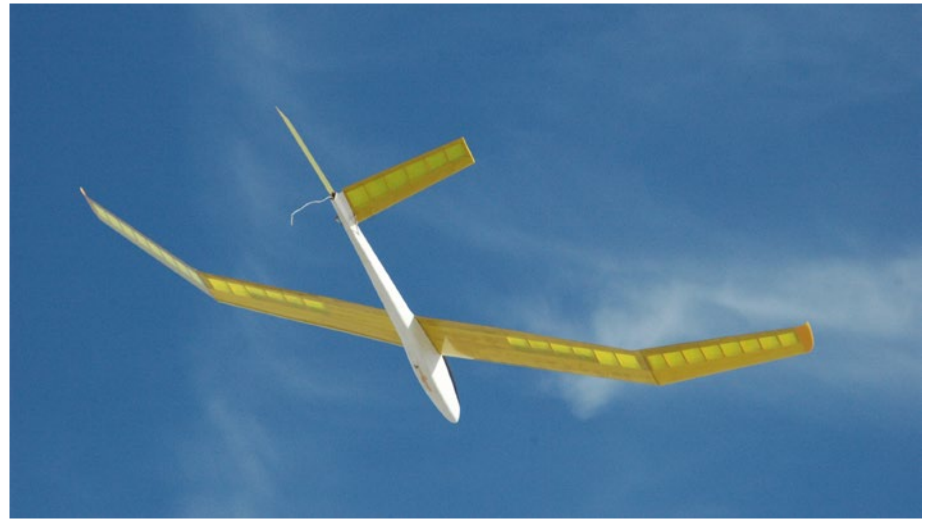
Flying:

Here's the section everybody reads first.

Double check your CG, control throws and control directions (nothing is reversed, is it?). Range check your radio and head to the field. You will want at least 100 yards of space. For the first flights concentrate on holding the fuselage level with elevator control. Chances are you will need to hold some elevator to get the right attitude. If you only have 100 yards and you gave your new plane a good throw, the spoilers will come in handy to prevent overrunning your field. After landing, adjust the elevator neutral setting and fly again. Once the plane is trimmed in pitch, do a couple hands off glides and see that it doesn't want to turn. When it's flying well from hand tosses, hook up the winch or highstart.

The end of a great flying day. All that work pays off!

Launching the Kite 100"



Egret 2 meter

If you launch with a winch, use proper woodie tow technique. The wing is pretty strong, but it isn't unbreakable. With the plan tow hook position, tows are straight and steep. A little up elevator trim can be helpful with a high power launcher. In brisk winds a little nose down trim will prevent popping off the line. There is no tendency to wander left and right. Stalls on tow are pretty much a non-event unless you get a really bad one. The model simply wallows on the line and doesn't climb until you recover. A deep stall on a strong launcher can lead to wing drop and some really high speeds in the recovery.

Not surprisingly, the two wing spans handle differently. It's kind of like climbing out of a 15 meter Discus and into a 20 meter Duo-Discus. You can tell they were designed by the same engineer, but they are not the same airplane!

The 2 meter ship has especially nice control harmony, responding to both rudder and elevator quickly. The 100" model is noticeably more leisurely in turns (but not exactly slow). However the large ship's elevator response is just as quick as the smaller one, maybe a little quicker. Neither plane exhibits the annoying "I just don't want to turn" trait of some RES models.

When conditions are smooth, these models will fly just fine for long periods with no pilot interference. On one test flight, the 100" model was flown through an entire launch until about a minute after release without touching the sticks. The only reason the pilot took control was because the plane was getting awfully far away.

Most important(!), these models don't like to be thrown around. Smooth and steady on the sticks really pays off. Unless conditions are quite rough, these planes only require small control inputs for most situations. Large control deflections bring with them large drag penalties and short flights.

Wing incidence angle is set so the fuselage flies level at best glide speed. If the nose is high, you are slower than best glide. If it's down, you're faster than best L/D. The attitude variation is easy to see in the landing pattern. Higher up, due to the

The Egret 2 meter in a fly-by

fuselage shape the model sometimes appears to be flying nose down when it isn't. This can take a little visual adjustment on the first flights.

Both models have weakly positive spiral stability. They will roll out of a shallow turn after a couple of circles. Steep turns will develop into spiral dives if you aren't paying attention.

Both models hold trimmed airspeeds well. Static pitch stability is positive and quite strong at forward CG positions. Aft of the limits mentioned in the setup section, pitch stability deteriorates quickly and the models can become quite a handful. Also, the further back the CG, the more abrupt stalls become.

Dynamic pitch stability is slightly negative. If you stall and let go of the stick, the dive-zoom-dive-zoom series will gradually get worse until you take control.

Even with the CG way too far back, these models won't spin. At very aft CGs they will tip stall in rough thermals. Recovery is almost instantaneous. I have not had one tip stall in the landing pattern, even in gusty, turbulent conditions, although it is certainly possible at aft CGs.

Unless the CG is very far forward, there is not a lot of warning before the stall break. Neither model will wallow or sink much. Recovery is quick as long as you're paying attention.

Unlike a lot of models, slowing down on final will not appreciably steepen your landing approach. Glide is flat right up to the stall. Conversely, dropping the nose and diving for the ground can lead to some very impressive speeds pretty quickly. If you need to get down, or get out of runaway lift, use spoiler!

Spoilers cause a nose down pitch change, but it is not as pronounced as a lot of models. The trim change is gentle enough that I haven't bothered to mix in elevator compensation. Spoilers will provide plenty of sink in most situations. Sink rates up to 1000 feet per minute are possible by applying full spoiler and pulling the stick back to the left or right corner to produce a spiral dive. Although spoilers increase stall speed slightly, they do not change the plane's mild mannered stall characteristics.

