POU-POU
AN UNUSUAL HOME-BUILT

Introduction:
This is a model of somewhat unorthodox design, and it also uses a few unusual building techniques. Although it has a T-tail and a "stabilizer," it is the wing that does the "all-moving," not the horizontal tail.

This confers some advantages, such as the saving in weight and complication that results from not having the servo, pushrod, and bellcrank that are usually required to operate the horizontal tail or elevators, and this weight saving is where it usually matters most — at the tail. But I have to confess that my main reason for building it was to find out whether or not it would fly; it does! It is a one-piece model that fits easily into the back of my diminutive hatchback and can be in the air a few minutes after arriving at the field.

The T-tail configuration was chosen to keep the horizontal tail as far as possible out of the downwash of the wing, since the downwash moves up and down as the wing incidence changes relative to the fuselage and I wanted to avoid constant trim changes.

The structural design of the tilt wing led me to adopt a parasol design with external bracing, and the latter allows a very light wing to be designed.

Some inspiration came from Henri Mignet's "Pou du Ciel" (Flying Flea) tandem wing home-built of the 1930's, and the name "POU-POU" is in tribute to this. As the design proceeded, it began to look more and more like an "ultra-light," and what could be more fitting for a small electric powered model?

The front fuselage is made deep A) to keep the landing gear as short as possible, since one cubic inch of steel weighs about sixty times as much as one cubic inch of balsa, and B) to house a variety of different power packs that I wanted to try out.

I worried some about the small wing servo I intended to use (25 oz.-in. of torque at 4.8 volts) until I calculated the pitching moment of the wing and the leverage of the pushrod about the pivot point and concluded that it would be good for at least 4g. This one is not intended for fancy aerobatics.

Not wanting to risk big bucks on this rather novel design, it is designed around the popular little Speed 400 motor (geared) and eight small cells. Its structural design is more sophisticated than it looks (I try to make as many parts as possible do more than one job), and its construction is not for the raw beginner.

Having said that, let's see what is entailed. Please read through the following carefully before starting to build; there are places where the correct sequence is important, and you can be in trouble if you don't follow it.

CONSTRUCTION:
Cut all parts as accurately as possible. This will save you a lot of trouble when you come to assemble them, and all will then go together like Laurel and Hardy.
All wood is balsa unless noted otherwise on the plans. Where the grain direction is important, it is shown on the plans. Again, to save weight, birch ply and spruce is used only where I consider it to be essential to do so. I avoided so-called lite ply altogether, as I have had bad experience with it in the past. Choose all wood carefully as weight is really critical for these small electrics; these Speed 400's don't like to pull models that weigh much over 20 oz.

I use mainly aliphatic glue and 30-minute epoxy, but feel free to use whatever glues you are familiar with. I find that there is always something else to get on with while waiting for glue to set. With these adhesives I use the plastic backing from iron-on covering to cover my plans and never have any sticking problems. I wonder why so many people spend money on wax paper or plastic wrap.

Since this is not a beginner's model, I shall assume that the builder is familiar with widely used building techniques, such as pinning and clamping and the edge joining of balsa sheets, etc.

Fuselage:
Start by cutting the fuselage sides. Cut to the inside of the lines shown on the plans, as indicated by the small triangles. By reversing and overlapping, the sides can both be cut from one sheet of 3" x 36" x 1/16" balsa plus a little scrap. Note the grain direction of the sides between F-1 and F-2. You will find

POU POU
Designed by:
C. Beaumont Lewis

TYPE AIRCRAFT
Sport Electric

WINGSPAN
41.5 inches

WING CHORD
8.0 inches

TOTAL WING AREA
332 Sq. In.

WING LOCATION
Parasol

AIRFOIL
Special Clark Y

WING PLANFORM
Constant Chord

DIHEDRAL, EACH TIP
4 Degrees/Side

OVERALL FUSELAGE LENGTH
28.0 inches

RADIO COMPARTMENT SIZE
6" (L) x 2" (W) x 2-1/4" (H)

STABILIZER SPAN
18 inches

STABILIZER CHORD (inc. elev.)
4.5 inches (Avg.)

STABILIZER AREA
80 Sq. In.

