WACO PG-2 POWERED GLIDER

A unique WWII twin engine aircraft that's loaded with fun.

By Peter Miller

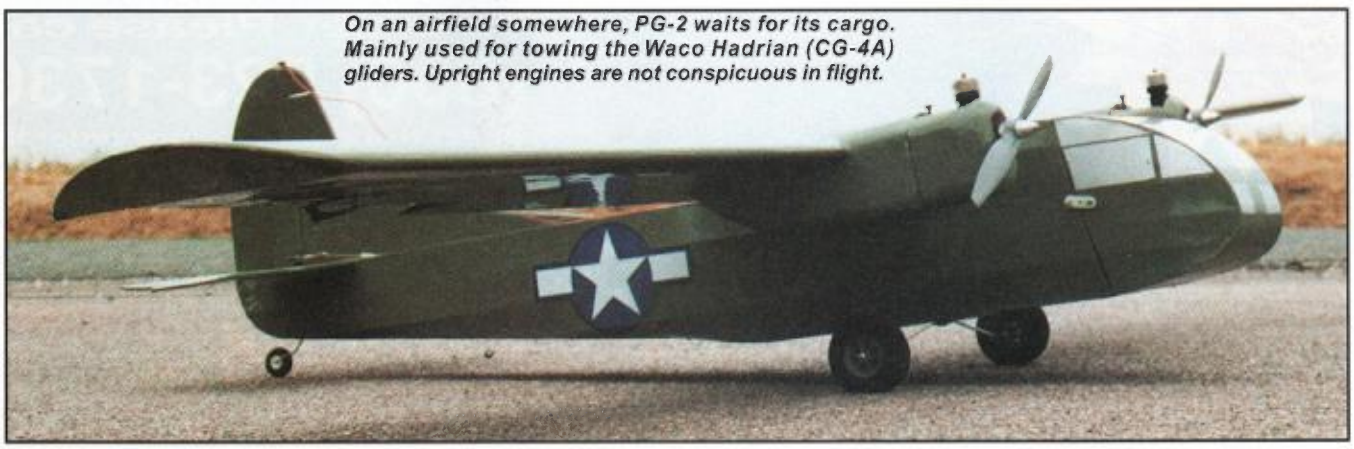
The Waco CG-4A glider, better known to British modelers as the Waco Hadrian, had an illustrious history in the airborne operations of WWII, although it was best known for the operations on D-Day and at Arnhem.

Less well known are the powered versions of this aircraft. The PG-1 was a standard Hadrian fitted with two Franklin engines attached to the wing struts, while the PG-2 had two Ranger engines fitted to the wing.

The idea was to use these versions for ferrying, battlefield liaison, and ambulance work, and also for towing standard Hadrians to the landing zones.

The best information that I can glean says that only ten PG-2's were built and that no one could work out how to use them, so they spent their life towing up normal glider Hadrians at training schools in the USA.

As a model, the PG-2 has a lot going for it. It is one of the easiest to build scale twins ever; the low power needed to fly the model means that it will be very docile under engine-out conditions, and there are a whole range of



On an airfield somewhere, PG-2 waits for its cargo. Mainly used for towing the Waco Hadrian (CG-4A) gliders. Upright engines are not conspicuous in flight.

NAME
WACO PG-2
Designed by:
Peter Miller
TYPE AIRCRAFT
Twin Engined Sport Scale Powered Glider
WINGSPAN
62-3/4 Inches
WING CHORD
8 Inches
TOTAL WING AREA
500 Sq. In.
WING LOCATION
High Wing
AIRFOIL
Clark Y
WING PLANFORM
Constant Chord
DIHEDRAL, EACH TIP
3/4 Inch under each Tip Rib
OVERALL FUSELAGE LENGTH
37 Inches
RADIO COMPARTMENT SIZE
(L) 9" x (W) 4-1/2" x (H) 4"
STABILIZER SPAN
16-1/4 Inches
STABILIZER CHORD (inc. elev.)
4-1/2 Inches
STABILIZER AREA
73 Sq. In.
STAB AIRFOIL SECTION
Flat
STABILIZER LOCATION
Top of Fuselage
VERTICAL FIN HEIGHT
7 Inches
VERTICAL FIN WIDTH (inc. rud.)
5-1/2 Inches (Avg.)
REC. ENGINE SIZE
(2) .049-.074
FUEL TANK SIZE
Integral or 1 Oz.
LANDING GEAR
Conventional
REC. NO. OF CHANNELS
3 (opt. 4)
CONTROL FUNCTIONS
Rud., Elev., Ail., Throt. (Opt.)
BASIC MATERIALS USED IN CONSTRUCTION
Fuselage .....Balsa & Ply
Wing .....Balsa
Empennage .....Balsa
Wt. Ready To Fly . 40 Oz. (2 Lbs. 8 Oz.)
Wing Loading .....12 Oz./Sq. Ft.

