Electric 1/6 scale radio controlled DH-84 Dragon-2

By Rodger Farley, Columbia Maryland

Specifications

Wingspan = 94.66", airfoil = 10.3% flat-bottomed with slight re-flexed trailing edge
Length = 68.6"
Wing area = 1700 square inches
Weight = 14.5 lbs take-off weight, 12.5 lbs without motor batteries
Wing loading = 19.6 oz/ square foot
Static thrust ~ 10 lbs; Static thrust / weight ratio ~ 0.7

Power system

Motors = AXI 2826-10 brushless outrunners, 35-40 amps current each
Props = APC 11x5.5 props
Batteries = Poly-Quest TW 4350XP-45 Li-Po batteries (14.8 volt 4350 milli-amp-hour)
Controllers: = Jeti Advance 77 Opto plus controllers
Endurance ~ 10 minutes with a mixture of throttle settings
Note for the power system: there are 2 of everything, completely independent twin engines. Brushless motors rely on the feedback of the individual motor to know when to commutate the windings, thus the independence.

Construction

This is not a simple project, but the construction techniques individually are simple. The fuselage is built very light but strong, somewhat like a large stick&tissue model, but with 1/64 ply instead of tissue paper. Balsawood, basswood, 1/64 3-lam plywood, 1/8" liteply, and aluminum are the basic materials. Flying surfaces are covered in Sig Koverall Dacron fabric attached with butyrate dope. Struts are K&S streamlined aluminum 0.5" tubing with hardwood end plugs. Finishing was accomplished with Lusterkote butyrate spray, first several coats of white primer, then dark red for the fuselage and aluminum for the flying surfaces. A clear lacquer sealer was used over all

after the decals were attached. The decals were drawn up on the computer, and then printed out on paper. Carefully cut out with an x-acto knife, they were attached with a glue stick. Adhesives used were thin and medium CA adhesive, sometimes mixed with wood flour for forming strong fillets. Form the fillets with smooth saw dust first, then drizzle thin CA over it, then back away from it while it rapidly cooks! There is a 1.5 deg down thrust for both motors and a 2.5 deg right offset only for the starboard motor. Since these are relatively un-tapered wings, tip stall was not as great a concern as it is with the DH 89 Rapide, so only 1deg of washout was used in the outer wind panels. With high aspect ratio wings, the chord width is relatively narrow (mean aerodynamic chord = 9") making the center of gravity placement fairly sensitive (3/8" too far back will be deadly). Small 1/8" dowels were glued to the bottom of the fuselage corresponding to the horizontal location of the c.g. when the passenger window line is level. This was used as a rocker level to determine the final position of the batteries in their 1/8" ply battery boxes. The landing gear is rigid except for the 4" balloon tires, so landings have to be pretty good. The tail wheel is custom built from 0.040" aluminum sheet, and unlike the free-castoring full scale version, this one is steerable with a spring isolation system. Control is affected with Kevlar kite strings terminating at bell cranks, avoiding long metallic lengths of wire which could affect the antenna reception.

Flying characteristics

Since the tail feathers are of scale size, they can be unduly influenced by the prop-wash when going slow. This means carefully ramping up the throttle while the plane gains speed and control. It has surprising performance on takeoff, but you must be prepared to give some down elevator as the prop-wash blankets the horizontal stabilizer and tries to pitch the nose up. It is not very aerobatic, and I would urge one not to do more than a wing-over. I have done rolls and low-g flip loops, but I may be pushing my luck…Turns are best done with some rudder coordination, but it is forgiving in that respect. Stalls are gentle with some small nose drop. Landings are easy, but the flare should be fairly smooth as the landing gear is rigid. Switch to low rates for landing so as to to over excite the pitch response. It likes both wheel and 3-point landings. In the air with its light wing loading, it has a very stately presence.

History of this particular aircraft

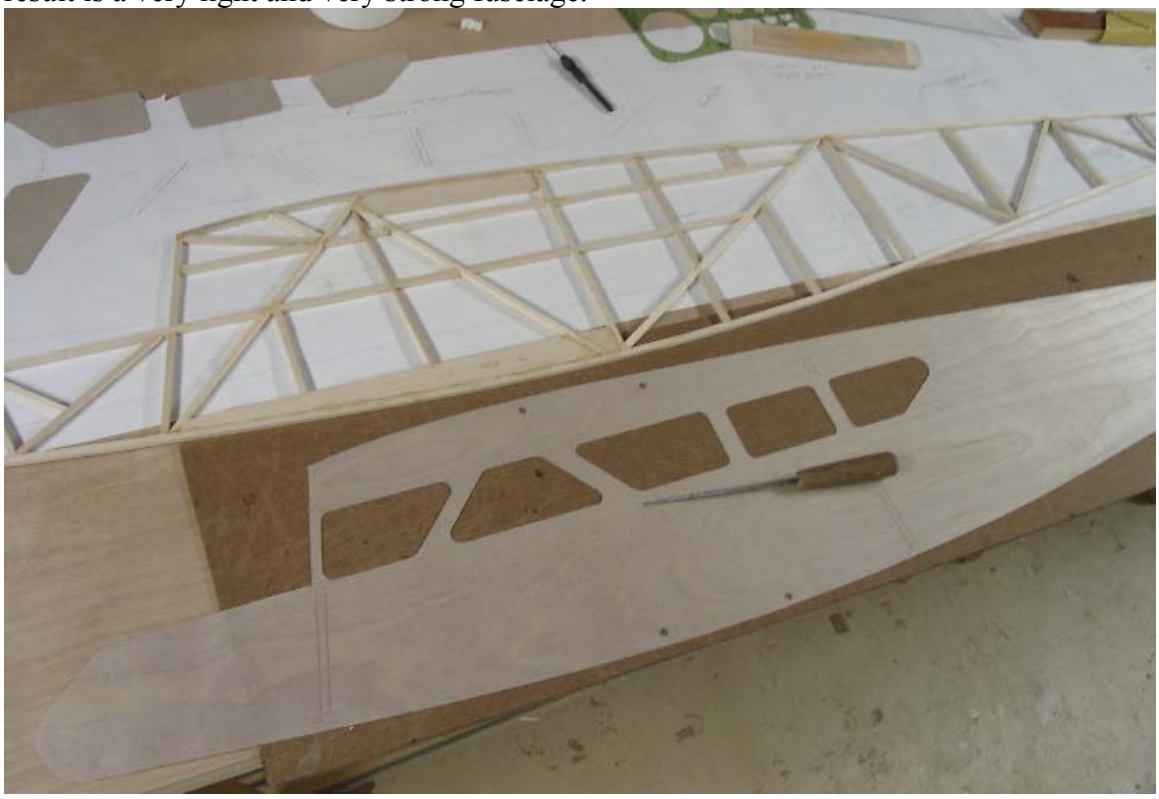
Built by de Havilland in Hatfield in 1934, certification number 6077, this aircraft was originally G-ACRF and was owned and operated by Aircrafts Pty Ltd (APL, forerunner of Queensland Airways) in 1936. It was mostly destroyed in 1954 by a crash and fire at Archerfield. It has undergone a superb restoration by owner Des Porter and was re-registered as VH-UXG.

Then in 1935…

…and now in 2005

Photo log of the 1/6 scale model construction

Light frame made with 1/4x1/4 balsa and basswood is then covered with a skin of 1/64 plywood. This plywood is very easy to work with, as it can be cut with scissors. The result is a very light and very strong fuselage.

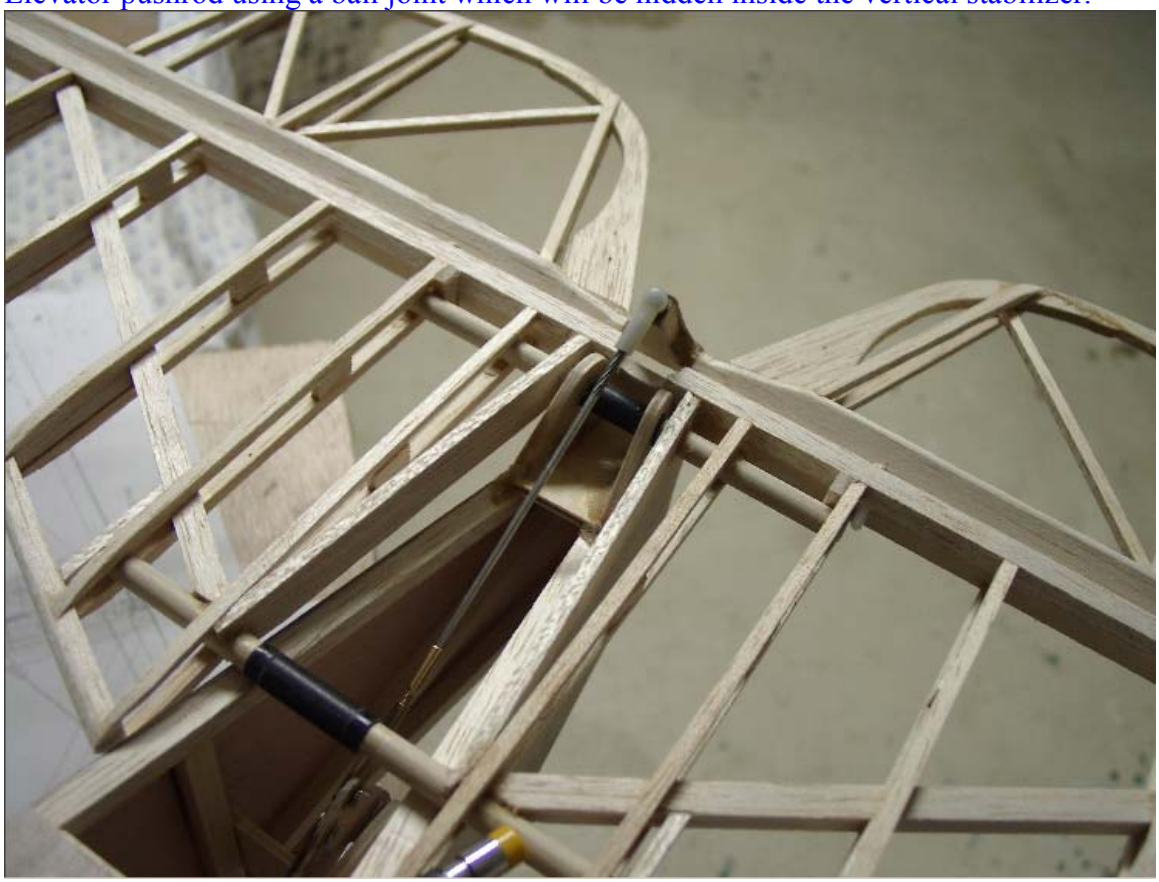


The 2 halves are then connected along the only two full fuselage bulkheads, with spacing cross sticks added. The fuselage structure is mostly self-jigging, but have a care…

The top 1/64 ply sheeting needs to be “tortured” into place, afterwards buckling breaks are glued on the inside for the areas that have “oil-canned”. The overhanging thin ply is trimmed off after gluing, then sanded smooth.

Bottom view before sheeting in 1/64 ply

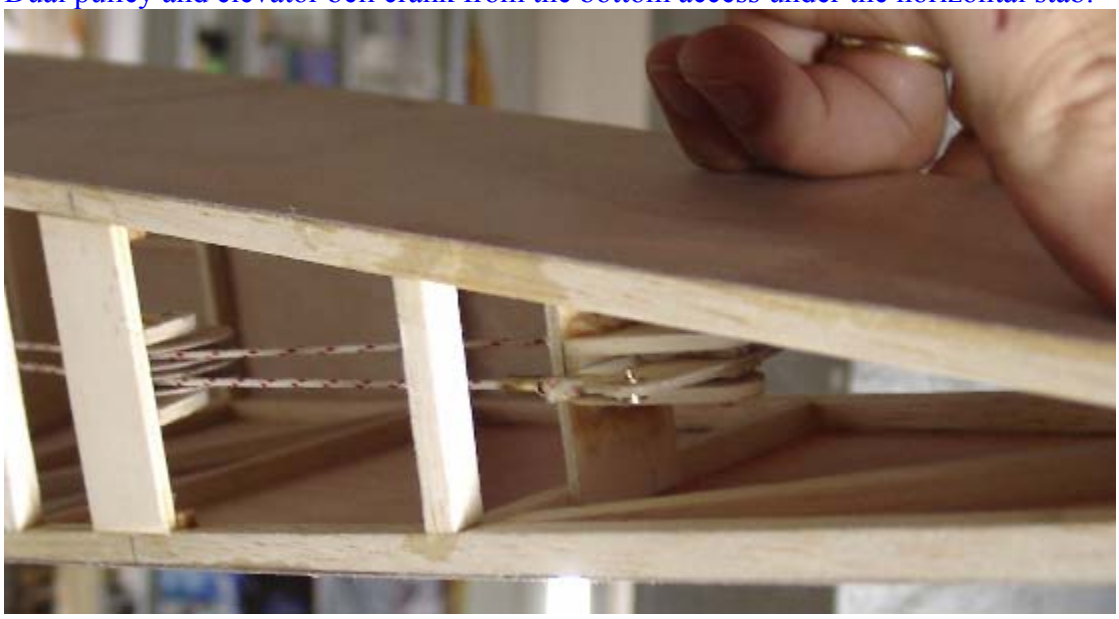
Elevator pushrod using a ball joint which will be hidden inside the vertical stabilizer.



Partial sheeting of the bottom showing where the access panels will be.

Vertical stabilizer sheeted with 1/64 ply. Also visible is the horizontal stabilizer incidence trim.

Dual pulley and elevator bell crank from the bottom access under the horizontal stab.



Aluminum reinforcement mount points for the tail wires.

Tail wheel bracket made from 0.040” aircraft sheet aluminum

Cockpit wind screen bow made with basswood and graphite reinforcement.

Inboard wing panel with center section sheeted for nacelle construction.

Under view of the landing gear and nacelle structure

First steps in constructing the removable motor cover using block balsa and 1/16 sheet

Nacelle motor cover sanded

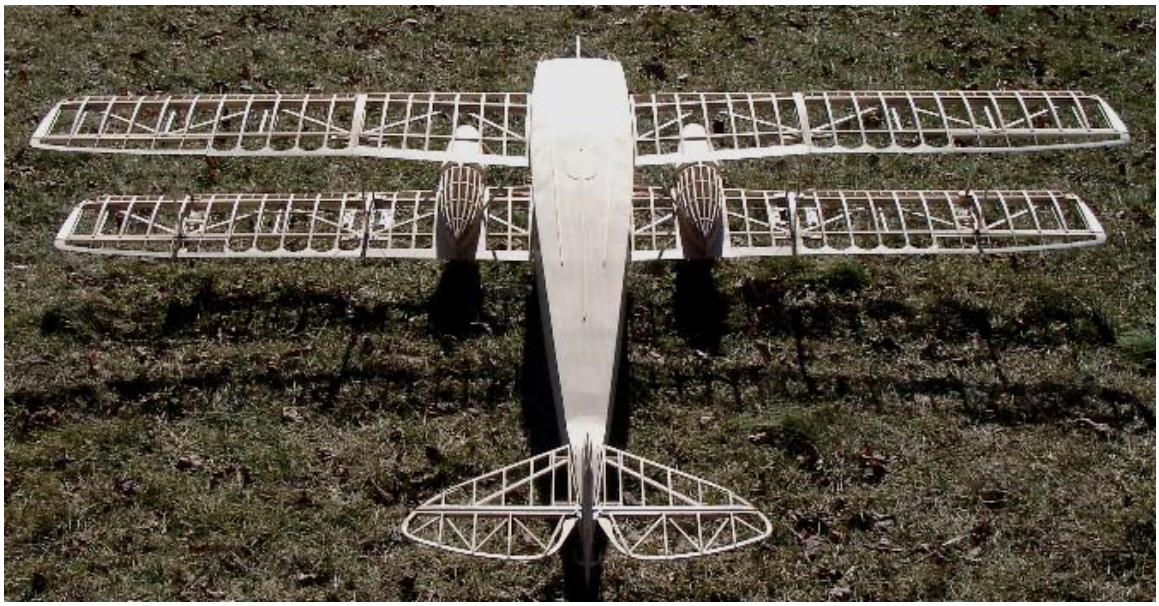
Diagonal strut interface to fuselage using cotter pins epoxied into upper fuse frames

Top aft nacelle structure showing the frames and 1/64 ply skirt sheeting

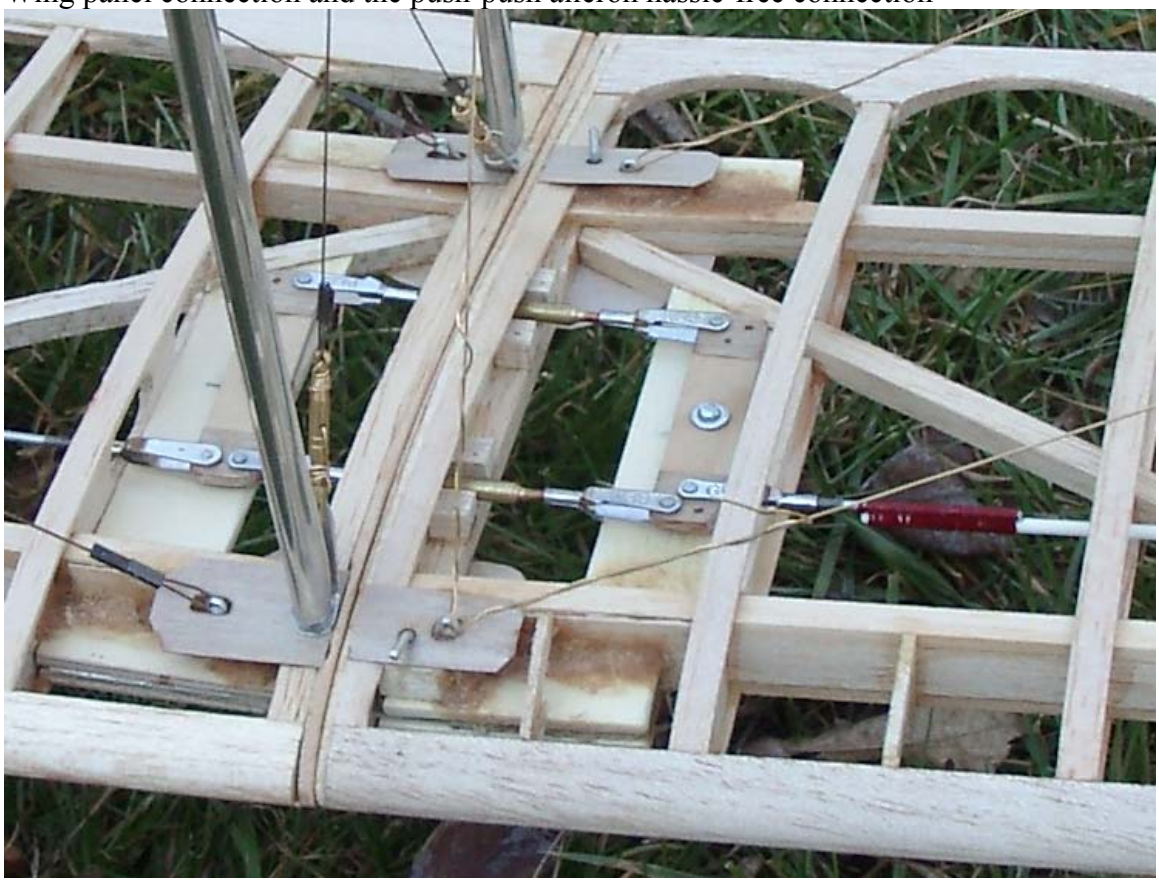
Bottom view showing access hatches and foam aft nacelle fairing