At the other end of the speed range, these models have legs. You can speed up quite a bit before that sinking feeling sets in. If you are moving from typical woodie "gas bag" sailplanes, the wide speed range takes a little adjustment in your flying technique. It allows you to work downwind with a lot more confidence that you'll still get home. It also means you can fly comfortably in winds that had demanded your full attention before. In lift, it is important to keep your speed under control. Letting the nose down even a little will quickly result in fast, big circles and less climb than you could be getting.

NOTE: I am not a fan of the dive test for setting the CG. Airplanes that use low pitch moment airfoils (such as these) will "pass" the dive test with the CG too far back for normal flying. In addition, a clean ship will accelerate very quickly, especially if it does start to tuck nose down. Set your CG by how your plane flies overall, not by how it behaves as it approaches Mach I.

Design changes in prototype development:

Most of the development work was done with the 2M design. The 100" ship incorporates changes listed for the 2M.

Initial version, 2M:

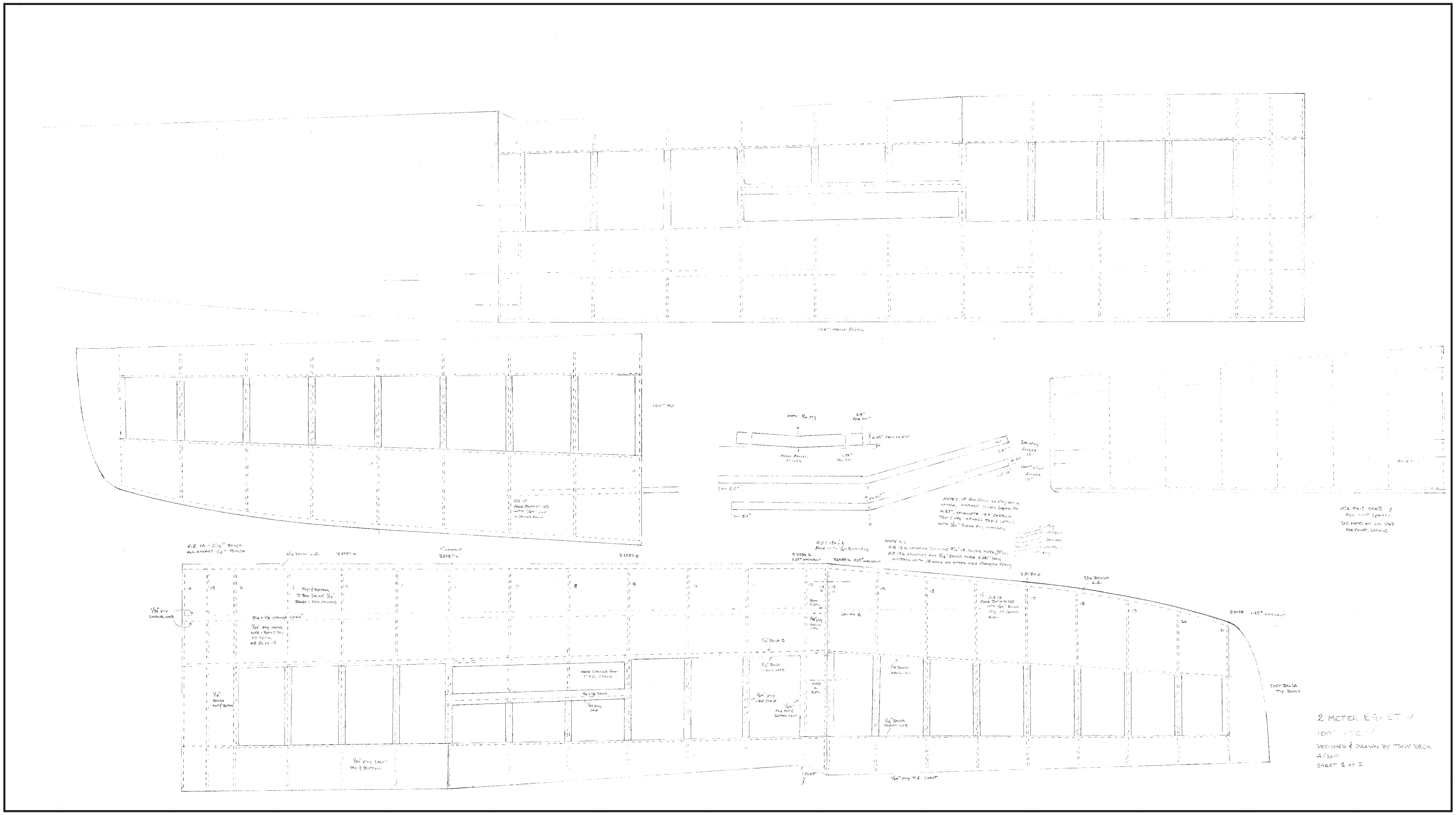
- Center panel of wing sheeted with balsa
- Double main spars in center panel
- Center panel built in one piece
- 16 degrees dihedral in tips
- Tip panels reinforced at joiner
- Straight taper tip panels
- Spoilers operated from single servo with cables
- Stab D-box back edge at 40% chord
- Stab root sheeted with 1/64 ply behind D-box
- Balance weights in stab LE

Tail angle 95^{o}
Mechanical V tail mixer
Flying Weight: 38 oz.