options that can be employed with the model.

As drawn, the model is very basic; the controls are rudder, elevator, and ailerons, but throttled engines could be fitted — Cox Queen Bees or PAW 80 or 100's for example.

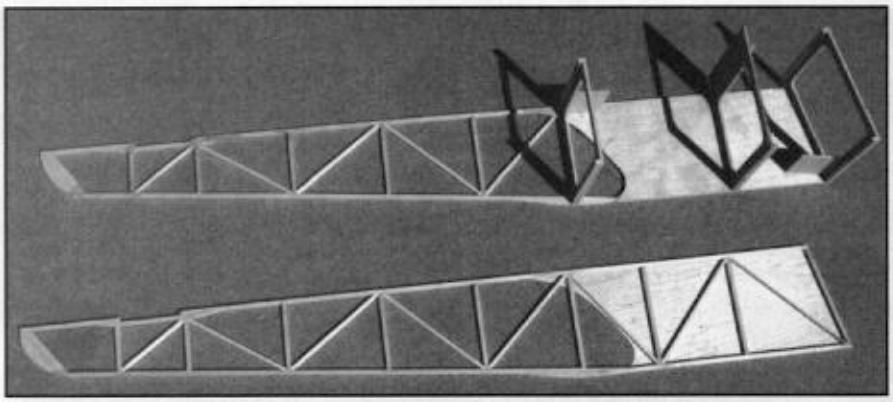
Options include air brakes, opening nose with R/C jeep driving out or even a straight glider. Build two, one with engines and one without and do some scale glider towing, but you will need more power than the Texacos.

In this year, the 50th anniversary of D-Day, it would be nice to run some simple competitions; how about a Triathlon — duration, cargo, and spot landing would be very suitable events.

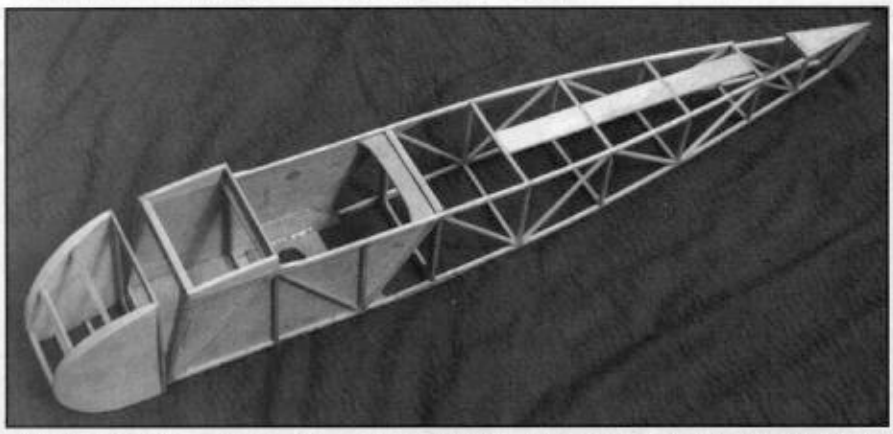
The model is 1/16 scale and is designed for quick, inexpensive construction. It is designed to be light, and anyone who doubts this and wants to "beef it up" should read the introduction to the construction.

Introduction

The Waco PG-2 is a wonderful scale subject from the designer's point of view. The shape is so simple that there is no wasted weight merely to achieve the scale outline.



The two side frames ready to be joined, light and strong.