Beginning of outer wing panel construction which starts with a basic bridge frame

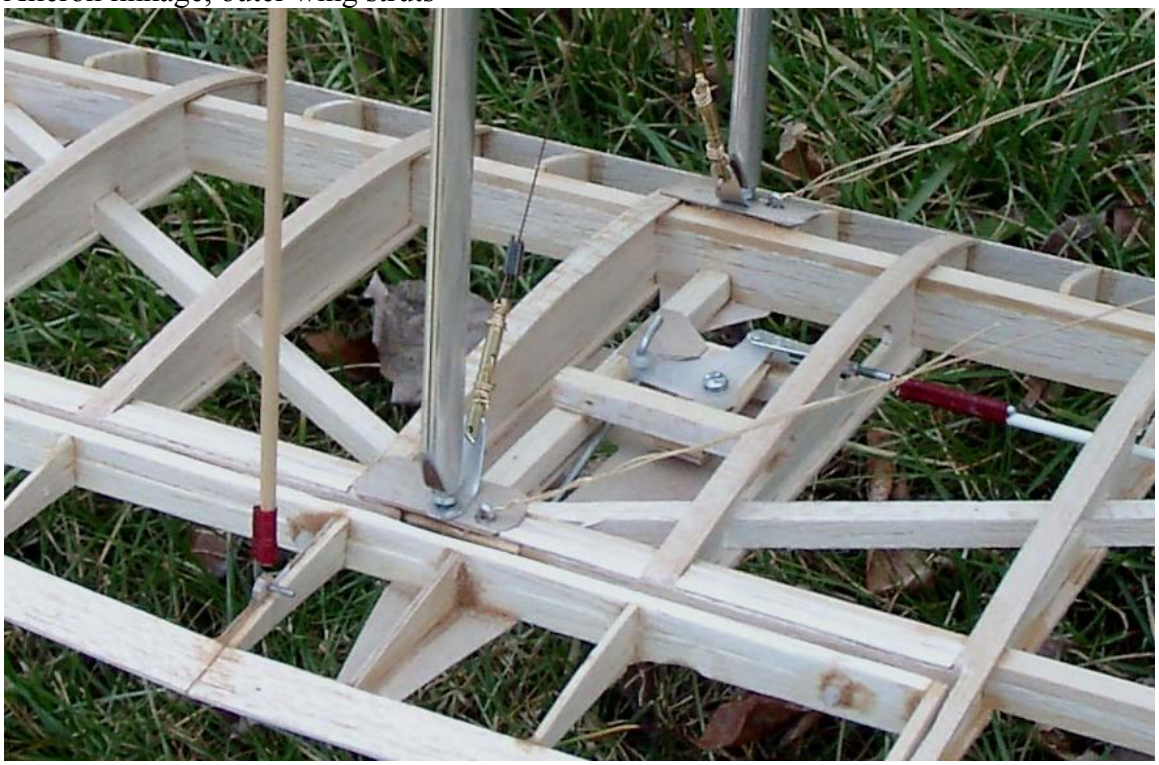
Nice skeletal view



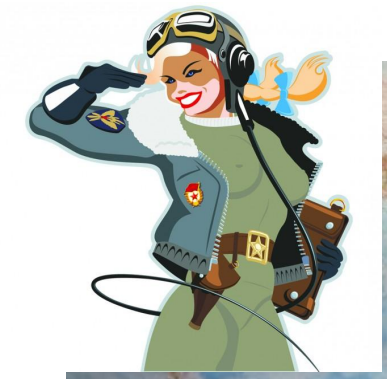
Wing panel connection and the push-push aileron hassle-free connection

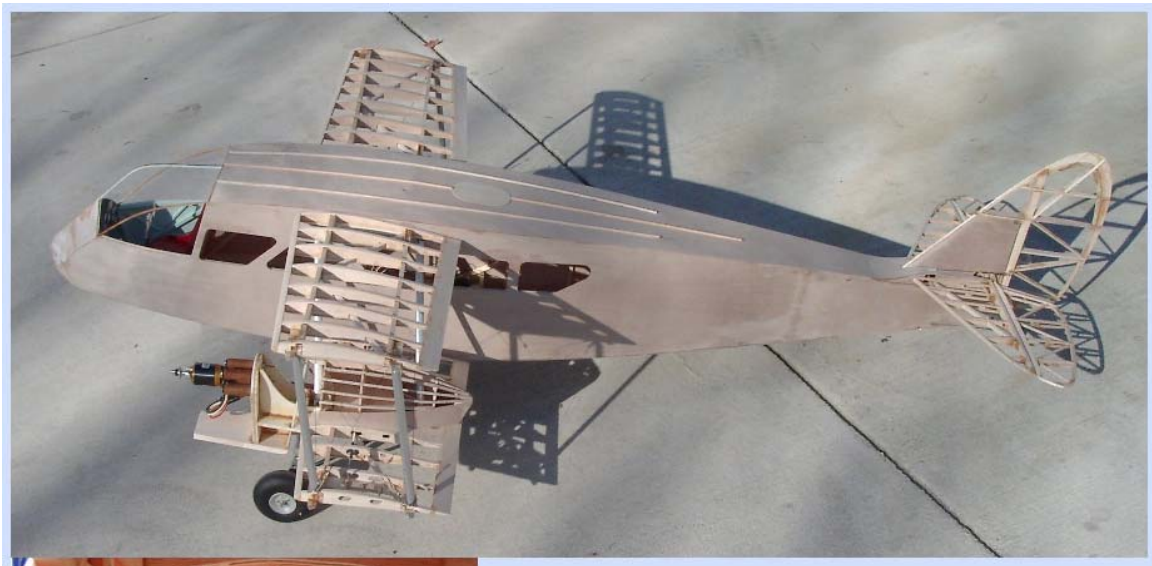


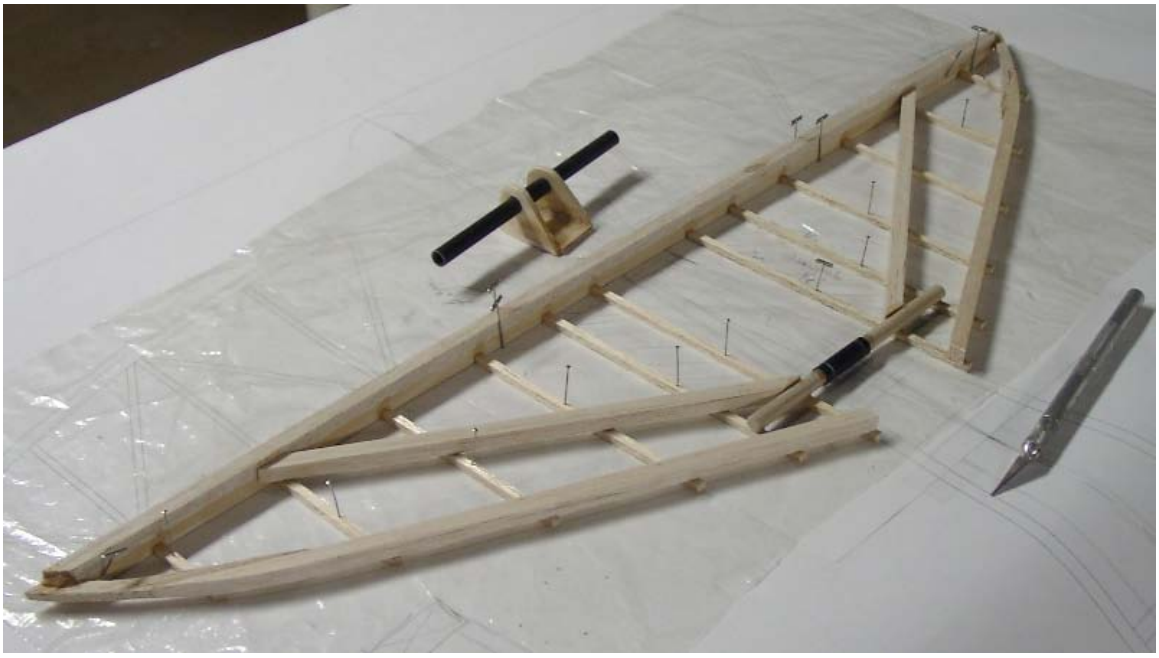
Aileron linkage, outer wing struts

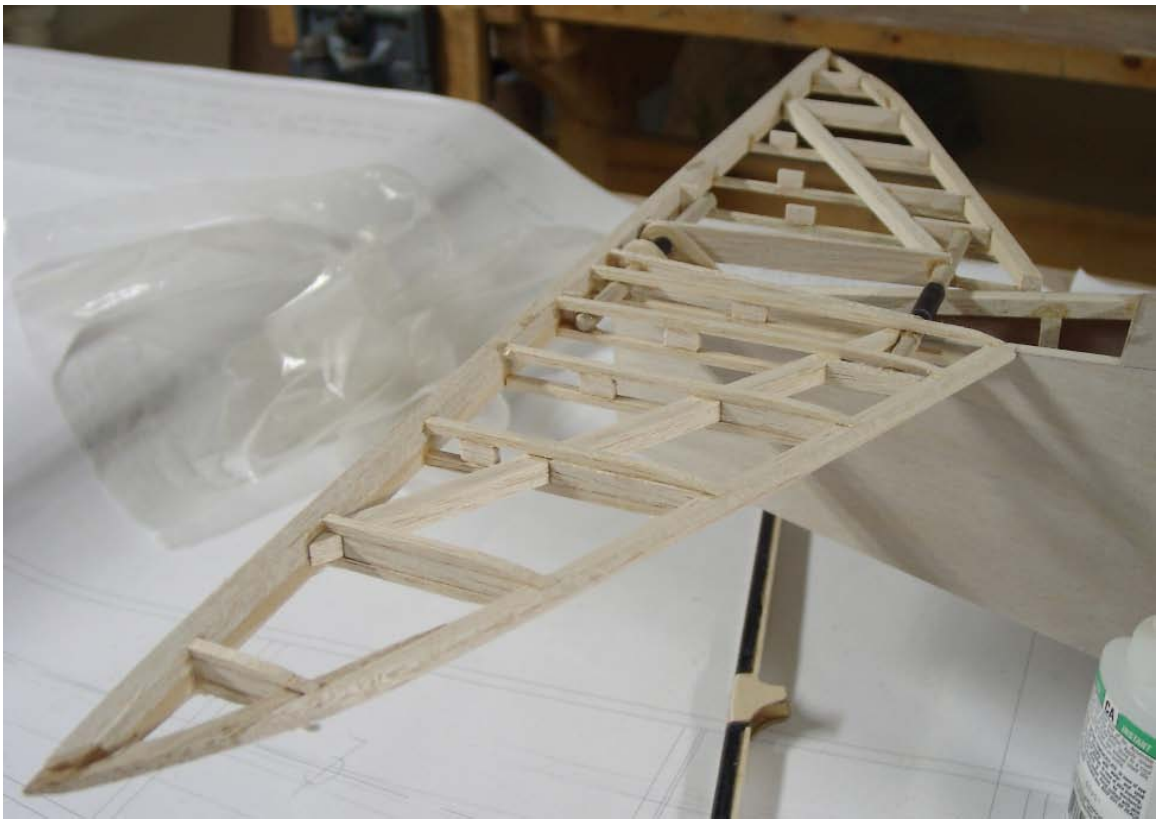


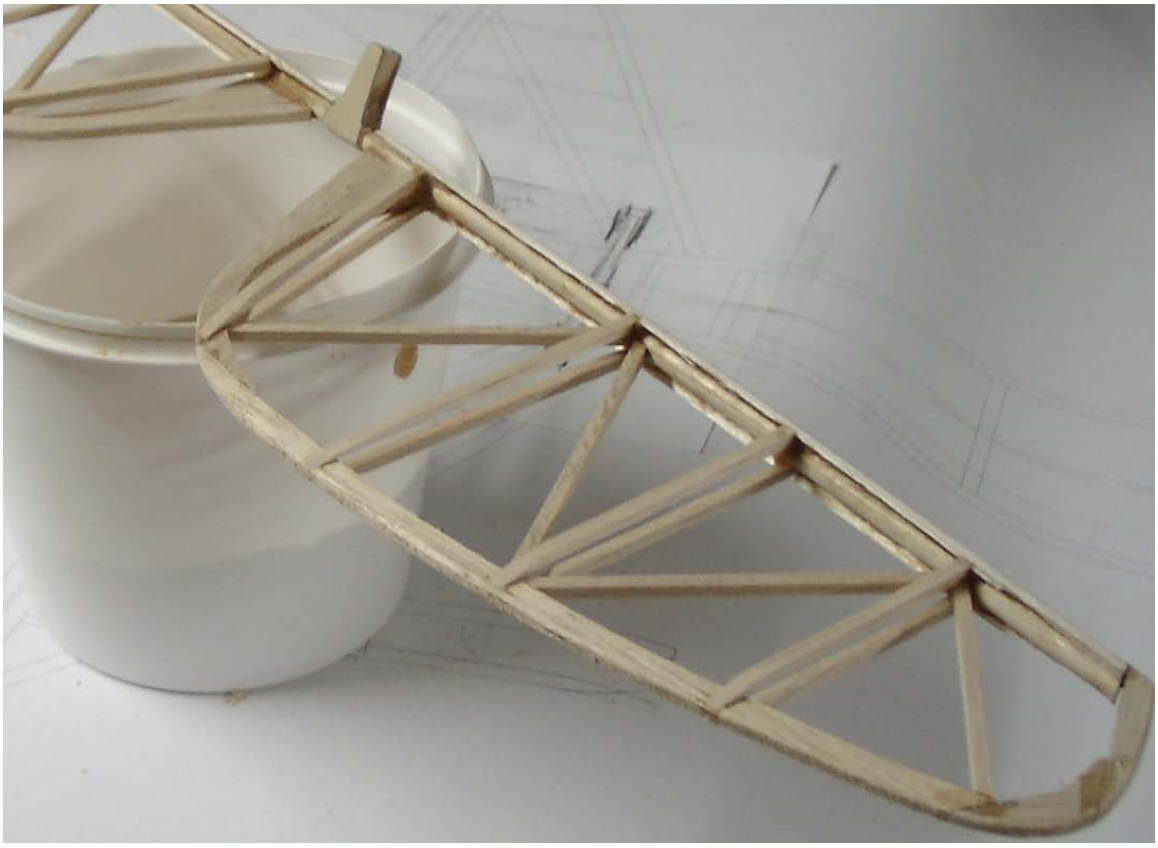
A view of the inside shot thru the cockpit looking aft.





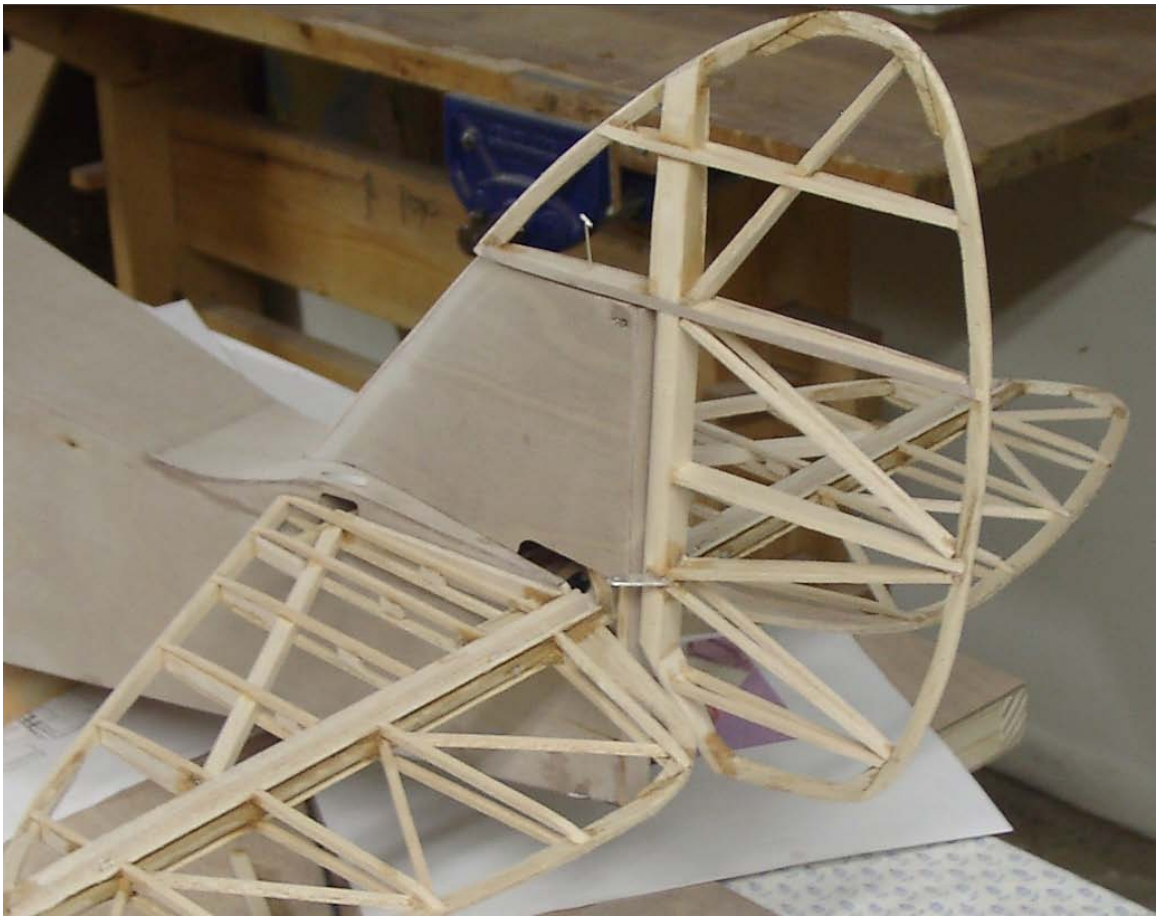






Notice that the elevator horn is made with a hard wood middle spacer and laminating ply sides connecting to the dowel elevator spar. This dowel has a "vee" of balsa for a L.E. The middle spacer then gets a metal ball-end screwed into the top for the control rod connection.