Version 2, 2M
Tip dihedral increased to 18 degrees
Excess structure removed from tips
Tail D-box reduced to 35% chord
Tail LE balance weights removed
Paneling behind D-box on tail removed
Flying weight: 35 oz.

Version 3, 2M
Wing sheeting in center section behind D-box removed
Wing chord at dihedral break increased 1/2"
Second spar at back of D-box removed
Spar shear webs changed to 1/32” and 1/64” ply
Center wing panel built in 2 pieces
Plywood joiner added to wing spar at center break
Fiberglass/carbon added to wing center joint
Tip panels LE changed to elliptical curve
Tip airfoil redesigned and thinned to 7.8%, old 8% tip section moved to mid panel
Mechanical V-tail mixer removed with mixing now in radio
Servos moved under spoilers, no cables
Spoilers changed from built up panels to 1" TE stock
Tail angle changed to 100^{o}
Fuselage nose shape changed to allow building on flat board
Retaining pin added to hatch nose
Flying Weight: 32 oz. (This is the original target weight.)

4/17 rev. 2.3



FULL SIZE PLANS (PDF): http://www.rcsoaringdigest.com/Supplements/Beck-Egret_Kite/Egret_Kite_Plan.pdf

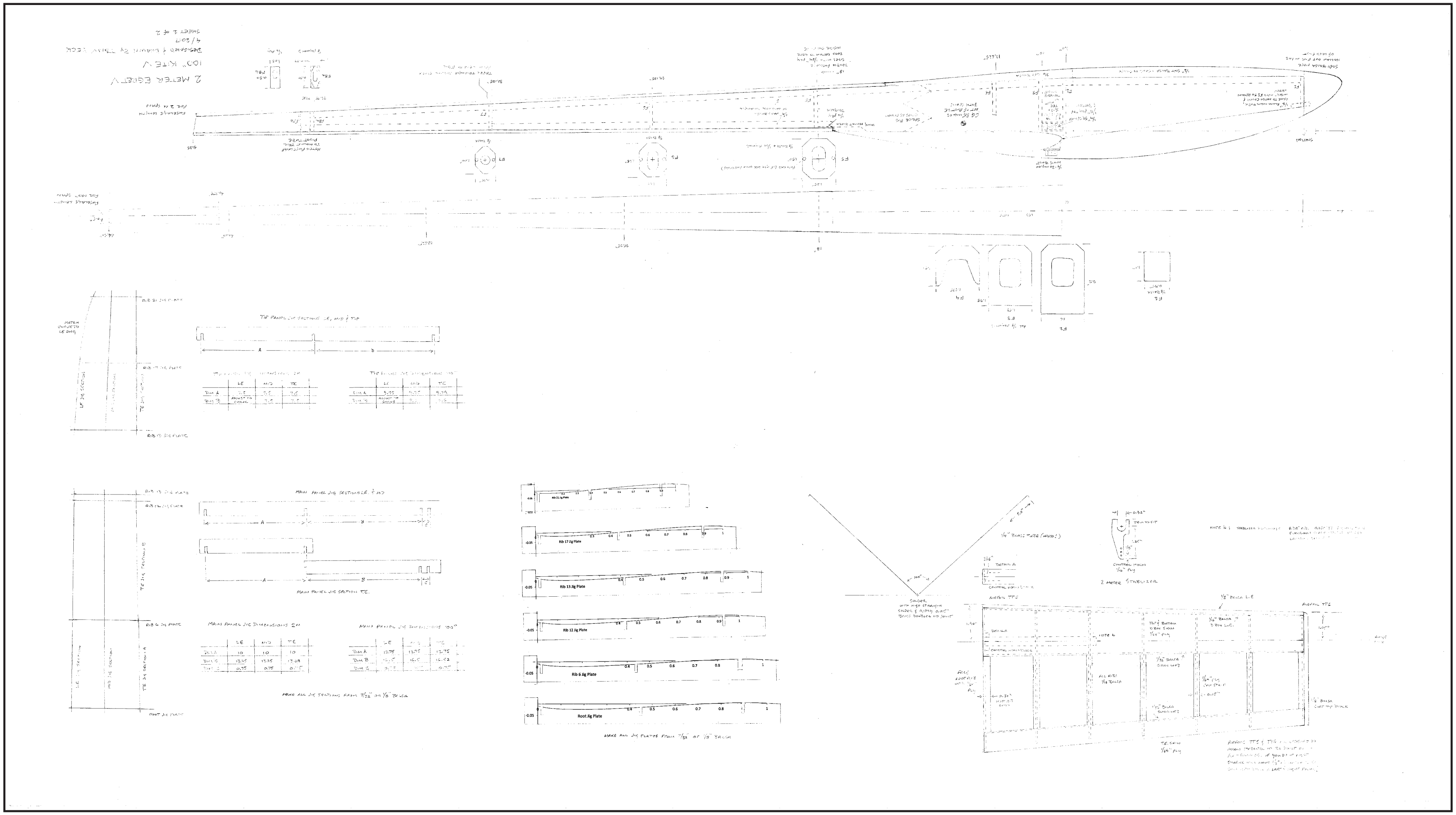
CONSTRUCTION MANUAL (PDF): http://www.rcsoaringdigest.com/Supplements/Beck-Egret_Kite/Construction Manual Rev 2.3.pdf

CONSTRUCTION MANUAL (DOCX): http://www.rcsoaringdigest.com/Supplements/Beck-Egret_Kite/Construction Manual Rev 2.3.docx

COORDINATE FILES (DAT): http://www.rcsoaringdigest.com/Supplements/Beck-Egret_Kite/Coordinates.zip

RIBS AND TEMPLATES (XLS): http://www.rcsoaringdigest.com/Supplements/Beck-Egret_Kite/Ribs_and_Templates.xls

HATCH COVER (JPG): http://www.rcsoaringdigest.com/Supplements/Beck-Egret_Kite/Hatch Cover.jpeg



VIDEOS:

- http://www.rcsoaringdigest.com/Supplements/Beck-Egret_Kite/KiteV 3.MOV
- http://www.rcsoaringdigest.com/Supplements/Beck-Egret_Kite/KiteV 4.MOV
- http://www.rcsoaringdigest.com/Supplements/Beck-Egret_Kite/EgretV_NW.mp4

How to lose or break perfectly good slope planes. Bother.