The basic fuselage box, ready for stringers and small amount of sheeting, then it can be covered. That didn't take long, did it?

My priorities were scale shape, ease of construction, light weight, and strength. The last two are very much interconnected because a light model does not need to be as strong since the inertia loads are less in an "arrival."

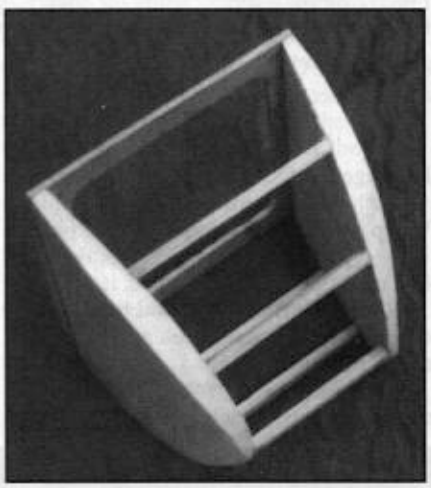
Full-size aircraft have their structures divided in primary, secondary, and tertiary areas and all loads are spread out by tapering off the strength. This was done without compromising the ease of construction. The only real loads on the fuselage are the wing attachment points and the undercarriage. The framework and 1/64" ply doublers combined with lite ply formers are more than adequate for this. I have built .40 powered camera planes to the same basic design as the fuselage using 1/4" sq. and 1/16" ply and they have survived some very rough operating conditions.

The wing is heavier than needed; the trailing edge could be lighter and smaller and the sheeting could be 1/32", but in the interests of warp resistance and ease of construction, I chose the sizes shown.

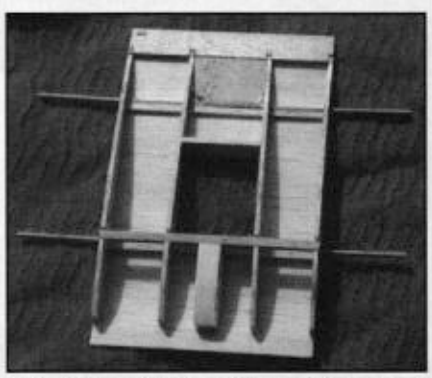
The engine loads and vibrations are taken by the "D" box leading edge over the first three bays; the only reason that the lower sheeting is extended is to provide some support for the rear of the nacelles.

The nacelle construction was developed for a powered glider with the Cox Texaco. That model has racked up at least a hundred flights and the nose is as solid as ever.

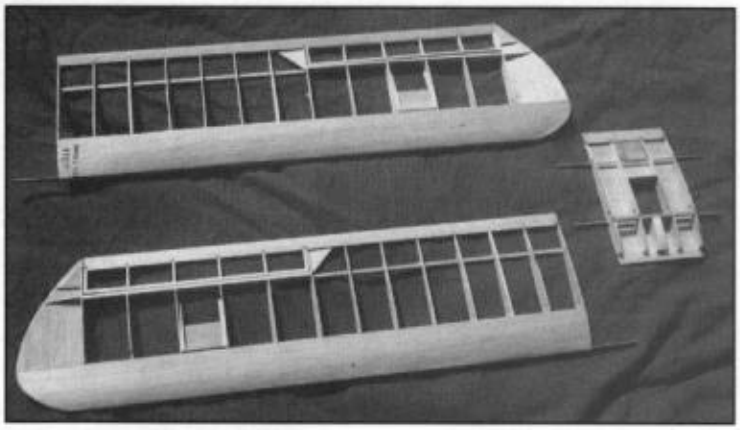
The tail surfaces are more than strong enough; just look at the tail construction on

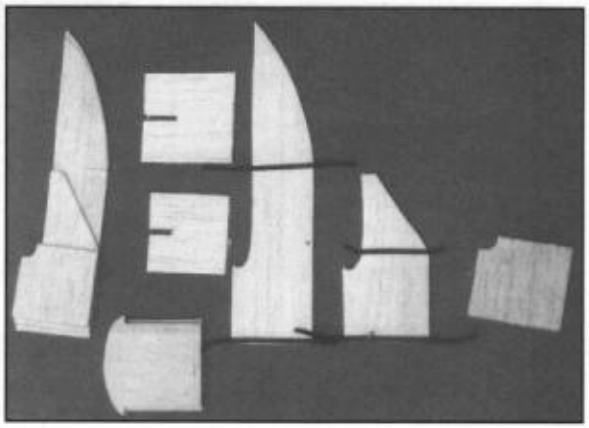


The nose can be built right onto the fuselage, or made separate like this. It could also be hinged for scale opening.