STAB AIRFOIL SECTION
Flat

STABILIZER LOCATION
Top of Fin

VERTICAL FIN HEIGHT
6-3/4 inches

VERTICAL FIN WIDTH (inc. rud.)
6-1/4 inches (Avg.)

REC. MOTOR SIZE
Speed 400 (7.2V) Geared

FLIGHT BATTERY
8 cells, Sanyo 600 AA or NR600AE

LANDING GEAR
Conventional

REC. NO. OF CHANNELS
3

CONTROL FUNCTIONS
Throttle, Rudder, Wing Tilt

C.G. (from L.E.)
2.25 inches

WING TILT
5° Up - 3.25° Down

RUDDER THROWS
1° Left - 1° Right

SIDETHRUST
0

DOWNTHRUST/UPTHRUST
0

BASIC MATERIALS USED IN CONSTRUCTION
Fuselage ............ Balsa, Ply, & Spruce
Wing ............... Balsa & Ply
Empennage ............ Balsa & Bamboo

Wt. Ready To Fly .... 23.5 oz. (1 Lb. 7.5 Oz.)

Wing Loading ....... 10.2 Oz./Sq. Ft.
The removable bottom hatch makes battery access easy. Note the large openings for cooling air. A simple jig was made from a scrap piece of lumber and 1/8" plywood to accurately assemble the wing pylon. The same jig base can be used to bend, fit, and assemble the motor mount.

The tailpieces are simple built-up balsa components. Note that the horizontal stabilizer is built as one piece and does not use an elevator. Be sure to use a square when aligning the vertical fin and horizontal stabilizer. The wing bracing is quite different than most parasol type models. Clevises are fitted in the wing during assembly and act as turnbuckles when they are connected with the cables attached to the fuselage.

Out why it is vertical when you come to form the fuselage nose. Next, glue the 1/8" sq. longerons and the small doublers of 1/8" and 1/16" sheet balsa in place, making sure you are building one left and one right side. Cut four of the curved 1/16" doublers that fit between frames F-2 and F-3 so that you are left with two of them to serve as side frames for the hatch. Glue the 1/4" sq. spruce blocks for the rudder servo to the sides before further assembly. These are located just ahead of F-4.

The front fuselage is self-aligned by the "dove-tailing" of frames F-2 and F-3 with the cockpit floor and the use of a jury "floor" between frames F-1 and F-2.

When building the frames, don't glue the ply bottom of F-2 into the frame sides yet as you will need to remove it in order to attach the landing gear legs. Just leave it slotted in place in the frame during the next steps. The 1/16"D holes in F-3 for mounting the wing servo should be drilled at this stage. You may need to modify the two plywood crosspieces of this frame to accept the servo of your choice.

Make centerline marks at the top of the front faces of all frames.

Strips of Velcro are glued to the bottom of the cockpit floor to support the power pack and the receiver. This is best done before further assembly. I always glue the felt part of the Velcro to fixed structure and the hooky part to the item to be mounted. Adhering to such a convention makes switching components (RX's, ESC's, etc.) between models much simpler.

Frames F-2, 3 and 4, together with the cockpit floor, are next glued to one side, using a card angle gauge (for which a pattern is supplied on the drawings) at F-3 and F-4 and a 3/16" packing piece under the fuselage side at F-2. Small weights are used to hold the slightly curved fuselage side down on the board until the glue sets.

The ventral fin post, of 1/8" sheet with 1/32" cheek plates on the bottom part, is now glued to this fuselage side, and the second fuselage side glued to the frames and cockpit floor. When the glue has set, the fin post is placed upside down on the plan view of the drawing, and the marks you made at the tops of the frames are lined up with the centerline. The fuselage is then suitably weighted or pinned down and the tail of the second side is glued and clamped to the ventral fin post. Use a set square to ensure that the fin post is truly square to the building board.

The cross-grain sheeting is next added to the fuselage bottom from F-4 to the fin post. Leave the top sheeting until later, when the rudder pushrod and both servos have been fitted.