An embarrassing article by Philip Randolph, amphioxus.philip@gmail.com

Erik Utter holding Philip's ankles for a airplane retrieval from a Chris Erikson Landing Zone. Table Mountain, Eastern Cascades, Washington, 2014. Photo by Chris Erikson

I have personally and extensively researched a number of perfectly good ways to lose or break perfectly good slope planes. I will make a list, so you won't have to read the rest of the article.

1: Trust NiMHi batteries. Well, nobody does this anymore, so proceed to #2.

2: Fly an improperly balanced model. CG too far aft makes for uncontrollable pitch instability.

3: Fly an improperly trimmed model. Too much up or down or it won't go straight and you are fighting to keep it level and then…

4a: Toss model without checking for correct control surface movement. You may get lucky.

4b: Toss model with ailerons or elevator reversed. You won't get lucky. Duh. (I stubbornly rebuilt the nose of a micro ASK-21 tossed off steep and rocky Timberwolf Mtn, fifteen miles east of Mt. Rainier.)

4c: Rates too high for expert pilot skill. (See below, as this example isn't about me.)

4d: Fly a model without preset flight modes for different conditions. (Please don't see below).

5: Fly in places with disastrous landing zones. (Duly designated members of CEWAMS call these 'Chris Erikson rock piles.' Note: CEWAMS stands [or sits, or falls over] for Chris Erikson's Wild Arsed Mountain Slopers. Or for Central and Eastern WAshington Mountain Slopers. Or Mostly Sillyheads. Or for something else, perhaps. The first name was to besmirch the fearless leader of our non-organization, known on Slopeflyer.com as 'Intrepid Slope Site Explorer…' If you can call his rock piles slope sites. Gawrd. Last month in 20 mph winds at Wahatis Peak, Eastern Washington, I saw him land a Cub crosswise to a bit of road surrounded by four-foot boulders. Should have taken a picture. I had to twist his arm to get him to an LZ a little more forgiving.)

6: Fly a properly trimmed model! without a failsafe receiver. "Gawrd it flies nice!" you say, when its battery has apparently died, as it disappears over the horizon.

7a: Fly anywhere near Erik Utter, who laughs when his 48" chevron rips the V-tail quite surgically off Sanders' Art Hobbies 60" thing.

7b: Other mid-air collisions. (2003, Eagle Butte. I'm still new, so Adam Weston maidens a 60" Fun One I bought from Pete Heinze. Quote: "It flies great. I'll take it in for a fast pass." The green Boomerang 48" EPP chevron that greeted it was undamaged.)

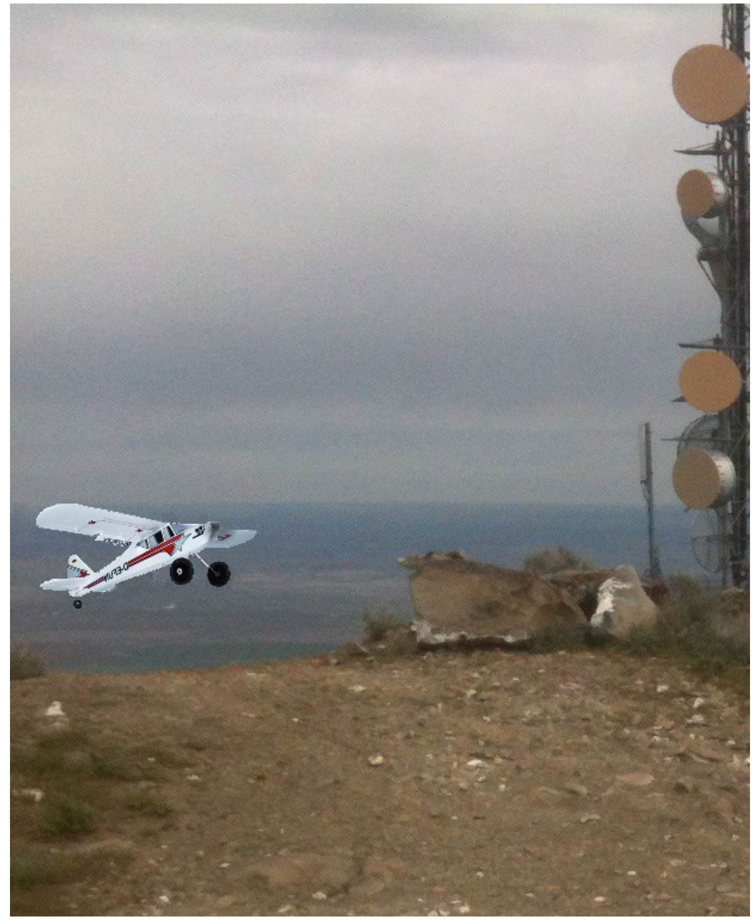
8: Swat at a fly and drop your transmitter.

9a: Take your eyes off your plane, just for a moment. (2010. Never saw the little Weasel again.)