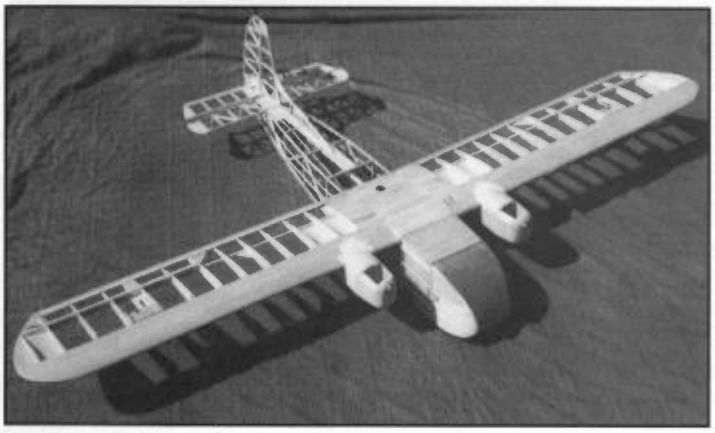


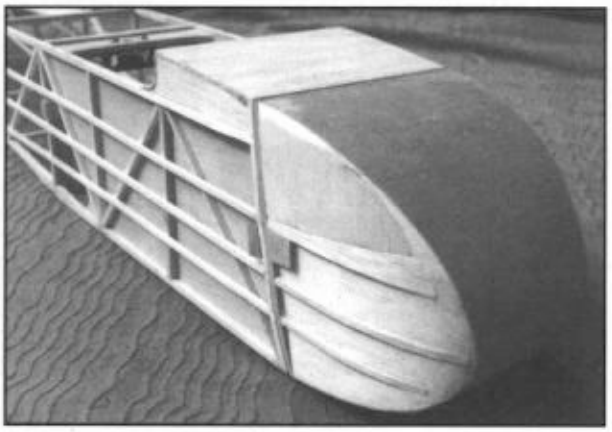
The center wing section ready for the outer panels to be joined to it.





LEFT: The wings just before joining, note L.E. dihedral brace is on the wings while the others are in the center section. RIGHT: The components of the nacelle; black tape is to mask areas where you do not want contact adhesive, i.e., where the formers are to be epoxied into place.





LEFT: Complete model ready for covering. The structure is light, simple, and adequately strong. RIGHT: The nose showing the extra lamination of sheet balsa in the side window areas to bring them level with stringers.

some of the Competition Fun-Fly models and consider the loads on them.

CONSTRUCTION

Fuselage:

Build the two side frames over the plan. When dry, take them up and glue on the 1/64" ply doublers. Join with F-2, F-3, and F-4, making sure that everything is square.

Pull the tail together and hold with a clamp, fit all cross braces and then glue the rear together.

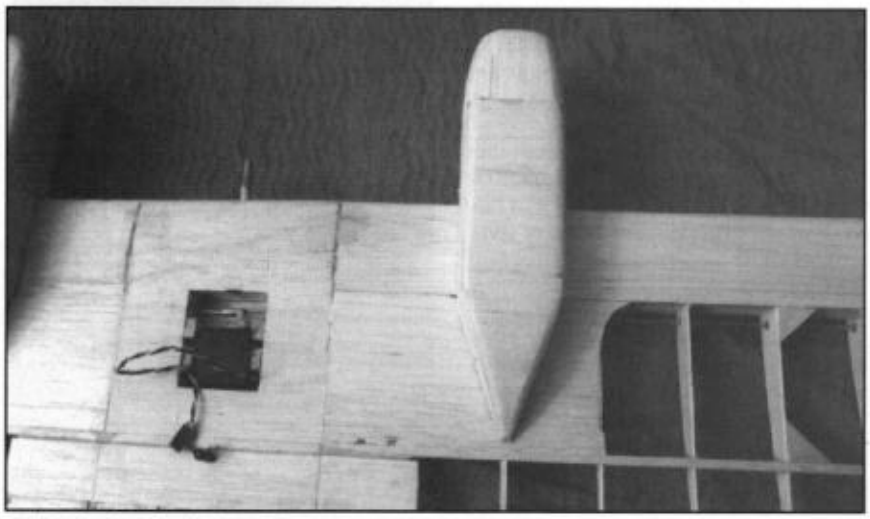
Fit the sections of 1/4" sheet on the sides to take the undercarriage plate and then glue in the U/C plate, rear wing hold-down plate, tail wheel leg on its plate, and the tail plane support plate. Glue on the 3/16" sheet pieces ahead of the wing location.