The elevator horn and connection is then hidden inside the hollow vertical stab which is covered with 1/64 ply

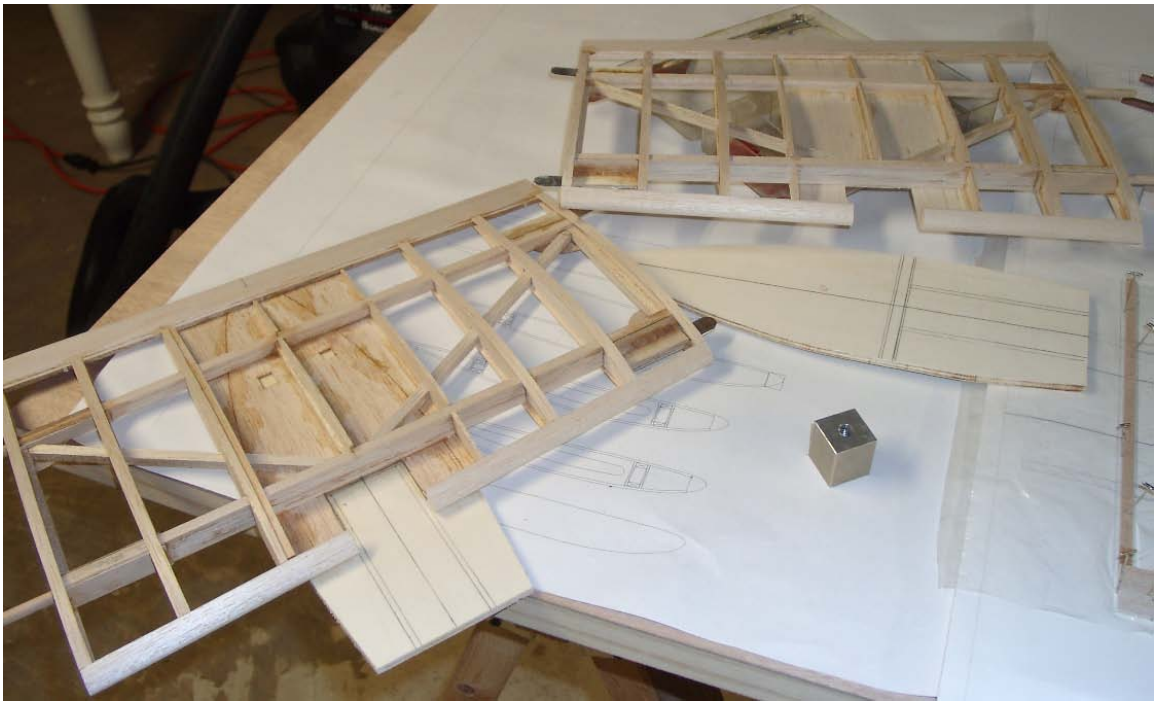


Rudder horn made from 0.040" aluminum, attached to vertical post with mixture of wood flour and thin CA. Dust in the wood flour (fine saw dust), then add drops of thin CA.

Beginning the inner wing panel by laying down the cap strips first, then gluing the spars and leading edge to them.

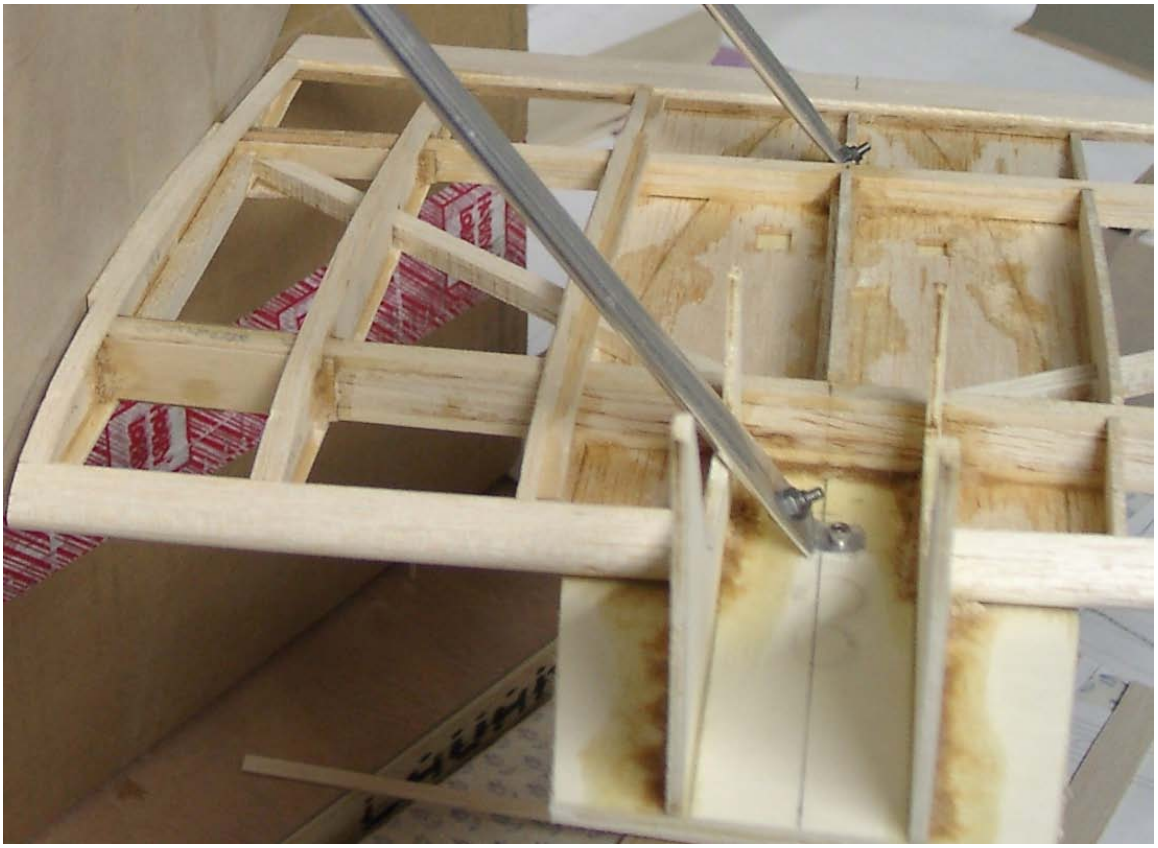
Add the bridging structure

Add ribs, and finish off with the top cap strips. The ribs need to have custom cut outs for the bridging structure

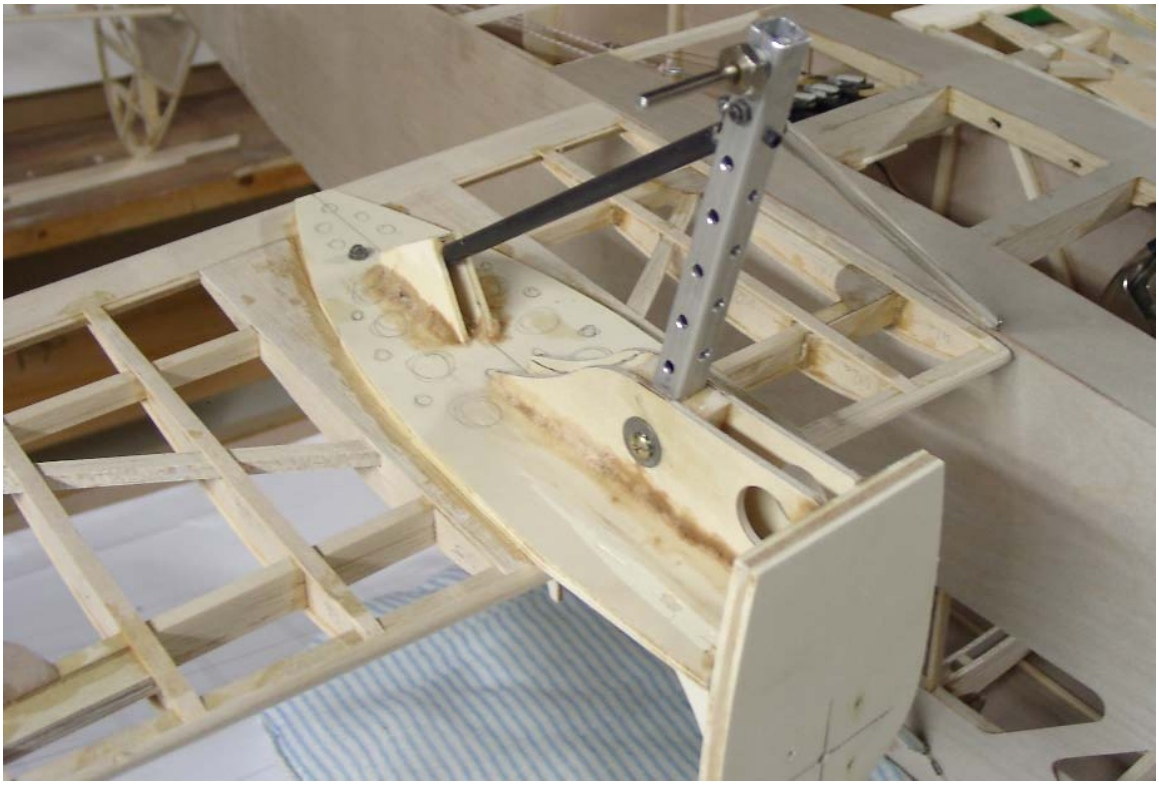


With the fuselage level, glue in the bottom inner wing panels using the dowel rods for alignment and attachment. This ties the wing with a shear path, but the struts and guy wires produce the rest of the load path, just like the real thing. If the wings don't line up with the drawn-on airfoils on the 1/64 ply, then adjust the fuse holes with a rat-tail file

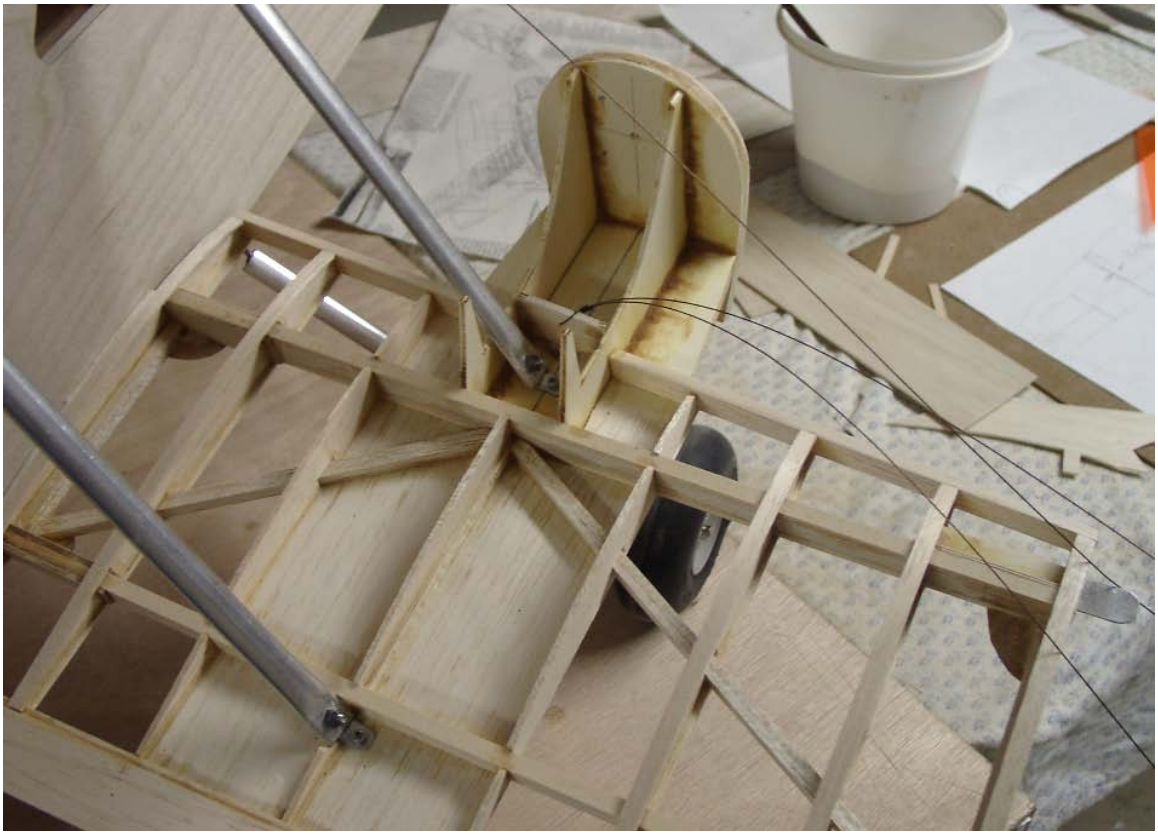
Cotter pins are anchored in fuselage frames, attached to struts with #4-40 Allen-head screw and nut.

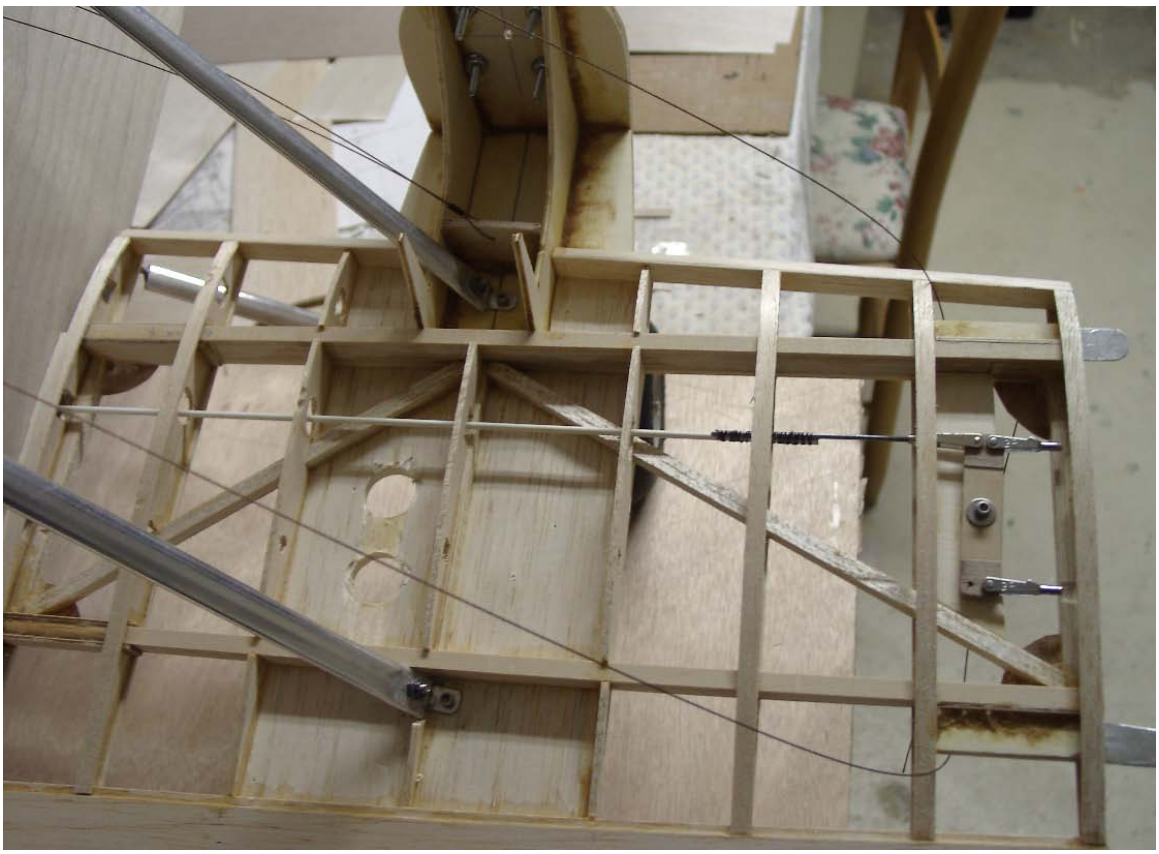


Attach nacelle end with bent aluminum tang, 4-40 screw and nut on bottom side



Wheel axle attached by threading/bonding inside a tight aluminum tube. That tube in turn is pressed into a hole in the square strut, and rotated around by hand until the aluminum tube galls into the aluminum of the square strut. This happens faster than you might expect (galling is welding of similar materials to each other by friction alone).