9b. Fly plane in front of sun. Burn retinas. Try flying a retinal shadow and then yell, "Where's my plane."

10: Get mixed up and start flying someone else's plane. When it doesn't respond, push harder on the stick, and ignore the thud somewhere in the trees behind you. (At Table Mountain, Cascades. There wasn't much left of Sanders' Banshee.)

11: Attempt dynamic soaring. Nuf said. (Well, I did inherit a 34" Red Herring that met a tree. I saw the video of it doing great DS loops at Quartz Mountain in the Cascades. Then it hit. Being



Tawdry composite photo-shop of an actual event, Wahatis Peak, Eastern Washington, April 23, 2017. Chris Erikson landed his 55" Multiplex Fun Cub right in front of that boulder, straight into 20 mph winds. He aimed it crosswise to the road right at the rock, got it close and dropped it on those big tires. No damage. The foreground was filled by two motorcycles, one ATV, two local girls, one local guy, and Philip. Missed us all. Composite and landscape photo by Chris Erikson. Multiplex Fun Cub photo bootlegged off their website. They haven't rewarded us for voluntary - and blatantly commercial - product placement (hint hint -- it's not too late). Great plane. It even glided well with the motor off.

Recovered Banshee remnants

EPP it's not in bad condition. But every bit of electronics were ripped right out of it, disappeared, gone.)

12: When sink happens, listen to Chris Erikson, who says, "You can save it. The lift is out farther. Commit!" (Yeah, well he lost his first 6' foamie 'Sheetrock' delta with early FPV gear looking for lift below Rampart Ridge, Snoqualmie Pass, Cascades. Probably about 2002. Below is forest. I looked for a JW of Adam's there, maybe 2008. Moral: Ditch. Don't commit. But I know you will.)

13: Trust that the guy you bought it from did an okay job with the linkages.

14: As a newbie, shove JR servo horns onto Hitec servos just before a slope combat in 2002. (I crashed a lot. It wouldn't stay trimmed. They felt okay, but slipped under pressure. Gawrd.)

15: Fly next to Chris Erikson, who still flies 72MHz with a long antenna which he pokes in your face like an extension of gesticulating hands while he tries to talk and fly at the same time. Lose control.

16: Listen to Chris Erikson talk about finding a soft landing zone for his Easy Glider. And then it hits you. Give him grief about you being a soft landing zone. (Saddle Mountain, 2017.)

17a: Fail to turn the toy airplane thingy on. (Does not always apply: When I was learning, maybe 2001, with a 2m Highlander, one of the best flights I did off the launch winch was when the plane was off. It soared in great circles and landed smoothly on the grass. But this violates rule number 5. If it had been better trimmed it would have gone straight, to who knows where.)

17b: No range test. (Does this fit here?)

17c: Fail to turn on the transmitter thingy.

17d: Turn the transmitter thingy on to the wrong model. May work, but probly not.

17e: Forget the transmitter. (Two days ago, as I write. 17 miles away, at home, when going to the flying field. But it preserves rather than destroys airplanes, so delete this suggestion.)

18a: Exceeding pilot skill level. Pilot error.

18b: Pilot lack of skill. (Doesn't apply to me. Well, maybe. Well, okay.)

19: Blowbacks. (See the attached fuzzy photo of Dave Yardis walking out of the woods with three planes some other guys lost. We found two of the owners, who didn't want them back.)

While helping to for my (permanently lost) fuselage Dave Yardis finds the remains of three planes blown back behind a ridge. Bald Butte, Oregon, 2015.

20. FPV. Second nature for gamers, but death to us old farts.

21a. Try to fly the thing through a bleacher. (My nephew, and a Gentle Lady. Also Erik Utter, many years back.)

Dave Yardis and recovered aircraft no one wanted.

21b. Try to fly the thing through a hill. (Okay, Chris was flying this fabulous prototype V-Wing designed by Marvin Totenberg, but it was bigger and had a larger turning radius than he was used to, so when he did a circle toward the hill the pesky hill interrupted it, and it didn't fly well after that. See "Slope Soaring Update," produced by Erik Utter, narrated by yours truly, Gawrd.)

21c, or 22, or something. Zagi Death Spiral and flat spins. See Slope Soaring Update. Gawrd.

23. Be in range of Lauren's kid Dave when he throws rocks at it, or tries to hit it with a stick. And succeeds. (Whidbey Island, about 2005.)

24. Potato guns. Yep.

25: No lost model alarm, and no phone number scribbled on the thing.

26: Kevlar tan, carbon black, and other camo-colored airplanes are harder to find than say, bright pink.

27a: Too much wind. (Saddle Mountain, 2008. 50 mph. I put a pound of ballast in a 48" JW plank. It's the only thing that will penetrate. But landing it rips its nose off.) Exceeded pilot skill level. (Eagle Butte, 2002 or so. 60 - 72 mph winds. Bill Henley is walking back with what was a 12' winspand glider. Nothing longer than 30 inches.)

27b: Too much wind. (We're all camped in a double basalt amphitheater in the Columbia River Gorge, Eastern Washington. It's like a big scoop. Bill Henley has a truck to sleep in and a Coleman tent staked to the ground to keep his airplanes in. Winds rock the trucks and swirl between basalt walls. Bill's tent attempts to fly without turning the transmitter on. Maybe that's a free-flight thing. Three guys tackle the tent as it rips off its tie downs. Airplane destruction and mayhem and broken things, too, like a DLG. Coleman gave Bill another tent, but. Bother.)

28: Not enough lift. (North Cascades, Chris Erikson is determined to fly his solid wood Thorn. He tosses it several times. It goes down. Minor damage.)