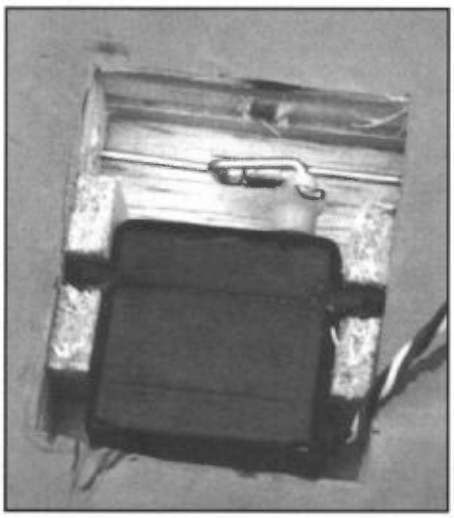
The nose can be built straight onto the fuselage, but there are three reasons for making it separate. One is that it can be made to hinge open in a scale manner, also it does improve access to the rx and battery, and it is easier to repair if you can take it off. If you opt for the fixed nose, don't use F-1, just glue the nose sides to F-2, the rest of the construction is the same.

Take F-1 and line it up carefully with F-2 and drill four holes in the corners for the location dowels. Cut the nose sides from 1/2" sheet and shape to the plan view.

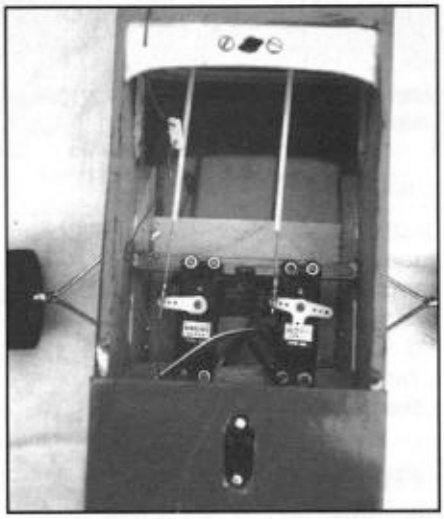
Fit the nose sides to F-1 and add the 3/16" sq. crosspieces. When dry, cover with 1/64" ply and add scrap 1/8" sheet to bring the sides level with F-1 in the window area.

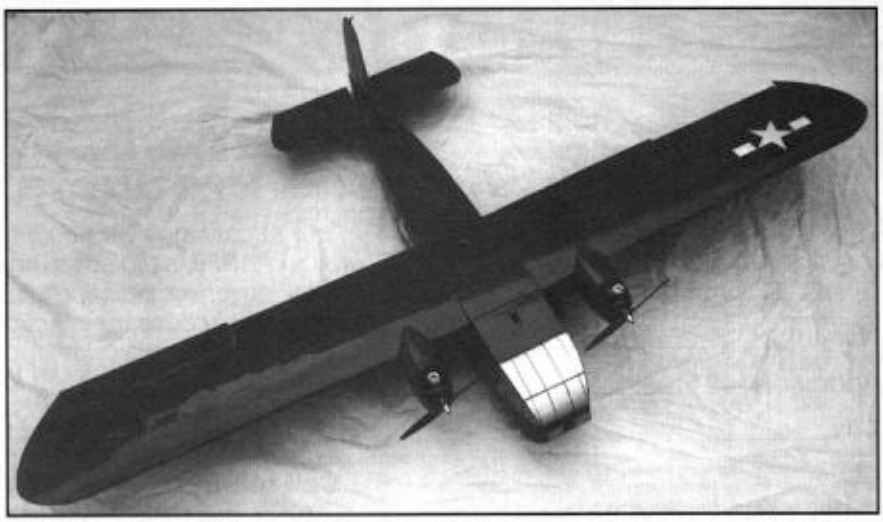
When the wing is complete, fit it carefully in position and drill F-3 and the wing for the wing dowel. Now you can cover the top of the fuselage from F-2 to F-3 with 3/32" sheet. Fit the control rods with suitable supports, add the stringers, and the fuselage is ready for covering.