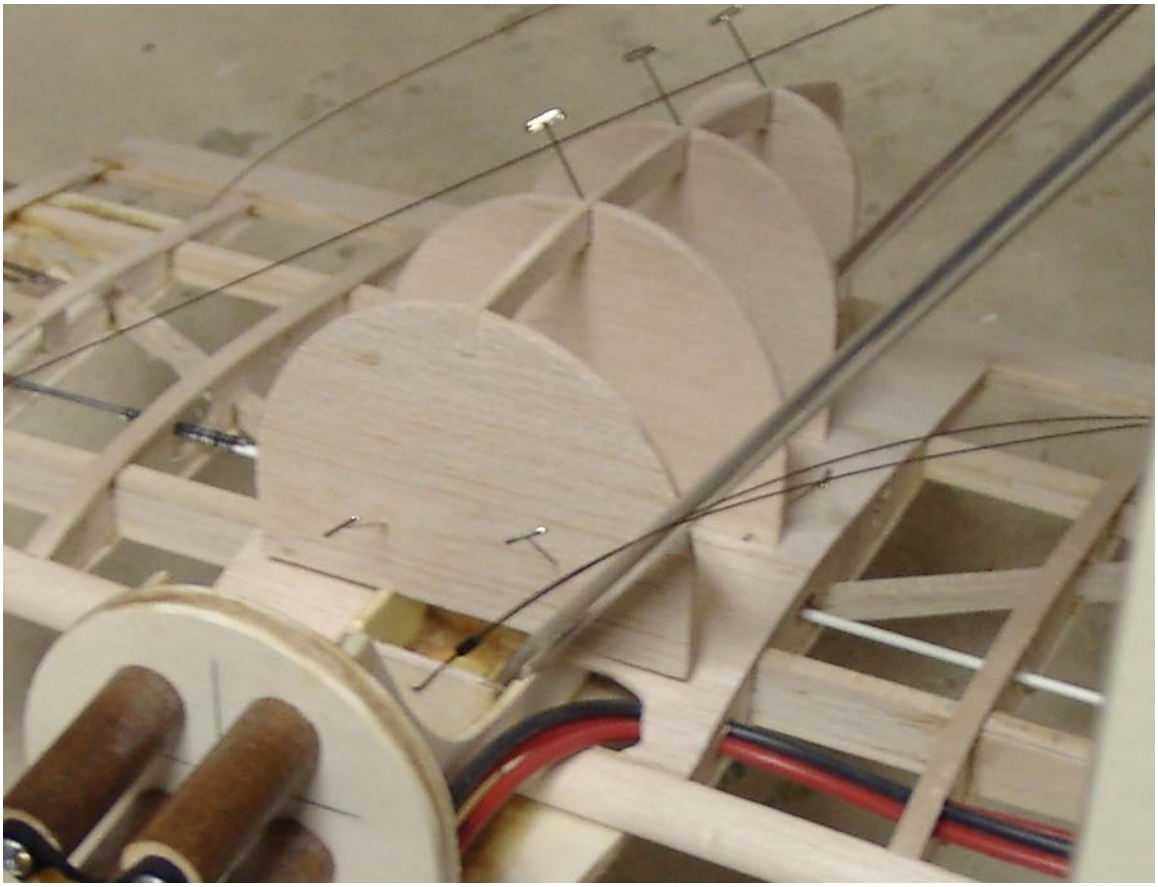


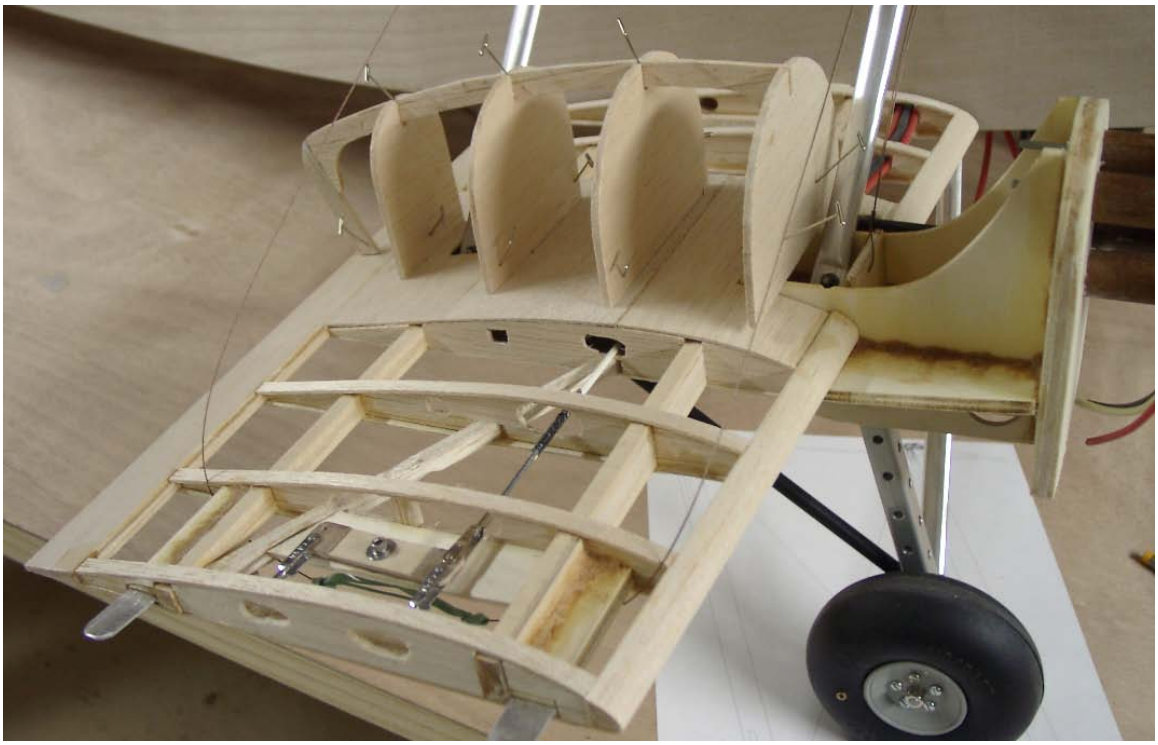

AXi 2836/1
Model Motor
AIRCRAFT

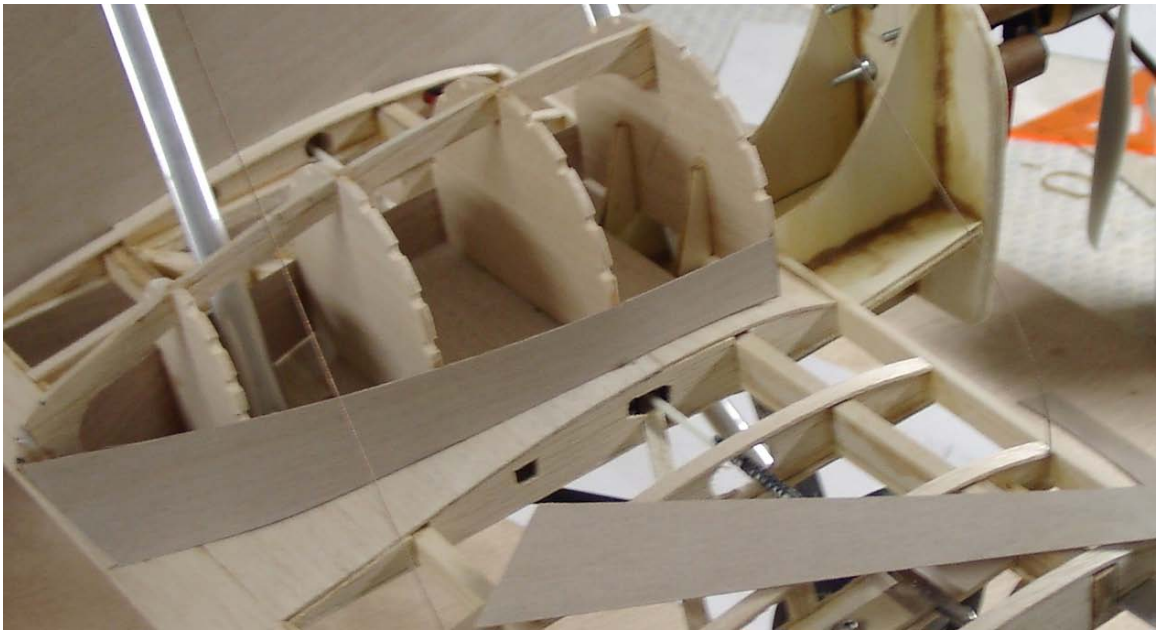
Fiberglass drag strut is anchored between a sandwich of lite ply with wood flour and thin CA.

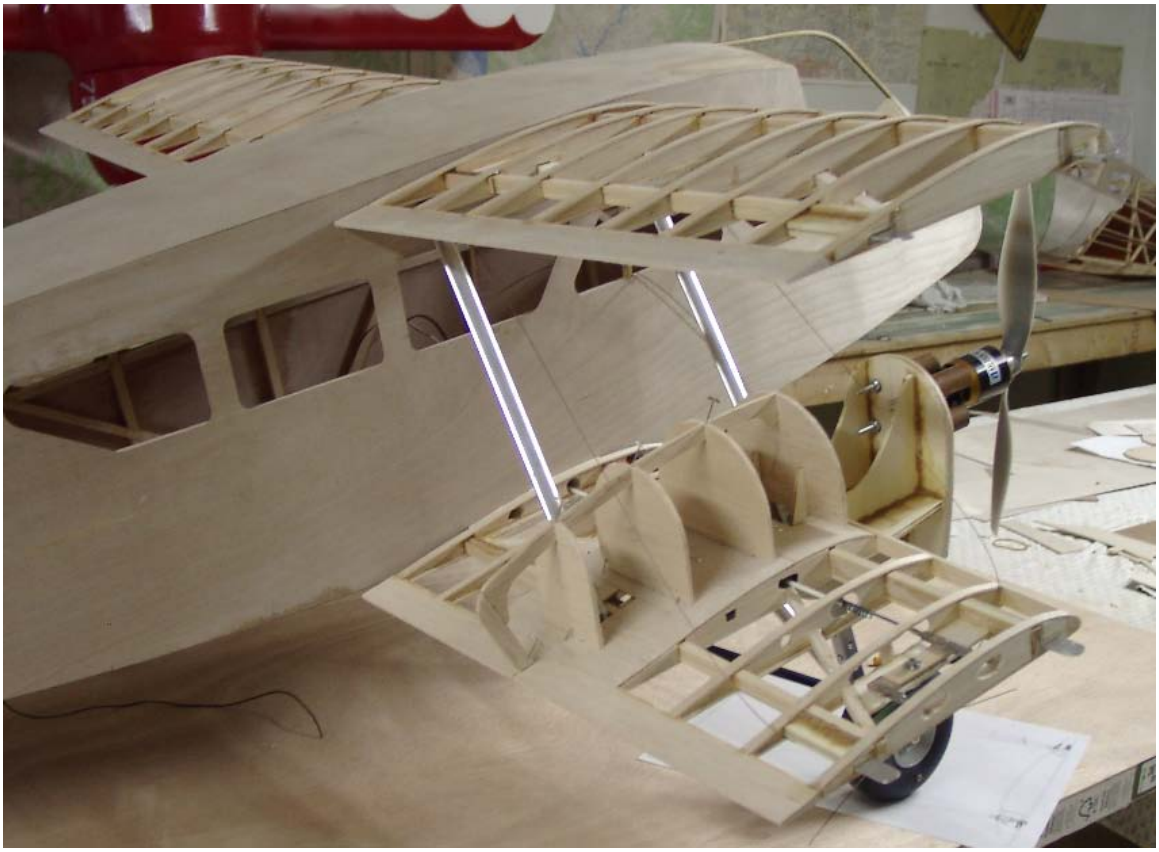
The lateral aluminum strut is made with an internal music wire that is folded into a long thin race-track (the break being in the middle), poking out a loop at either end. It is then anchored inside the aluminum strut with wood flour and thin CA.

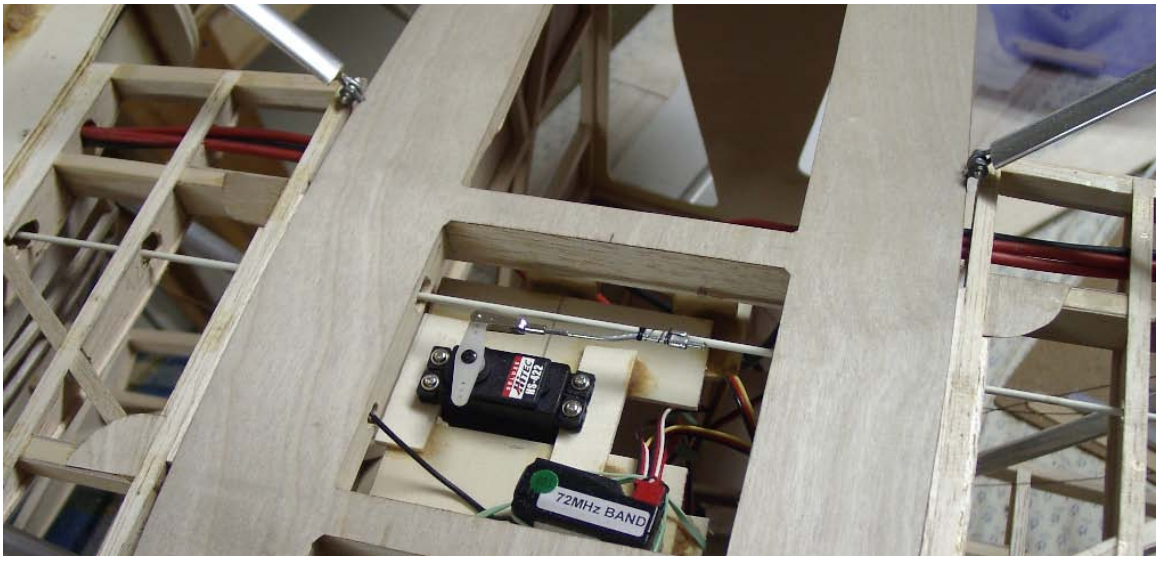
You can see the loop protrude out the top end of the lateral strut. It is attached to the fuse which has a cotter pin loop poking out of the bottom corner, using a 4-40 screw and nut.







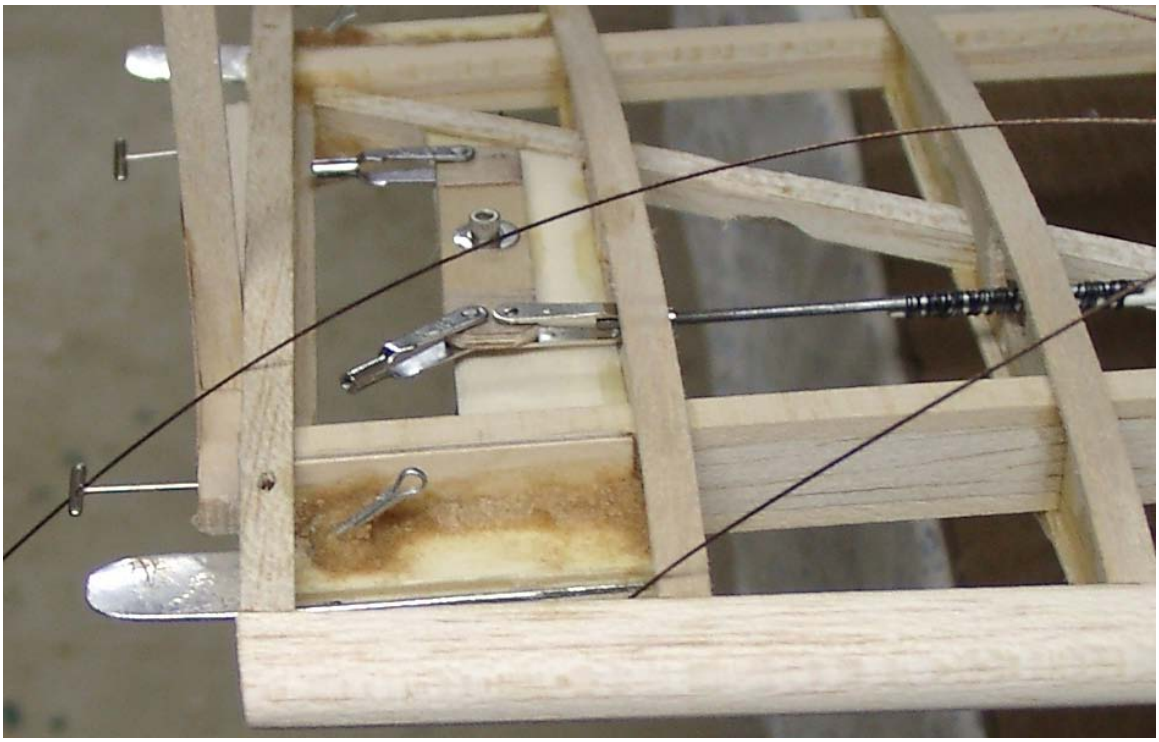




The tail wheel was made steerable, and has internal springs (instead of the usual external springs) because the actual tail wheel was locked or free (for hangar movement). This separate line attaches to the rudder line close to the servo. Notice the paper tube antenna wire guide made from rolled up paper.