29: Hanger rash. (2009. I flopped an Encore 60" into the bed of my truck. Drove. Something shifted. Crunch. Wing re-bagged.)

30: When she tells you to grow up.

31: Dog parks. (I chased the dog. It said, "Oh boy. He throws me a stick." It only left tooth marks in one elevon of my 34" Red Herring [foamy delta]. It's owner said, "But she's a bird dog.")

32: Biological infestations. Like, those tall tree things that get in the way.

Perceptive readers of the above list will have recognized that the greatest risk of losing or breaking planes is caused by flying them. You do not want to lose or break your planes. Therefore it is logical that you should not fly planes. It follows that since you persist in flying planes you are not logical. You are not a rational being. But you are probably an engineer, in which case you think you are rational, which is a symptom.

Fortunately you have stopped reading because the above list was adequate. So I don't have to worry about being embarrassed by all the planes I've stupidly lost or broke and have described below because you have stopped reading. Plus, I have omitted a few, and have attempted to embarrass a couple other CEWAMS to dilute the unfortunate attentions upon your author's mistakes:

Re. #1, NiMHi batteries, planes trimmed too well, and no failsafe Rx: I lost 1.5 perfectly good planes to those damned NiMHi batteries. Okay, on the slope each had flown fine for a while. And then I'd recharge them. Now, Erik Utter had some, charged violently, and they worked. Quote: "I treat my batteries like 'bad'." Triton charger, maybe that was the difference? I was always trying to charge them slowly. My Multiplex charger would say, "Yep, full charge. Took a bunch of mAHs." My battery tester would say, "Yep, full charge." And then. I've never had a problem with NiCads or Lithiums.

60" carbon wing V-tail Blazer: 6 years ago at Bald Butte, in northern Oregon, a few minutes into a flight it stops responding. It is too well trimmed. It flies straight. It doesn't have a failsafe to put it into a spiral. It heads off to the left and behind the ridge. I run after it. I think I see about where it went into huge tall douglas fir. I charge into the woods. I see its carbon wing flutter down. I climbed to the top of the tree, about 100' up, to where its top was busted off. Never saw the fuselage again. Bother. But five years later Dave Yardis found the remains of three other gliders which had blown back in about the same direction.

48" foamie Zipper (plank) knock-off, northern Cascades: Same deal. It stopped responding. I watched it all the way to the next ridge. About 8 years ago.

Re. #4d, #6 and #25 Lack of flight-mode presets for different conditions. Too well trimmed. No failsafe. No LMA.: Pterodactyl 60", Timberwolf Ridge, 6000', east of Mt. Rainier: I had this nasty looking fuse that I called 'Rock Bouncer.' Our late Tony Paszek had filled the electronics and added a V-tail. I bolted on a 60" wing Tor had bagged and painted with eagle feathers. It had winglets. Somehow we called it the Pterodactyl. I didn't think it would fly great, but I was wrong. Very fast, in huge lift. I kept giving it down trim, for speed. And then the lift died. Well, I should have had an alternate flight mode for minimum sink. I didn't. So it was going too fast and sinking too fast for a sink cycle. Chris was saying, "Commit! You can find lift!" Well down on a talus slope it was going out of sight, so I tried to put it in gently. It disappeared. 2.4 GHz means 'line of sight radio contact only.' My guess is that instead of crashing it regained flight attitude and flew downhill for a mile or three. Too well trimmed. Camo colors. No LMA. No failsafe to stop it from flying into oblivion. No phone number, in case some hunter or a moose found it.

Re. #2 Improperly balanced model: Jade Shogun, 2016, Saddle Mountain, Eastern Washington: Someone had built this thing with forward swept wings. I got it for free. Eventually I would find that the proper CG was ridiculously far forward, but not before pitching into Chris Erikson rock piles and tumbling downwind, shedding balsa. Months later it looked really futuristic-military in the air, far enough out so all the bumps and patches weren't visible.

Colibri V with a 44" carbon and Kevlar wing, Saddle Mountain: It needed just a bit more lead in the nose. It was slightly twitchy, but I figured I could handle it. But then on the inner part of a circle…did it catch an odd bit of turbulence or was it pilot error? It dove. I pulled back on the stick to stop it from crashing hard, but it was out of sight below the curve of the hill. It had an LMA. No beeps. A couple of us covered the area. I went back a month later and walked the miles below the cliffs. I figured

The remains of Chris Erikson's 28" F9F Panther.

I prevented it from crashing, but out of site it flew off into the distance. No failsafe to guide it down in circles. No bright colors to make it easy to find. Just a bit more lead and maybe it would have been forgiving enough for me to keep it up.

Re. #3 Improperly trimmed model: Models are easiest to fly when they mostly fly themselves. When out of trim they can be impossible, or just twitchy enough so you are more apt to get into trouble.

May, 2016, Saddle Mountain, Eastern Washington: 38" EFX Racer, fast 43" electric. I had the elevator trim way to far up. Uncontrollable. I put it back together.

April, 2017, Saddle Mountain: Chris Erikson is flying a 28" F9F Panther, electric ducted fan. It flies great. Fast. Handles 20 mph winds easily. But then he tries to land it. The roll rates are uncontrollably high. It turns into smaller chunks of foam. Too high roll rates obviated a controlled landing.

2m foamy Highlander: 2003. Gentleman Bill H. convinced me this should be my first plane, and that I should build it with ailerons. A bunch of the SASS club were flying Whidbey Island sites, in north Puget Sound. Quote, from Adam Weston: "That's too hot a plane for you." Someone would help me get it into trim, but then I'd crash it, and it wouldn't be in trim anymore. Out of trim it was impossible. Duh.