LEFR: Underside of wing showing servo installation and bottom of nacelles. Nacelles should have a curve as shown on plan, I forgot to make saw cuts to help bending until too late. RIGHT: Close-up of servo installation. Space ribs to suit your servo during center section construction.





LEFT: Almost room for the tx in that radio bay. Those servos are big ones. Switch is on the roof, forward of the wing. RIGHT: Most models of the Waco glider cheat on fuselage width, this one is true scale and must provide some lift.

LEFT: Olive Drab is superb camouflage, it blends tonally with most backgrounds but stands out against the sky for good visibility. RIGHT: You might think that the plane has just landed in the desert and the nose is about to open to disgorge troops. Hadrian (CG-4A) gliders had a very honorable battle record.

Wing:

The wing is very conventional in construction; however, there are one or two areas where it will pay to follow the sequence that I used. Cut out all the ribs and mark them for proper location.

Assemble the wings over the plan. The L.E. dihedral brace is cut on the centerline and is fitted to the wings at this stage.

Install the tips, sheet the L.E., and fit the aileron bellcrank mounts and strut mounts. At this time, install the shear web between the front spars with 3/16" sheet balsa for the first three bays only.

Build the center section over the plan with the lower dihedral braces. Do not fit the L.E. at this stage. Sheet the bottom of the center section and add the shear web between the front spars. Now join the wings to the center section on a flat surface with the tips propped up 3/4" at the outermost rib. When the glue has set, do not take the wing from the board. Add the L.E. to the center section and then sheet the top of the center section. Now take the wing up and complete the sheeting around the root area. Add the aileron control rods.

Nacelles:

The nacelles are very simple. Cut out all the parts and laminate N1 and N2's.

Glue the doublers and treblers to each other. **Note**: Mask off the area where the

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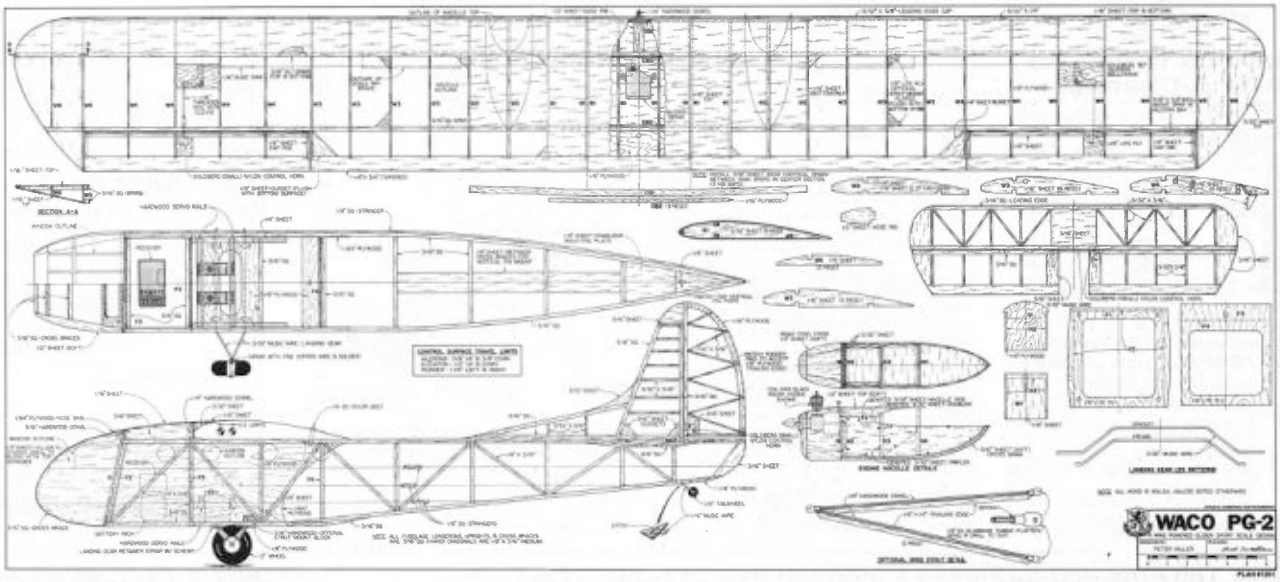