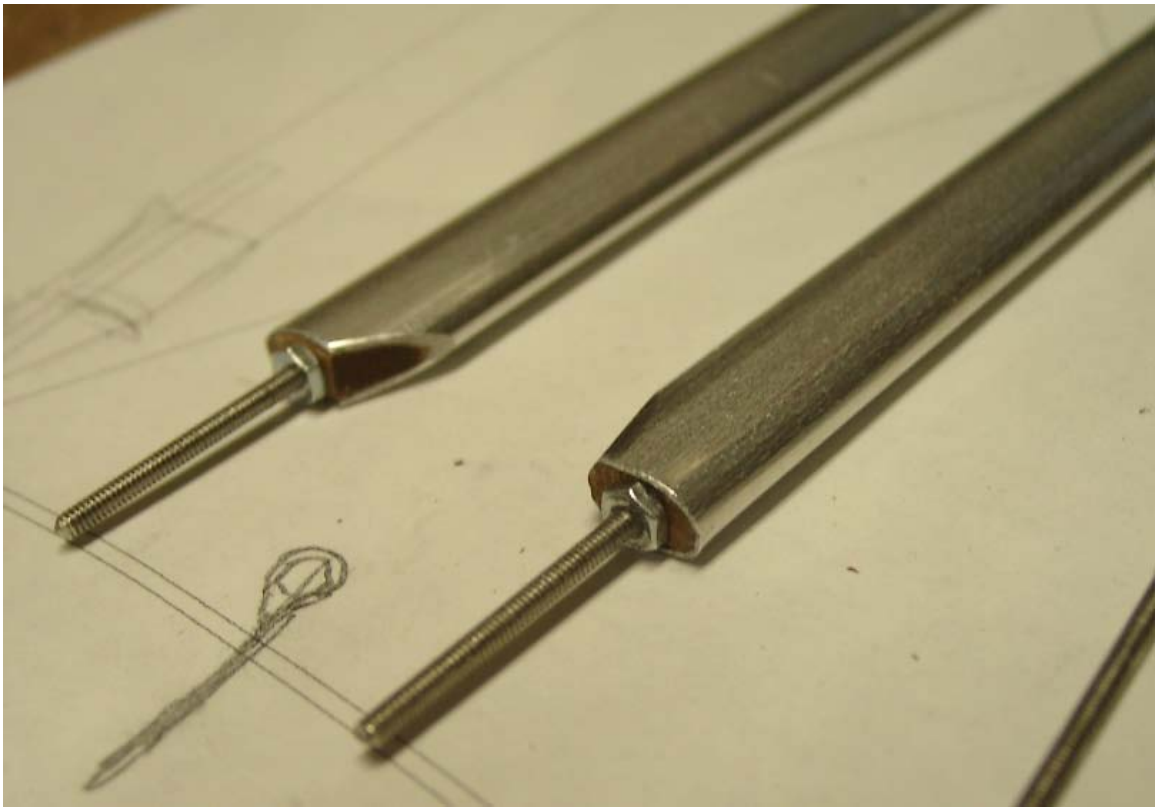
Wind screen sides 1/8" inch round dowel soaked in water for ease of bending.
Hole drilled into cockpit frame corner to support round dowel.

Aluminum tang joiner before match drilling. Notice how it has been anchored both by adhesive and a 0.062" pin.

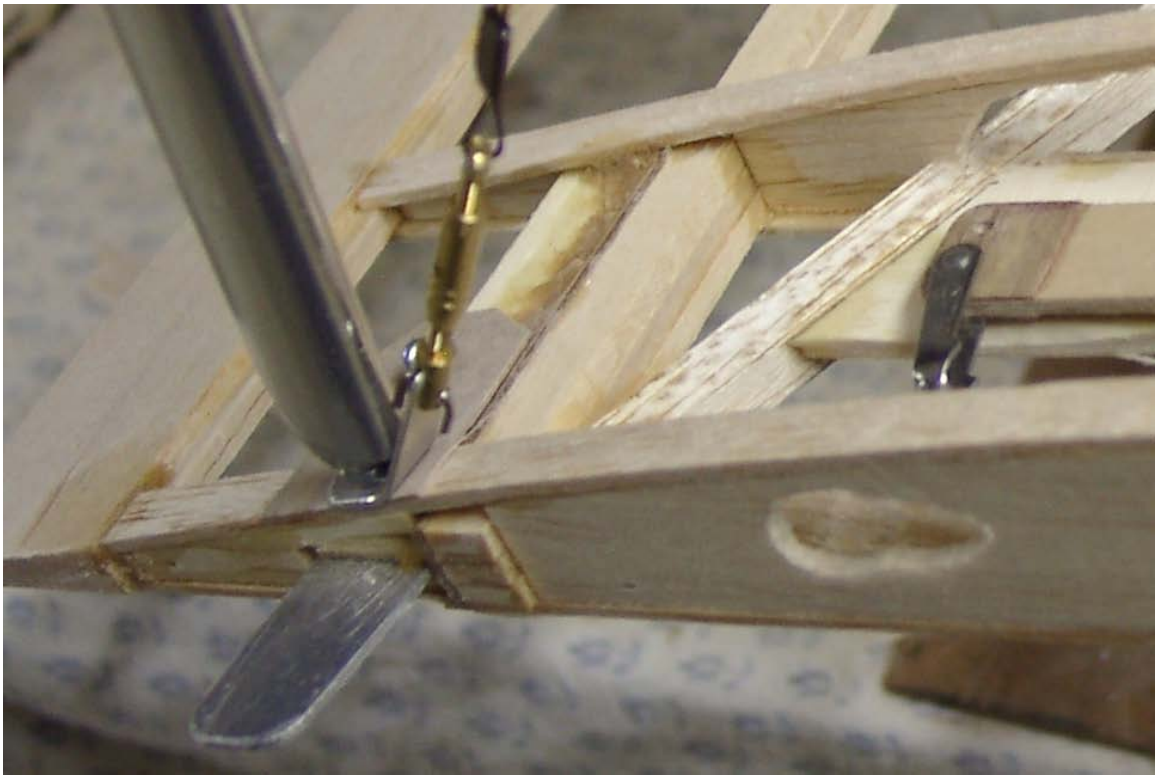


Cotter pin drilled and anchored to ply/aluminum sandwich wing joiner. Adhesive potting is made by dusting in wood flour (fine saw dust), then adding

thin CA. Watch out; the reaction is fast with profuse CA smoke, but the result is fast and as hard as a rock (better than epoxy).



4-40 threaded rod anchored in strut ends with hardwood plugs CA'ed.

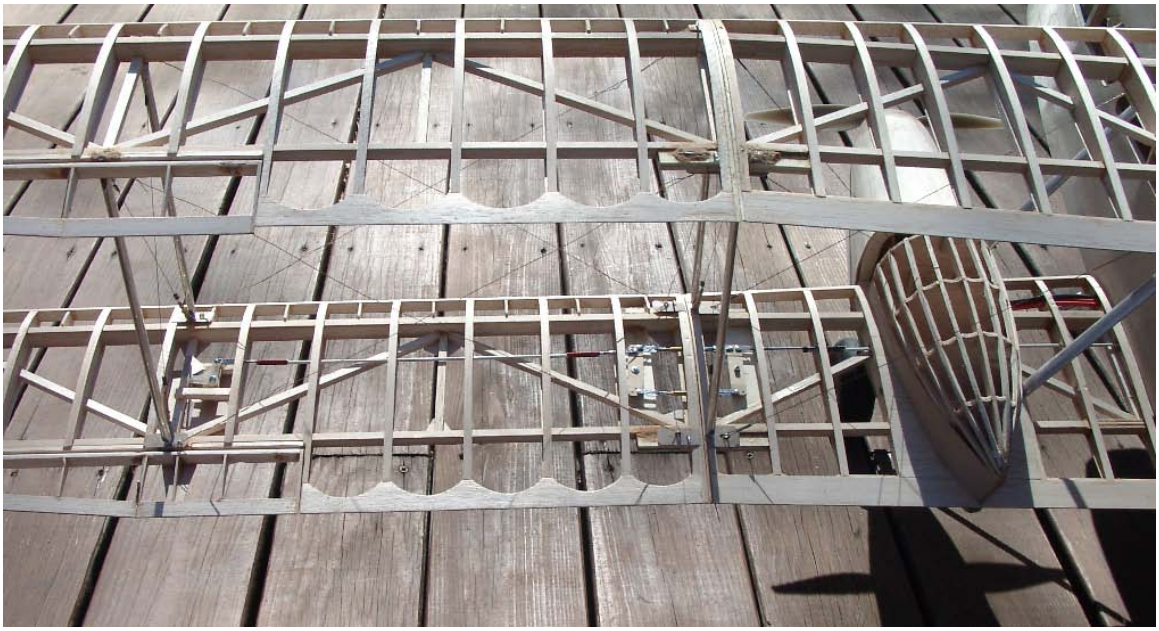


Bottom strut attach. Drill hole thru aluminum tang and nut from bottom side.

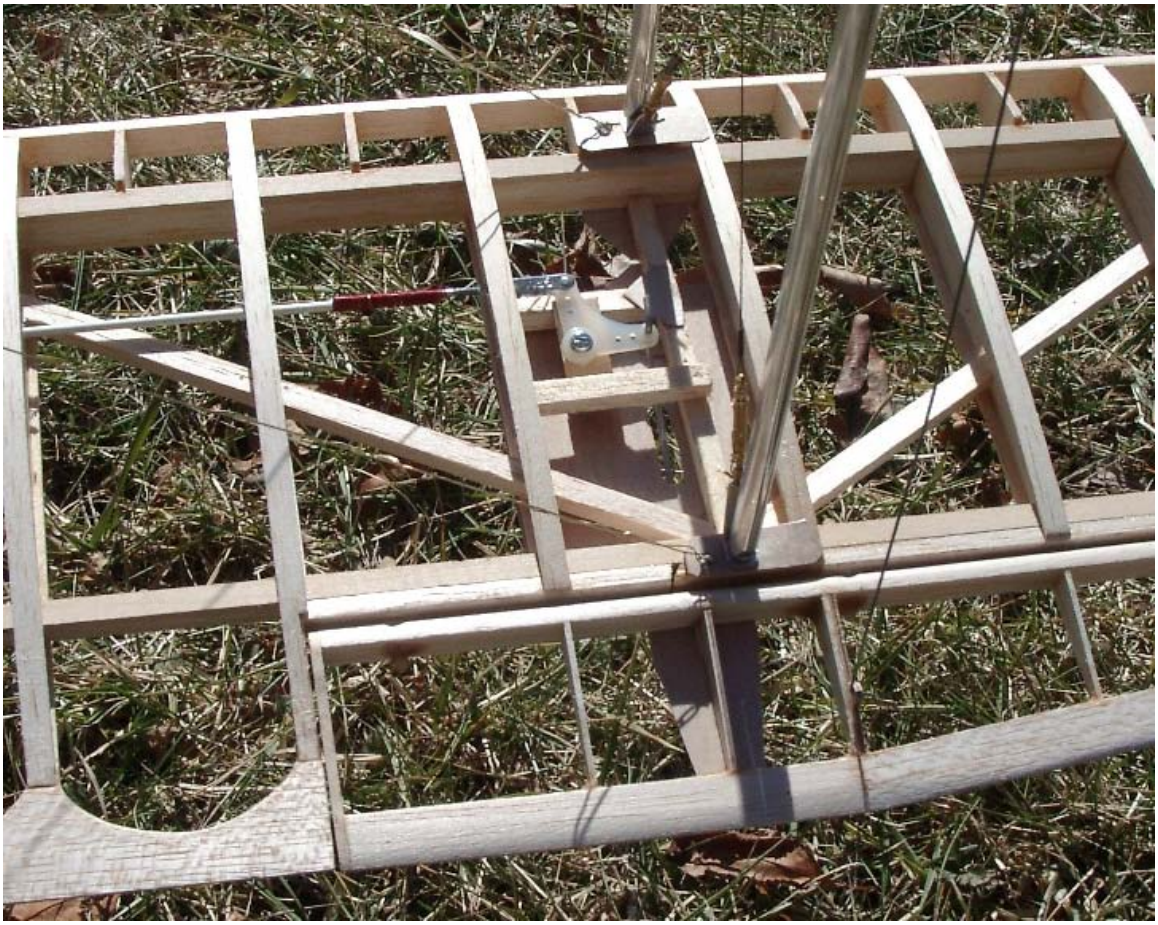
Outer wing panel bridge frame. Notice space for aileron.

Plane suspended by 2-point sling. Removable cowling in the making.

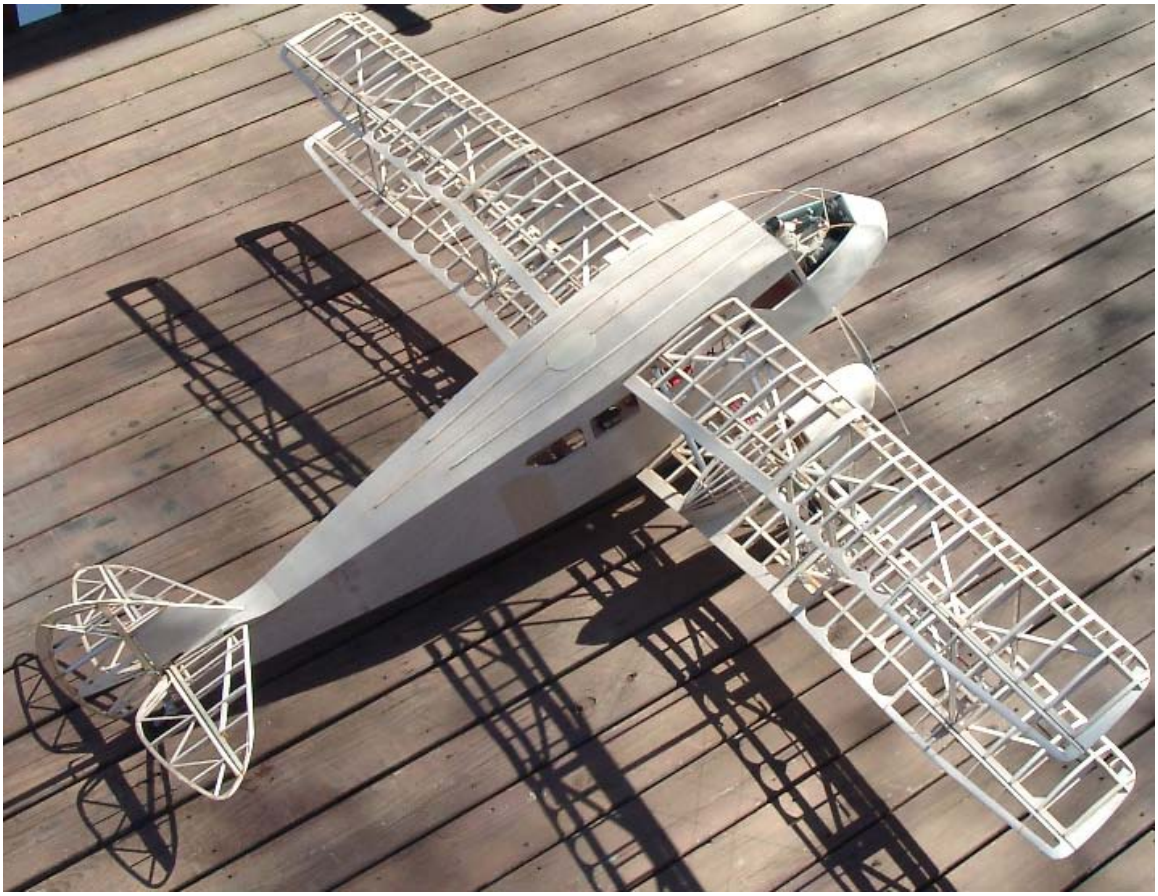
Cowl has thick front plate, but sides are merely 1/16 balsa soaked and wrapped around the internal formers. Apply light fiberglass to inside to stabilize.

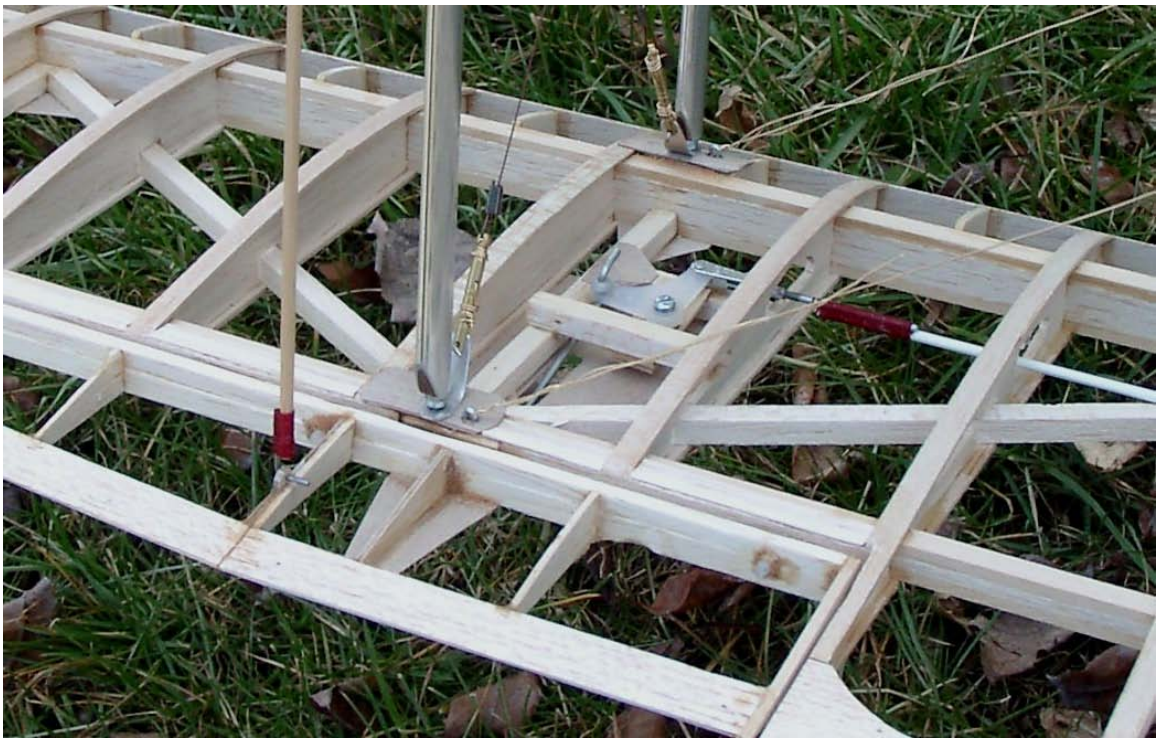


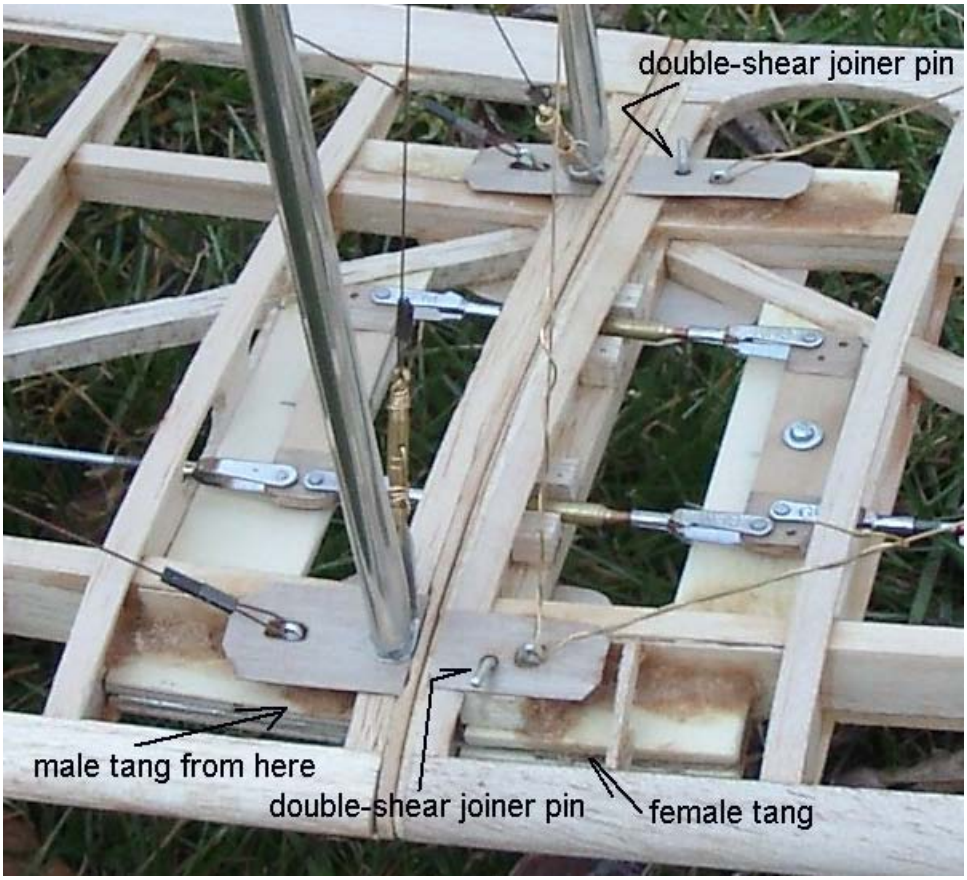
Notice the 2 connector shear pins, with holes matched drilled after wing alignment is verified. Don't drill the 0.062" holes (for the 0.062" pins) until you are dead certain the outer wing panels are where they are supposed to be!!! Starting with the top wing, drill one hole, insert a 0.062 pin, verify alignment, then drill the 2nd hole and insert the pin. Use a straight piece of pine to brace the wing panel to to insure it is following the L.E. line of the inboard panel. This assumes you went to some pains to insure the inboard panels were correctly aligned before they were glued to the fuselage.
Move to the bottom wing and repeat. You can drill up from the bottom. I had to add a rib-shaped wedge to the bottom wing inner/outer interface to line up the bottom wing line with the top wing line. This is due to the funky geometry of having the upper wing a consistent dihedral, but the bottom has a dihedral change outboard of the nacelles.