Re. #32 Biological infestations: 2m foamy Highlander, 2005: Rampart Ridge, Snoqualmie Pass, Cascades. I put it 50 feet up a tree. I came back a month later with climbing spikes and a belt. Got it.

Banshee (48" plank), 2007: We're flying stuff from above a 200' cliff at Grayback Mountain, southern Washington. Erik Utter has just built a Banshee. It flies great, for five minutes. From the talus a couple hundred feet below the cliffs soars a 140' imPondersable Pine. Erik puts his Banshee about 120' up. A year later it is a pile of mouse-chewed foam and tape at the bottom of the tree. He puts it back together with foaming Gorilla glue, more tape, and a coroplast political sign.

After year in a tree, a winter's snow, and mice. Two days later he flew it.

Immorality: Recent psychological species studies indicate that humans are unrealistically optimistic. Such optimism keeps us keeping on, while realism would make us whine dismally like Eeyore and feel too dismal to put together another toy airplane. Since you and I keep flying toy airplanes we are not realists. Therefore we are not rational. Not being rational we don't have to accept this. Which is more fun.

The above is a rational argument. By my standards. Or lack.

Heh.

Slope Soaring Candidate

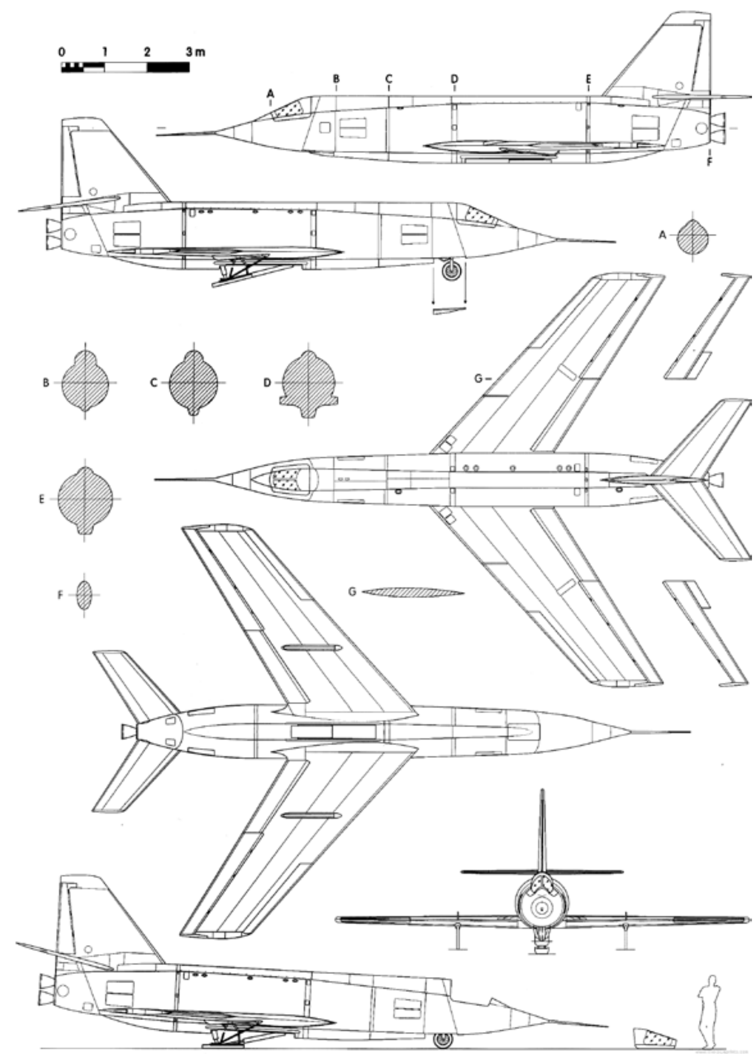
Bell X-2 “Starbuster”

The Bell X-2 “Starbuster” developed in 1945 by the Bell Aircraft Corporation in conjunction with the U.S. Air Force and NACA, the National Advisory Committee for Aeronautics. Designed to explore flight in the range of Mach 2-3, the X-2 was powered by a two-chamber XLR25 rocket engine and featured swept back wings. Two were built.

One X-2 was destroyed in an in-flight explosion which occurred during a captive flight while testing the liquid oxygen system. The wreckage was never recovered from Lake Ontario.

Dropped from a B-50 “mother ship,” the throttleable rocket engine took Lt. Col. Frank K. “Pete” Everest to Mach 2.87 (1,900 mph, 3050 km/h). Iven C. Kincheloe flew the X-2 to a peak altitude of 126,200 ft (38,466 m), and Milburn G. “Mel” Apt was able to reach Mach 3.2 (2,094 mph, 3,370 km/h) at 65,500 ft (19,960 m). Apt for some reason attempted to make a banking turn at Mach 3 and lost control of the aircraft. He safely ejected but was killed when he failed to leave the ejection capsule and open his parachute. The X-2 program was cancelled following Apt’s accident.

Wingspan: 32 ft 3 in (9.8 m)
Length: 37 ft 10 in (11.5 m)
Height: 11 ft 10 in (3.6 m)
Wing area: 260 ft² (24.2 m²)
Airfoil: 2S-50 bicon
Empty weight: 12,375 lb (5,600 kg)
Loaded weight: 24,910 lb (11,300 kg)
Maximum speed: Mach 3.196 (2,094 mph, 3,370 km/h)



https://www.the-blueprints.com/blueprints/modernplanes/bell/75745/view/bell_x-2_starbuster/

PANELLING A WING WITH PLYWOOD

A video course by John Greenfield
<http://www.scalesoaring.co.uk/VINTAGE/HintsTips/Articles/Ply Panelling/Wing sheeting.html>

The Scale Soaring UK web site has archived all 23 of the *RCSD* sailplane walk-arounds for easy access by scale modellers. These walk-arounds are excerpted from the magazine in their entirety, and the file size is relatively small. Identified by a small photo, finding documentation for a sailplane of interest is easy. <http://www.scalesoaring.co.uk/RCSD/RCSD.html> when you get the chance.