FULL SIZE PLANS AVAILABLE - SEE PAGE 201

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various formers go and use contact adhesive. You do not want contact adhesive on the wood where the formers go.

Note carefully the multi-stepped joint where N1/N2 is joined; it must be a good fit. When properly made, this joint is almost indestructible. Assemble the sides to the N1/N2 former and N3. Cut slots in the bottom of the wing for N3 and N4.

Make some dry runs to ensure that everything fits and lines up. Then glue N4 to the rear of the main spar and glue the nacelle to the bottom of the wing, ensuring that N3 is firmly glued to the rear face of the L.E. Do not apply glue to the nacelle sides behind N4 at this stage.

When the glue is dry, cut the rear of the nacelles sides behind N4 and bring the tips together and glue to the wing sheeting. The correct curve is shown on the plans and this could be achieved in one of two ways: The nacelle sides behind N4 could be cut separately with the grain vertical, or saw cuts could be made on the inside to allow the curve to be formed.

Fit the soft 3/16" sheet bottom to the nacelles and the soft 1/2" sheet on the top, and sand to a smooth curve.

The cowls are built-up from soft 1/2" sheet and shaped as shown.

If throttled engines are used, the tank can be fitted between N2 and N3 and some juggling of former spacing may have to be done.

Tail Surfaces:

The tail surfaces are so simple that they do not need much description. The only slightly unusual feature is the 1/16" ply T.E. on the rudder which is fitted into slots in the rear of the 3/32" x 3/16" rudder ribs. After assembly, the vertical fin and rudder are then sanded to an airfoil shape. The horizontal stabilizer assembly is small; some might even feel that it is too small for stability; however, I found no problems with this,

Designer admires his work before the first flight, he prefers small, light models with low engine power.

but it does mean a forward C.G. and fairly sensitive pitch control. More experienced modelers may want to increase the size of the tail plane a bit to suit their flying styles. The horizontal stabilizer and elevators are built-up flat, with the edges rounded as shown on the plans.

Covering:

The color scheme is standard Olive Drab. I have only seen references to an all Olive Drab scheme and photos of the Hadrian do not show any variations between colors. When it is realized that glider operations were carried out at night, the overall Olive Drab scheme makes sense.

I covered the model with Olive Drab Solarfilm, I used silver Solartrim for the cabin area but black or light blue might look a bit better; I used what I had in stock.

Cover and hinge the tail surfaces and cover the fuselage before assembling the tail to it, but be sure to trim away the covering where the glue goes. The engine bays should be fuelproofed.

The insignias I used are Flair USAF self-adhesive stars, but these are available from many sources. The stars are about the right size, but the one photo of a PG-2 that I have shows the earlier style without the bars. This photo shows a very plain aircraft with no numbers or letters.

The control surfaces are hinged with the covering material; the ailerons being top hinged, while the rudder and elevator use the "Center Pivot" type hinge, or you may use your own favorite type of hinge.

Installation:

With the amount of space available, fitting the radio is easy. Assemble the model and check the balance point while sliding the radio around on the top.

I used standard size radio components with the old, large servos in the fuselage and a smaller one on the wing. No micro-radio needed in this model.

I found that the servos went at the front of the bay under the wing with the rx and battery in the next bay forward. If your model has come out a bit tail heavy for any reason, the battery can go in the nose. There is no need to add any lead, just move things forward until the model balances no more than 2" behind the L.E.

The switch fits on top of the fuselage just in front of the wing.