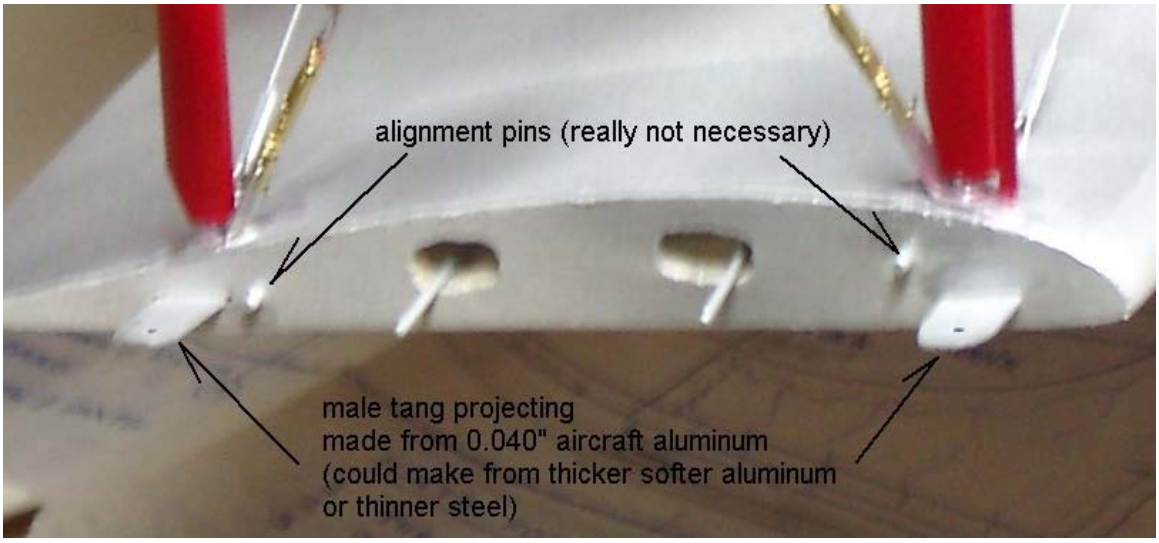



Notice the twin line support.





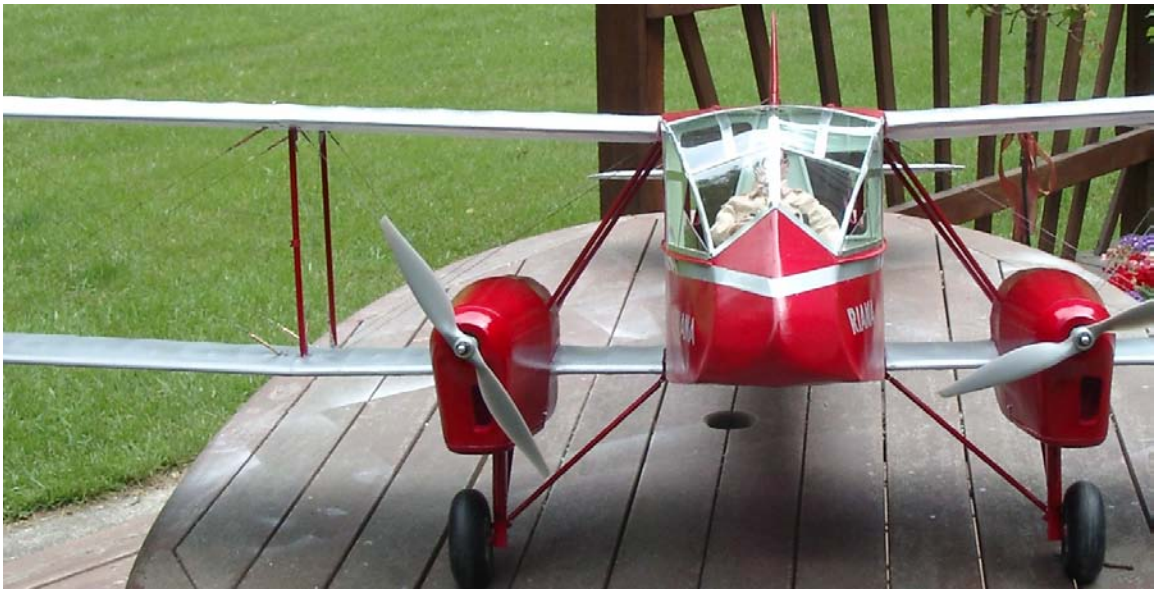

double-shear joiner pin
male tang from here
double-shear joiner pin
female tang


alignment pins (really not necessary)
male tang projecting
made from 0.040" aircraft aluminum
(could make from thicker softer aluminum
or thinner steel)

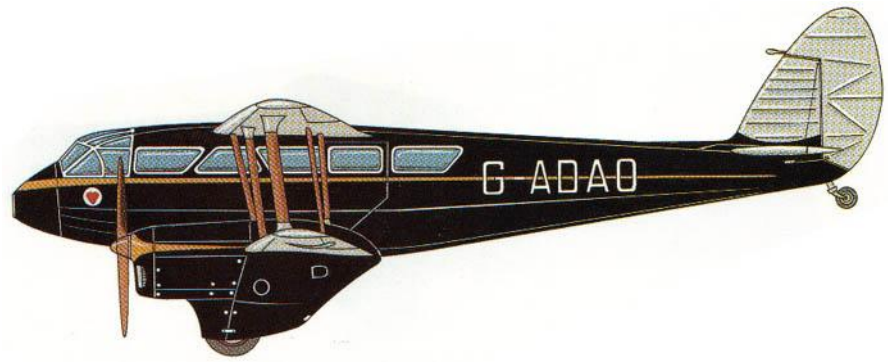
Glassing is glued onto the inner cockpit frame, then an outer aluminum frame is glued over the glassing edges/corners.


VH-UXG
APL


VH-UXG



de Havilland Dragon



The **de Havilland DH.84 Dragon** was a successful small commercial aircraft designed and built by the de Havilland company.

Design and construction

Following the commercial success of its single-engined de Havilland Fox Moth that had first flown in March 1932, that aircraft's original commercial operator Hillman's Airways requested that a larger twin-engined version be built. It was a simple, light design with a plywood box fuselage using the same type of engine and similar outer wing sections of the earlier single-engined aircraft. It was originally designated the DH.84 "Dragon Moth" but marketed as the "Dragon". The prototype first flew at Stag Lane Aerodrome on 12 November 1932, it and the next four aircraft were delivered to Hillman's which started a commercial service in April 1933. It could carry six passengers, each with 45 lb (20 kg) of luggage on the London-Paris route on a fuel consumption of just 13 gal (49 l) per hour. The wing panels outboard of the engines could be folded for storage.

The Dragon proved very attractive as a short-haul low capacity airliner and was soon in service worldwide. From the 63rd aircraft late in 1933, the Dragon 2, with improvements including individually framed windows and faired undercarriage struts, was produced. Even though these changes were largely cosmetic the streamlining improved the aircraft's speed by about 5 mph (8 km/h), allowed 250 lb (113 kg) more payload to be carried and added 85 mi (137 km) of range.

British production of the DH.84 ended at the 115th aircraft, when it was replaced on the assembly line by the more powerful and elegant DH.89 de Havilland

Dragon Rapide. However, during the Second World War, the DH.84 was put back into production at Bankstown, Australia as a navigational trainer for the Royal Australian Air Force, being preferred to the Rapide because its smaller engines were then being manufactured locally for de Havilland Tiger Moth production. A further 87 were built, for a total of 202 produced.

A new four-seat Dragon was delivered in 1933 to the Royal Flight for use by the Prince of Wales. It was sold in 1935. It was later pressed into service by the Royal Australian Air Force during the Second World War.

A special aircraft named *Seafarer* was built for Amy Johnson (a pioneering English aviator) and her husband Jim Mollison (a famous Scottish pioneer aviator) to make an attempt at the world long distance record. It had a strengthened landing gear and the cabin had extra fuel tanks. It was intended to fly from New York to Baghdad, Iraq, but at their first attempt at a transatlantic flight from Croydon Airport in South London to the United States on 8 June 1933 the landing gear collapsed. After repairs *Seafarer* left Pendine Sands in South Wales and arrived at Bridgeport, Connecticut in the United States 39 hours later. However, on landing the aircraft turned over and was damaged.

The engines and fuel tanks were recovered from *Seafarer* and used in another Dragon named *Seafarer II*. After three attempts to take off from Wasaga Beach, Ontario, Canada for Baghdad, Iraq, the attempt was abandoned and the aircraft was sold. On 8 August 1934, the new owners, James Ayling and Leonard Reid, took off in the Dragon, renamed *Trail of the Caribou*, from Wasaga Beach in another attempt at the distance record. Although the intended target was Baghdad, throttle problems forced the attempt to be abandoned, and *Trail of the Caribou* landed at Heston Aerodrome, an airfield west of London, in Middlesex, UK after 30 hours 55 minutes, making the first non-stop flight between the Canadian mainland and Britain.

The inaugural service of the Irish Airline Aer Lingus was provided by a DH.84 Dragon, registration EI-ABI and named *Iolar*, which means "Eagle" in the Irish language. For the 50th anniversary of the airline in 1986, a replacement Dragon was acquired, restored, reregistered as EI-ABI and repainted as the *Iolar*.

Following the War, surviving DH.84s passed into commercial service, but only three are still flying today.

Variants:

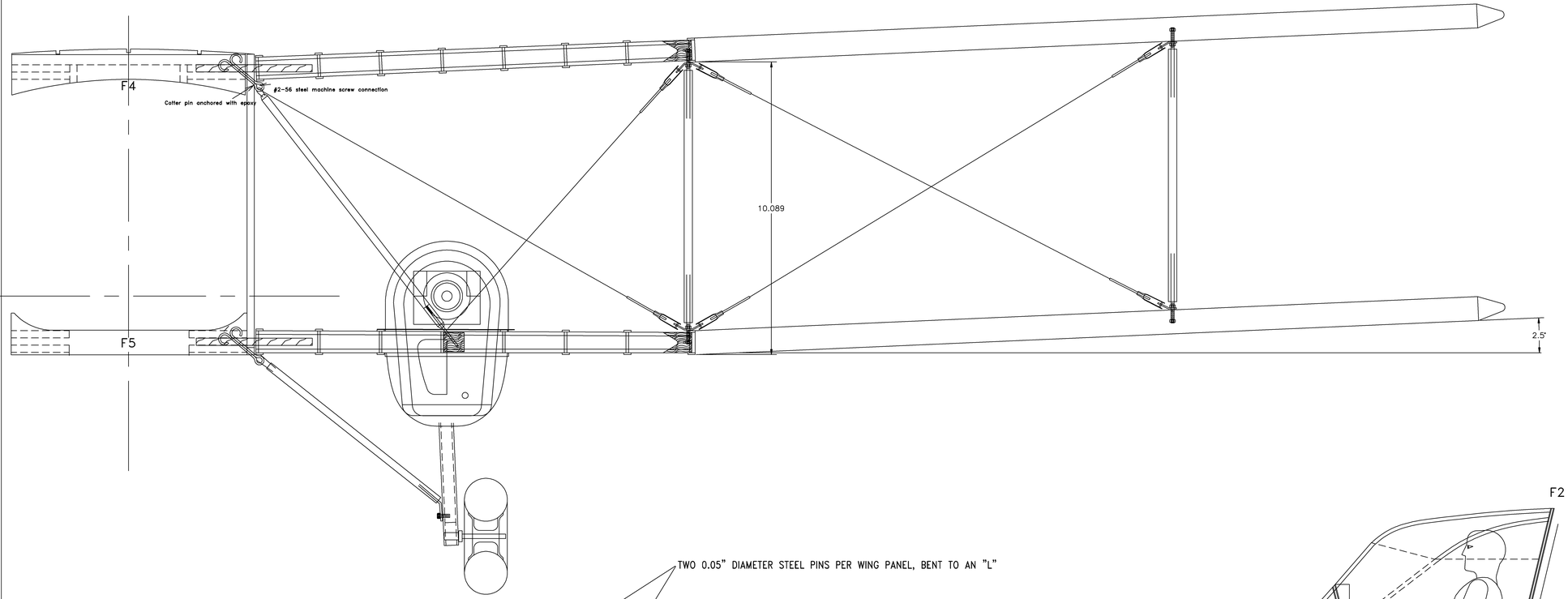
- **Dragon 1** : Twin-engined medium transport biplane.
- **Dragon 2** : Improved version. Fitted with framed cabin windows and two faired main undercarriage legs.
- **DH.84M Dragon** : Military transport version. The DH.84M was armed with two machine guns, and it could carry up to sixteen 20 lb (9 kg) bombs. Exported toDenmark, Iraq and Portugal.

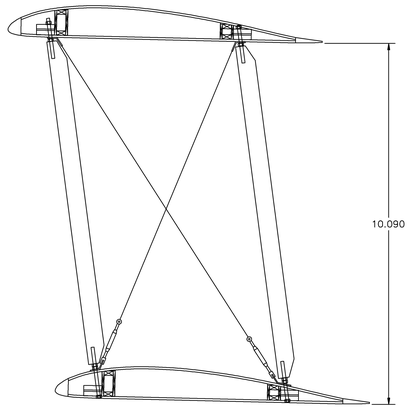
General characteristics:

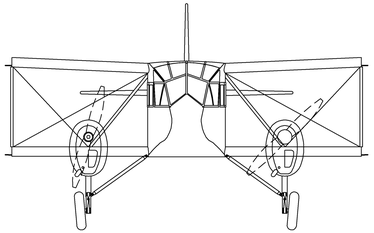
- **Crew:** one, pilot
- **Capacity:** 6-10 passengers
- **Length:** 34 ft 6 in (10.52 m)
- **Wingspan:** 47 ft 4 in (14.43 m)
- **Height:** 10 ft 1 in (3.07 m)
- **Wing area:** 376 ft² (34.9 m²)
- **Empty weight:** 2,300 lb (1,045 kg)
- **Loaded weight:** 4,200 lb (1,909 kg)
- **Powerplant:** 2 × de Havilland Gipsy Major 1 4-cylinder air-cooled inverted inline, 130 hp (97 kW) each

Performance:

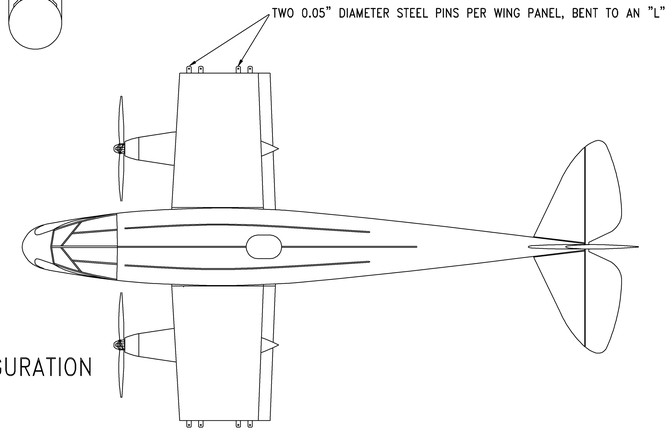
- **Maximum speed:** 128 mph (111 knots, 206 km/h)
- **Cruise speed:** 109 mph (95 knots, 167 km/h)
- **Range:** 460 mi (400 nmi, 740 km)
- **Service ceiling:** 12,500 ft (3,800 m)
- **Rate of climb:** 612 ft/min (3.1 m/s)