The front fuselage nose can now be closed. The jury floor is pinned, but not glued, in place between the fuselage sides and the frame F-1 is glued and pinned in place. This is the one time I used CA glue, as I could then clamp the sides to the frame with my fingers. The curved plywood motor mount pieces are then glued and clamped in place at the top of the nose together with the 3/8" x 1/4" spruce crosspiece at the front of the cockpit.

The top front decking is glued in place, and the jury floor removed and added to your scrap bin.

The bottom piece of F-2 is removed and the landing gear wire sewn to its front face. I drilled the numerous holes with a No. 62 drill, bound the wire to the ply with strong thread, and then coated the thread on both sides with epoxy. This assembly is then glued into F-2 with epoxy.
The hatch frame side pieces are pinned in place inside the doublers at the bottom of the fuselage between F-2 and F-3, and the hatch crosspieces glued between them. Allow the glue to set thoroughly, then remove the hatch frame and add the 1/16" cross-grain sheeting and the latch pieces. The hatch is secured by a single 6-32 mushroom headed nylon bolt passing through a tapped hole in the ply friction latch.

The bottom of the nose can now be sheeted. I found it easier to cut the hole for the cooling air before gluing it in place. The remainder of the fuselage sheeting is best left until you have made a trial installation of the servos, etc.

The nose block is carved and sanded from medium balsa, with a notch at the top for access to the front pylon screw. A 1/8"D hole is drilled through it transversely for the rigging dowel.

The wing pylon is made from 1/8" ID aluminum tubing, and pre-assembled in a simple jig. It is attached to the fuselage by three screws, two into the spruce crosspiece at the front of the cockpit and one into the spruce at the top front of F-1.

Tail:

The tail feathers are very simple and easy to build, and provide a little relaxation after you have built the fuselage. Don't forget to put 1/32" shims under the fin L.E. and stab T.E. when building them flat on the board.

Sand the front of the fin ribs flush with the L.E. to give it a (sort of) streamline section. The ventral fin is glued to the bottom of the fuselage and the front of the ventral fin post after sanding it in a similar fashion. The rear ribs of the horizontal stabilizer are also sanded to a taper between the spar and the T.E.

The L.E. of the rudder is sanded to a shallow "V" so that the rudder can swing to full thrown with a minimum hinge gap. I used Easy Hinges, and have my own pet method of cutting slots. But so, I am sure, do you.

The horizontal stabilizer is braced to the fin by two bamboo splints epoxied into partial holes in the stab and fuselage at the finpost (mine started life as shishkebab skewers). Make sure they keep the stabilizer squared with the fin when you come to assemble the tail.

Wing:

This is as simple as I could make it; if you have built a trainer, you will have no problem with this. Do not be tempted to beef it up. Because it is externally braced it is plenty strong, and saving weight is important.

I made a template of 1/16" birch ply, with the 3/8" x 3/32" spar slots. Cut all the balsa ribs, then after enlarging the slots to accommodate the joiners, use this template as the center rib, to which the pivot points are attached. The pieces are also of 1/16" birch ply, and were inserted and glued in place after the
Bottom of the wing was covered.

The lightening holes in the ribs and shear webs are optional, but note there are no lightening holes in Rib 4. I know boring holes is boring, but those in the webs are easily made with a short piece of 1/2"D copper plumbing pipe, filed to a cutting edge on the inside of one end. These holes and the scalloped T.E. account for more than half an ounce of weight saving.

Do not omit the diagonal braces between Ribs 0 and 4, which are best fitted after the wing is removed from the board. Glue the short 3/32" x 3/8" doublers to the roots of the spar caps before assembly.

I find it easier to complete one wing panel, then prop it up with the root rib aligned to the plan and build the other panel against it after gluing the joiners in place. The dihedral is 4 degrees per side, which means that the first panel should be propped up with the bottom of the tip rib 2.7" above the board.