In addition to the *RCSD* walk-around archive, Scale Soaring UK also features a plethora hints and tips for scale modellers. A topic of interest to us, the use of heat-bonding sheeting to an underlying rib structure, is covered in five videos created by John Greenfield. These are downloadable from Scale Soaring UK web site at the URL noted in the title.

John built a 1:2 scale Wein and used the techniques shown in the videos to form the plywood leading edge of the model.

These videos cover the creation of the scarf joints for joining panels to cover longer spans, applying PVA glue to the rib structure and sheeting, and fixing the sheeting using heat.

The videos are 3 to 5 1/2 minutes each. Numbers 1 and 2 are 1280 x 720; 3, 4 and 5 are 1920 x 1080. The largest video is under 130MB in size and all are downloadable MP4 files.

To further pique your interest, here are some screen grabs from the videos...

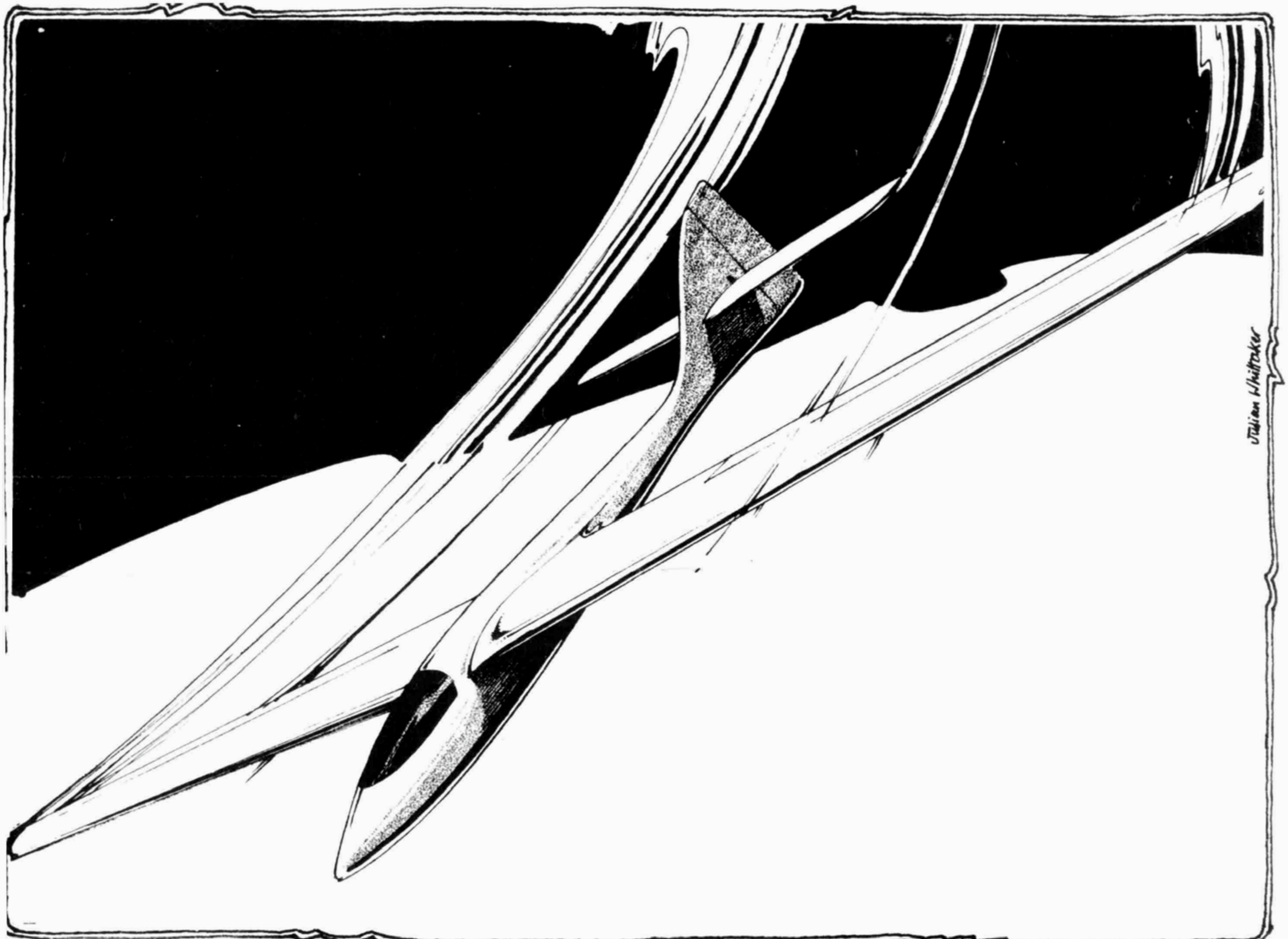
1 - Prepare the plywood by sanding the scarf joint on the edge of the panels

2 - Applying the glue safely to the wing and panel

3 - Fixing the plywood to the top of the wing

4 - Preparing the underside with glue

5 - Bending the panel around the Leading Edge and fixing the sheet to the underside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