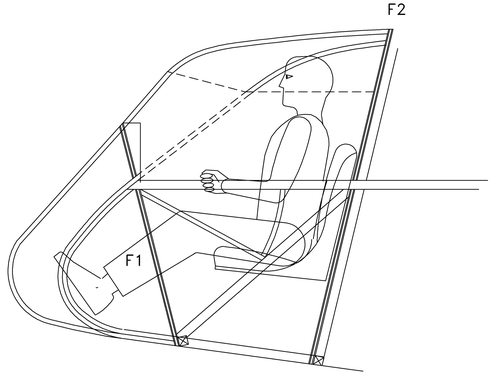






STORAGE AND TRANSPORTATION CONFIGURATION





0 1 2 3 4 5 6
INCH SCALE

DH-84 DRAGON 2

94.66" Twin Engine Radio Controlled Scale Aircraft

Designed and Drawn by Rodger Farley 1/6 scale

FUSELAGE & WING DETAILS

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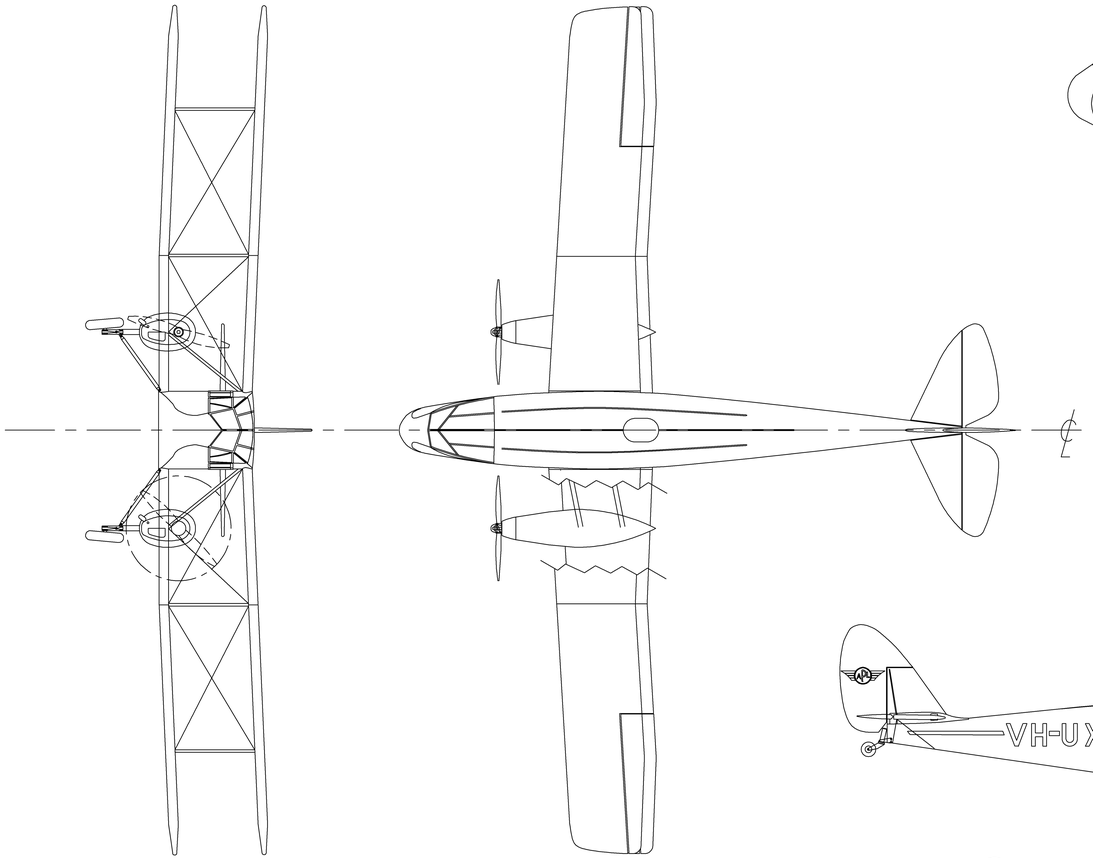

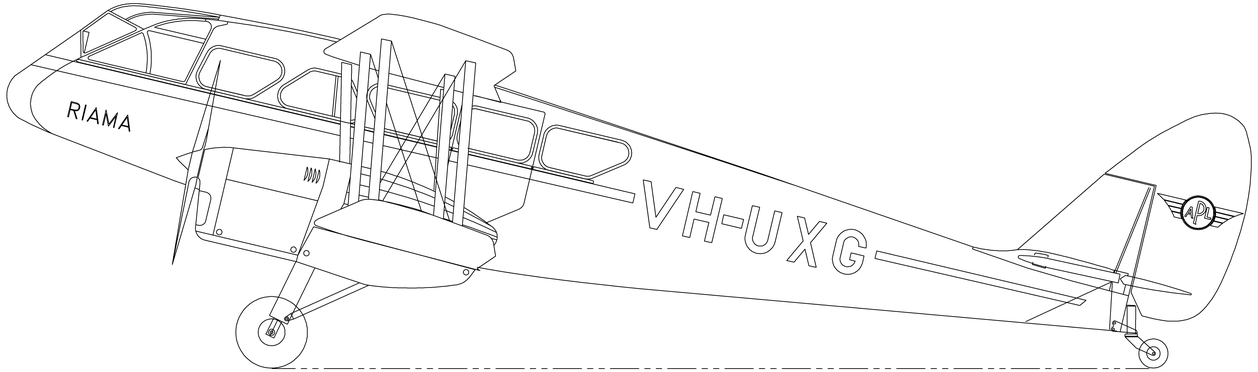

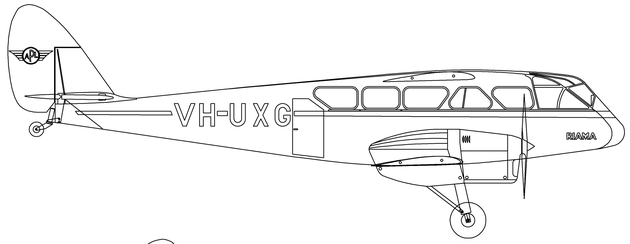

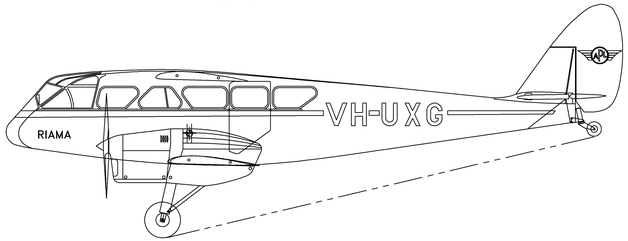

DH-84 Dragon 2, 1/6 scale
VH-UXG "RIAMA", c/n 6077
Completely to scale except with alteration to landing gear shown

Wing Span = 94.66"
Length = 68.6"
Weight = 14.5 lbs
Wing Area = 1700 sq inch
Wing Loading = 19.6 oz / sq ft
Static thrust /weight ratio ~ 0.66

Motors: AXI 2826-10 (2)
Props: APC 11x5.5E (2)
Batteries: Poly-Quest TW 4350XP-4S LiPo(2)
14.8V, 4350 milli-amp hr
Controllers: JETI Advance 77 Opto plus (2)
Construction: balsa, 1/64 ply, bass, aluminum
Covering: Sig Koverall dacron fabric attached with butyrate dope
Paint: Lusterkote butyrate dope spray, dark red and aluminum
Decals and numbers printed on paper, glue-sticked on.
Painted surfaces lightly abraided with Scotch-brite pad
Clear laquer sealing coat over all

CONTROL TRAVEL:
ELEVATOR +/- 16°
RUDDER +/- 20°
AILERON +/- 18°
WITH DIFFERENTIAL, UP 20°, DOWN 16°

Servos: Four HS-422
Receiver: Futaba R149DP PCM 72MHz

1 ° washout, 1 ° nose-up horz.stab incidence
1.5 ° down thrust, 2.5° right thrust (right motor only)

APL
RIAMA

DH-84 DRAGON 2

94.66" Twin Engine Radio Controlled Scale Aircraft

Designed and Drawn by Rodger Farley 1/6 scale
9-2006

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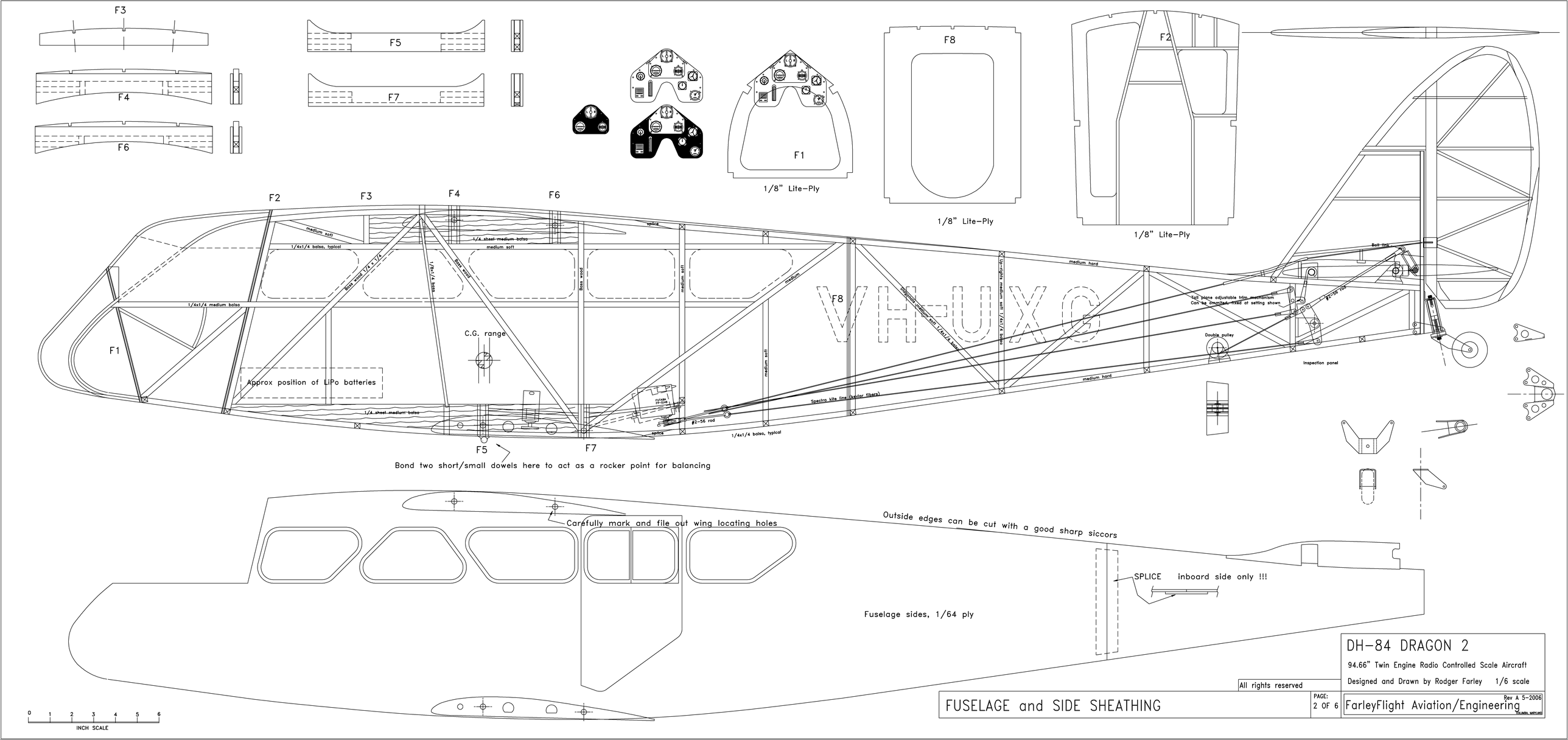
GENERAL ARRANGEMENT AND NOTES



DH-84 DRAGON 2

94.66" Twin Engine Radio Controlled Scale Aircraft

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FUSELAGE and SIDE SHEATHING

PAGE: 2 OF 6

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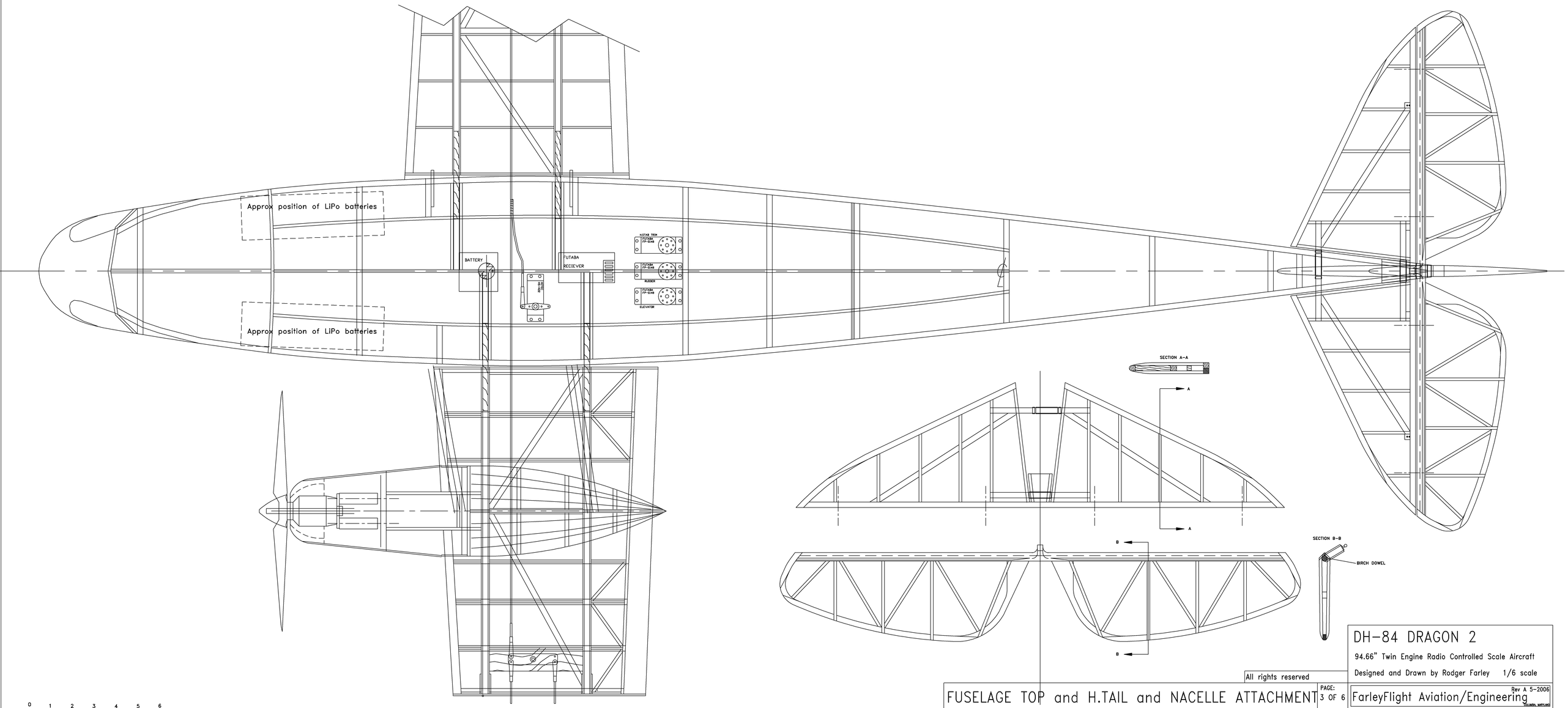

DH-84 DRAGON 2

94.66" Twin Engine Radio Controlled Scale Aircraft

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FUSELAGE TOP and H.TAIL and NACELLE ATTACHMENT

PAGE: 3 OF 6

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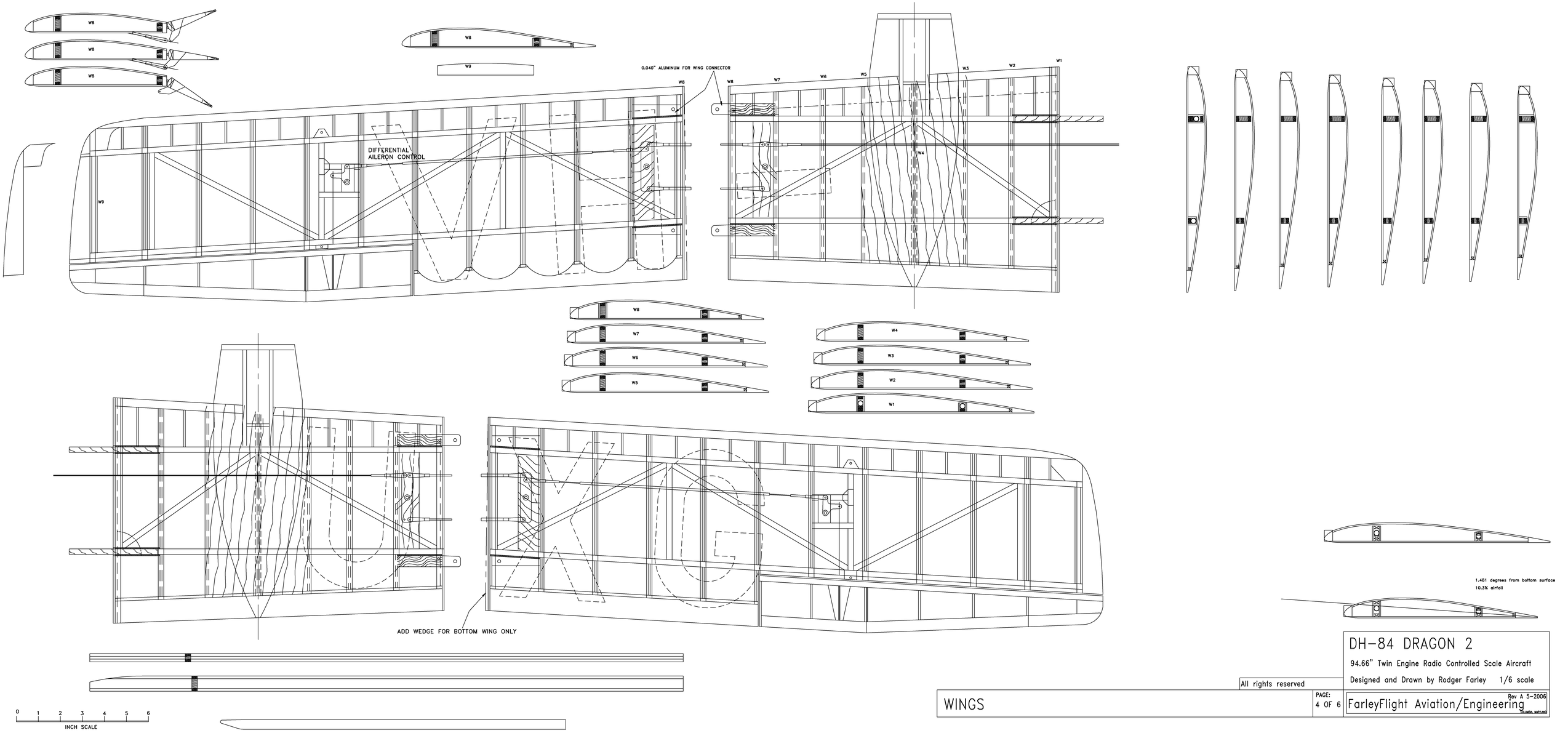