The only tricky bit is the installation of the clevis "turnbuckles" at Rib 4. Each consists of a 2-56 clevis and a 2-56 x 3/4" socket headed bolt. Make sure they are in line with the wing bracing, as viewed from the front. They make an angle of about 30 degrees to the bottom of the wing. These "turnbuckles" are fitted after covering the bottom of the wing and before covering the top. The short 1/8"D dowels are to prevent the clevises from turning when torque is applied to the bolts. File flats on them as necessary to make them a sliding fit in the clevises you use. For tensioning the wires, the 2-56 bolts are accessed by an Allen wrench through small holes in the top covering and the plastic guide tubes that are epoxied to the tops of the spruce triangles. When fitting these tubes you should allow for the dip in the covering when it has been shrunk; if you don't, you could have unsightly bumps on top of the wing where the tubes stick through the covering.

After covering, I ironed in a washout of 3/16" under each tip rib. (Later increased slightly for RH rib — see under Flying below.)

**Landing Gear:**

The legs of the main gear are bent from 3/32"D music wire, with a couple of degrees or so of camber and toe-in. I decided to use an old pair of Trexler wheels from my junk box, since these seemed to be in character with "Pou-Pou." To make them easily removable for inflation, lengths of 3/32"L.D. brass tube were soldered over the axles, protruding 1/4" beyond the ends of the wire, and drilled for the cotter pins and washers that secure the wheels on the axles. If not flown for a week or two, these tires needed to be re-inflated, so I have since replaced them with somewhat lighter 2-1/2" Dave Brown wheels, which also...
The tail wheel assembly is made from 1/16” D wire and pivots in a brass tube epoxied in the ventral fin. To prevent any possibility of it falling out, the top 1/4” is bent slightly until it is a push fit in the tube. A short piece of thinner wire is soldered to it and attached to the rudder for steering by a pin with an eye in it and a short piece of fuel tubing. The springiness of this thinner wire will act as a servo saver, protecting the servo from shocks transmitted by the tail wheel.

**Installation:**

Two micro servos are used, one using the elevator channel to tilt the wing and the other for the rudder.

The wing servo is mounted behind the cockpit on frame F-3. The rudder servo is mounted on the 1/4” sq. spruce rails just ahead of frame F-4, and the pushrod is of 1/8” sq. hard balsa.

The power pack is attached, by Velcro, to the bottom of the cockpit floor. This is quite adequate for these small packs unless you intend to pull jet jockey g’s, which I don’t recommend with this model. So far I have used eight cells of 600 AA’s and eight cells of NR600AE’s, with about the same results, although the former is an ounce or so heavier.

The RX is mounted behind the pack, again by Velcro, to the bottom of the cockpit floor. The antenna exits through the cooling air exit and is taped to the bottom rear fuselage.

The ESC is in the cockpit, again secured by Velcro (what would we do without that stuff?) and hard wired to the motor terminals; the wires passing through a hole in the front deck. The battery wires pass down through a hole in the cockpit floor. The Jeti 10 ESC I used has current limiting, but your ESC may need a fuse. If you are using BEC, which is almost essential for small models, the fuse must be fitted between the speed control and the motor; otherwise you will find yourself without R.C. should the fuse blow. The pilot sits on top of the ESC, more or less hiding it from view.

To separate Velcro, I use a simple tool made from an old credit card, sanded thin from 20g aluminum plate, cut with a jeweler’s saw, and attached to the front deck by four screws, two into the top of F-1 and two into the plywood side pieces under the deck. You will need to bend the back legs apart when you fit the screws.

**Covering:**

I would have liked to have used LiteSpan, as it truly is light, but I didn’t have any and my nearest model shop is 200 km away. So I settled for some remnants of MonoKote I had left over. This is a small model, and easily lost to sight, so I recommend contrasting colors such as red and yellow or yellow and black. The translucent colors weigh slightly less than the opaques. I don’t go for fancy stars and stripes as they only add weight. Don’t forget to install the fittings in the wing before you cover the top.

The instrument panel is the simplest possible; just one dummy green light labeled “FLY” and one dummy red light labeled “BAIL OUT!”

**Assembly & Rigging:**

After fitting, but not gluing, the rudder hinges, the fin post is glued with epoxy to the top of the fuselage and to the back of the ventral fin post, making sure it is square with the fuselage. The fuselage is then blocked up, upside down, on books or such until the horizontal stabilizer can lie flat on the board. The stab is then epoxied to the top of the fin and diagonals measured to ensure that it is square to the longitudinal axis. Weights, such as old power packs, are placed on top of the fuselage bottom, close to the tail, to add a bit of pressure. Check that the stab is truly square with the fin.