I made all the horns from 1/16" plastic laminate but standard horns could be used. Note the position of the aileron horns as this gives some aileron differential. Connect up the controls and set the throws as follows: aileron — 5/8" up, 3/8" down; elevators — 1/2" each way; rudder — 1-1/4" each way.

The engines are fitted upright for ease of starting. I used Cox Texaco 049's which do not have throttles. P.A.W. 80's or 100's could be used, or Cox 074 Queen Bees.

There is room in the nacelles for small tanks, and a throttle cable set-up would not be hard to rig, something on the lines of the aileron control or even flexible control rods could be used. Throttles would make flying

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Waco PG-2 Powered Glider

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a little safer in the event of an engine cutting out at an awkward time.

The U/C is very simple to make and is fitted after covering. It is very close to the C.G. and could be moved forward slightly to prevent the nose from rubbing on the ground. The grass on our field is so long that it doesn't make any difference to me. Struts are shown on the plan. I have not fitted them as they cause drag and can catch in long grass.

All-up, ready to fly weight is 40 oz., which gives a wing loading of just under 12 oz./sq. ft. Try and keep to this weight, especially if using unthrottled engines.

Pilot's Notes:

These notes are for the model as described and contain recommended operational procedure, a general description of flying the model follows them.

Starting Up: For the first flight of the day, start each engine in turn and run for at least one minute or longer to ensure that any congealed oil is flushed out of the fuel system; if any adjustment of the needle valve is needed, continue running for an additional minute. You need to be certain that the engines will not change their settings in flight.

Refuel both engines and restart, good Texacos which are warm will start first flick.

The model can be hand-launched quite easily. Once trimmed out, solo launches are safe.

Flight On Asymmetric Power: If one engine cuts and you do not have throttle control, **under no circumstances allow the nose to rise**, but fly the model level or allow a very gentle descent. At all times maintain airspeed. Failure to observe this procedure will result in the model stalling and falling into a spin.

In level flight, rudder trim will counteract the asymmetric power.

Spin recovery is easy, apply opposite rudder and aileron and pull out gently, Note that at least 50' of height will be lost.

Read this section and memorize it, the safety of your model depends on correct operation.

Flying:

Flying a twin engine model is exciting and, providing the above notes are remembered, it is pretty safe.

Climb-out is positive but not fast, with all that drag it can't be. The model is quite stable

directionally and in roll, but it is neutrally stable in pitch; the engine note is a good guide to what the model is doing, if the revs rise it has gone into a dive, if they sag it is climbing.

Rudder will kick the model around but is not a good control for turning, ailerons are rather sluggish but positive, coordinated turns are best, with electronically coupled ailerons and rudder, turns are beautiful. Elevators are positive but not twitchy.

My first flight with the Waco was terrifying because one engine went sick and then died while I was still trimming the model; fortunately, I had some height.

As soon as the nose came up, the model slowed fast, dropped a wing towards the dead engine and fell into a spin. This happened about three times before I mastered it and by then I was creeping round the field at about 20' turning very gingerly, lucky that it was a huge, flat grass field.

Subsequent flights were much better and I soon mastered the technique for asymmetric power.

Once both engines have stopped, the glide is quite fast and steady. The rate of descent is about the same as the rate of climb but the model will also thermal nicely. On the fifth flight, I found a nice thermal and stayed with it for about ten minutes. The model will not lock into a thermal, it has to be flown round in the lift.

For the aerobatic types, the model will loop but the current aileron throws will not make it roll, but these are not scale maneuvers anyway.

Throttles would make the model much better and safer as one could cut the other engines if one died, but I am having a lot of fun with it as it is.

So What Else?

I suppose that this model could be used for power slope soaring (PSS) with the dummy engines or just plain slope soaring without them. I imagine that it could be launched with a high start for flat field soaring and the drag would be a lot less in the pure glider form. I would suggest that the struts are made functional for this.

I have built the model in the simplest possible form but I am sure that others can add all sorts of ideas as described in the introduction — throttles, opening nose, etc., but you will need more power if the weight gets any higher.

This year is the 50th Anniversary of D-Day, here is a very simple and inexpensive model for shows or celebrations of the event.