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WINGS

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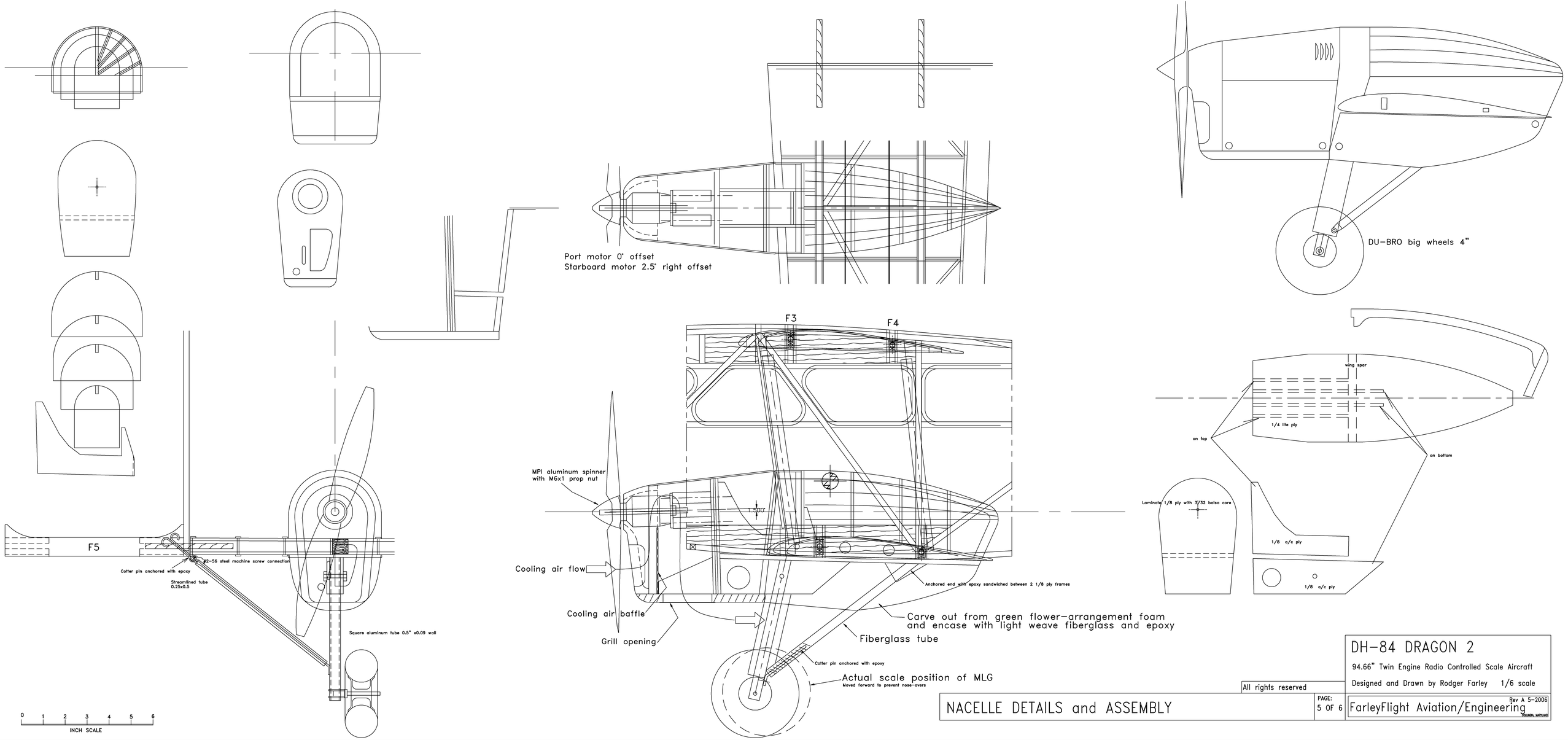

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NACELLE DETAILS and ASSEMBLY

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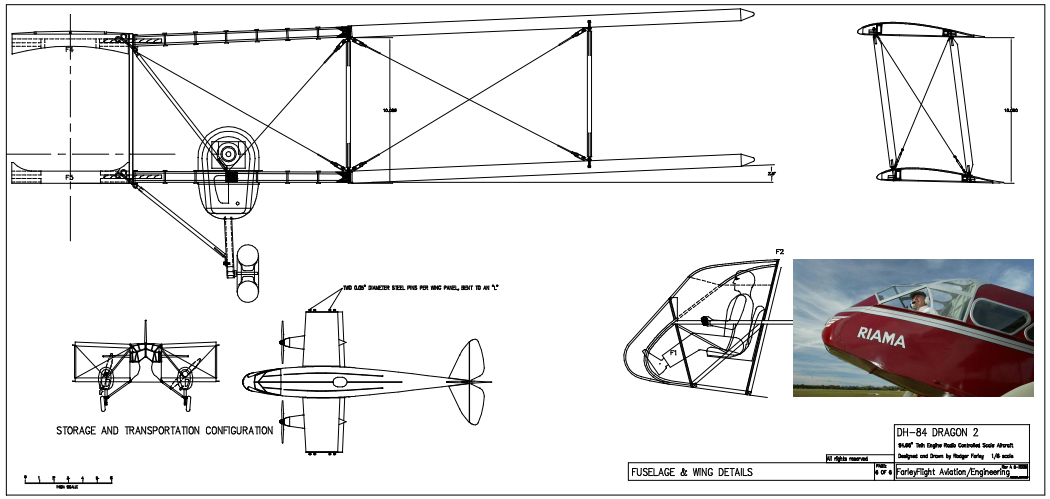
F5
F2
F1
TWO 0.09" DIAMETER STEEL RODS PER WING PANEL, BENT TO AN "L"
STORAGE AND TRANSPORTATION CONFIGURATION
RIAMA
DH-84 DRAGON 2
94.88" 1:6th Engine Radio Controlled Scale Aircraft
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FUSELAGE & WING DETAILS
PAGE 5 OF 6
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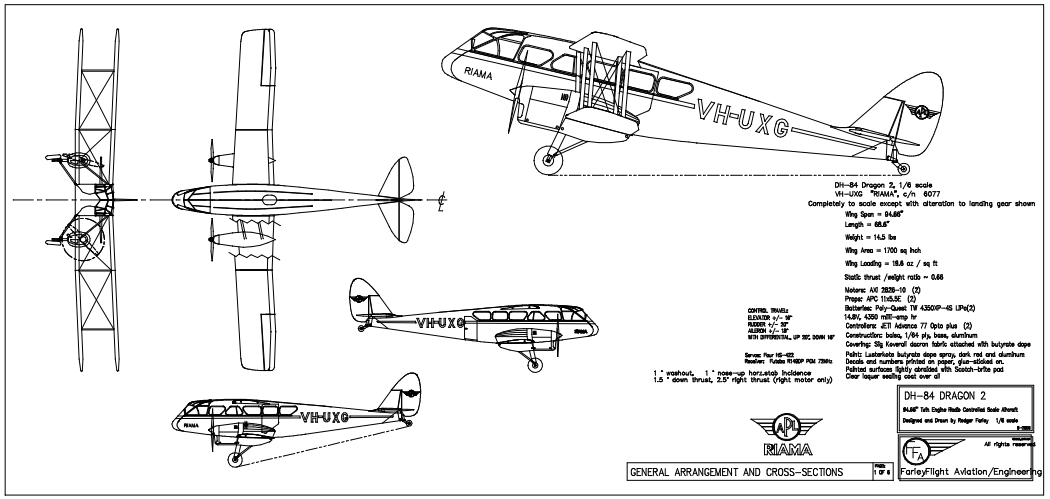
RIAMA
VH-UXG
DH-84 Dragon 2, 1/6 scale
VH-UXG "RIAMA", c/n 6077
Completely to scale except with alteration to landing gear shown
Wing Span = 94.88"
Length = 68.8"
Weight = 14.5 lbs
Wing Area = 1700 sq inch
Wing Loading = 18.6 oz / sq ft
Static thrust /weight ratio ~ 0.66
Motors: A10 2826-10 (2)
Props: APC 11x5.5E (2)
Batteries: Poly-Quest TM 4350HP-4S LiPo(2)
14.8V, 4350 mAH-amp hr
Controllers: JETI Advance 77 Opto plus (2)
Construction: balsa, 1/64 ply, bass, aluminum
Covering: Sig Kwaverl dacron fabric attached with butyrate dope
Paint: Lustrekote butyrate dope spray, dark red and aluminum
Decals and numbers printed on paper, glue-stickied on.
Painted surfaces lightly abraded with Scotch-brite pad
Clear lacquer sealing coat over all
CONTROL TRAVEL:
ELEVATOR +/- 18°
RUDDER +/- 32°
AILERON +/- 18°
WITH DIFFERENTIAL, UP 30% DOWN 18°
Servos: Four HS-422
Receiver: Futaba R-168DP PCM 72MHz
1.1° washout, 1.1° nose-up horz.stab incidence
1.5° down thrust, 2.5° right thrust (right motor only)
DH-84 DRAGON 2
94.88" 1:6th Engine Radio Controlled Scale Aircraft
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GENERAL ARRANGEMENT AND CROSS-SECTIONS
PAGE 1 OF 6
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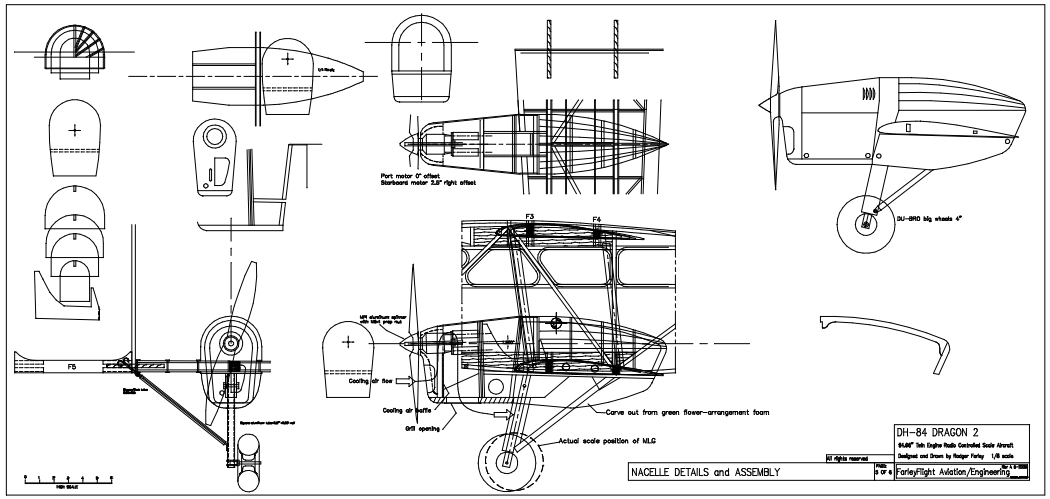
Port motor 0° offset
Starboard motor 2.5° right offset
DU-BRO big wheels 4"
F3
F4
F5
Cooling air flow
Cooling air baffle
Grill opening
Carve out from green flower-arrangement foam
Actual scale position of MLG
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94.88" 1:6th Engine Radio Controlled Scale Aircraft
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NACELLE DETAILS and ASSEMBLY
PAGE 6 OF 6
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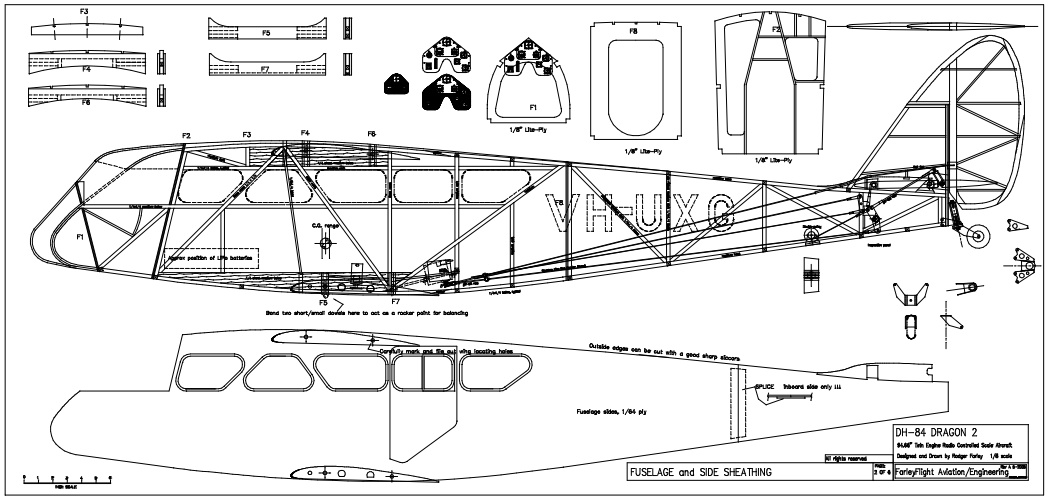
F3
F4
F5
F6
F7
F8
F1
F2
1/8" Lite-Ply
VH-UXG
C.G. range
Approx position of LiPo batteries
Bend two short/small dowels here to act as a rocker point for balancing
Carefully mark and file out wing locating holes
Outside edges can be cut with a good sharp sissors
SPLICE Inboard side only !!!
Fuselage sides, 1/64 ply
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94.88" 1:6th Engine Radio Controlled Scale Aircraft
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FUSELAGE and SIDE SHEATHING
PAGE 3 OF 6
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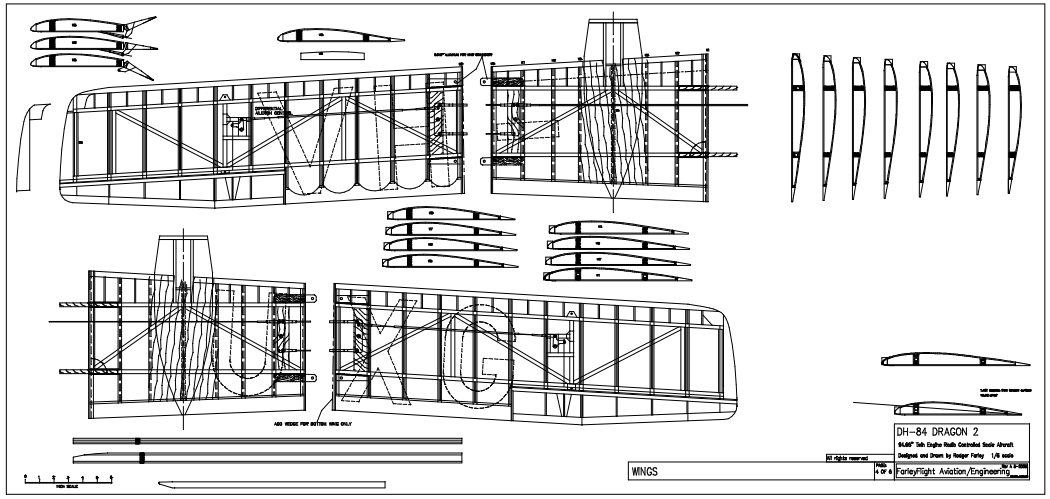
ADD RIDGE FOR BOTTOM WING ONLY
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WINGS
PAGE 4 OF 6
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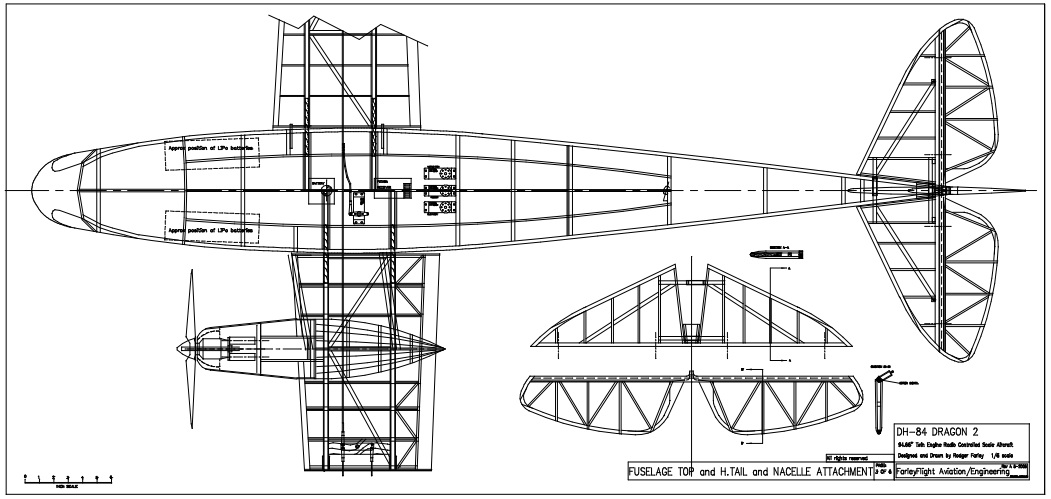
Approx position of LiPo batteries
Approx position of LiPo batteries
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94.88" 1:6th Engine Radio Controlled Scale Aircraft
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FUSELAGE TOP and H.TAIL and NACELLE ATTACHMENT
PAGE 2 OF 6
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