When the epoxy has completely cured, the tail braces can be fitted by springing them into the sockets you have prepared in the stab and fin. Use epoxy to secure them and check again with a square.

Next, the wing is mounted to the top of the pylon with a 4-40 bolt and nut. Check that the wing is free to tilt without binding and lock the nut with a second nut. The wing pushrod is then fitted and adjusted so that there is a 1.7” gap between the T.E. at the center and the top of the fuselage immediately below it when the servo is at neutral. (This is a good starting point, but you may have to make small adjustments later.) The model is then replaced on the board and a loop of cord prepared that will stretch from the L.E. of one wingtip around the fin post and back to the other wingtip. This loop is then secured to the wingtips so that it is taut, and adjusted at the fin post until the wing is square with the fuselage in plan view. Check this by measuring the diagonals between the wingtips and the fin post. When satisfied that the diagonals are the same, secure the thread loop at the fin post with a piece of tape.

From the front, check by sighting over...
the wing that it is correctly aligned with the stab. Block both sides of the wing to ensure that it stays that way. You are now ready to rig the flying "wires."

Rather than use metal wires that might cause radio problems, I chose to use a strong polyester thread that had been doubled and pre-stretched for a couple of days by hanging a loop of it with a weight (a small vise) at the bottom. This was rigged as a continuous loop on each side through the wire hooks at the fuselage sides and the fully extended clevises at each of the #4 ribs of the wing. These hooks are attached to both ends of a short dowel passing through the nose block, and to both ends of a strip of 22g aluminum secured to the bottom of the fuselage just behind the hatch. The hooks make it possible to remove the wing easily for transport or repairs, but make them secure by nipping them closed if you intend to try flying inverted. No outside loops, please!

The loops are then pulled taut and knotted; simple reef knots will suffice. The knots are then moved up to the clevises and the bight at each clevis is served with a finer thread. The servings cover the knots, and a drop of glue rubbed into each with a fingertip makes everything secure.

The clevis "turnbuckles" are then adjusted to tension the braces on both sides. I do this by twanging the "wires" and adjusting until I hear the same note from both sides. I find it hard to describe what this pitch should be, but it is in the higher end of the bass register.

I measure all incidences using sticks with marks 11.46" apart, attached to the flying surfaces with rubber bands. A difference in height of 0.2" at the fore and aft marks is equivalent to one degree.

Flying:

I found it hard to decide what range of tilt to provide for the wing, but finally decided to try 4 degrees up and 3 degrees down. The neutral incidence was then set at +2 degrees to the horizontal tail. These settings were subsequently changed during initial test flying (see below). The initial C.G. was at 28% of the mean chord, and could be adjusted easily by moving the power pack fore and aft.

For control, I used my Futaba computer radio. This is rather overkill for a simple three channel model, but it makes it very easy to change the throws and to make other adjustments during the initial test flights.

Having not flown without ailerons for a long time, I decided to use one of the program mixers on the radio to set up the rudder stick as master (Ch 4) and the aileron channel (Ch 1), which I was using for the rudder, as slave. I could then use the left stick (Mode 2) to control the rudder during take-offs and the right stick to make turns once airborne. This has worked well, but don't try to coordinate turns in the air with the rudder! With a little camer and toe-in at the wheels, the take-off runs are very straight, unless it hits a bump, and rudder corrections are rarely needed.

I was a little worried about the effect of variable down thrust, as the wing tilts relative to the thrust line, and set it initially at zero. I have had no reason to change this since, but it can easily be done by inserting washers under the motor mount.

I was more worried about take-offs and landings, though fairly confident it would fly well once airborne.

Well, time to stop worrying and start flying.

I was right; on the first two attempts at take-off it trundled along on our scrubby grass/dirt field in a nice straight line, but this flea wouldn't jump! But from a hand-launch it climbed away slowly and steadily and made a good 5-minute first flight. On landing I gave it full back stick but it didn't want to flare and made a three point landing on two wheels and its nose. So back to the workshop.

The Trexler wheels, which are draggy both on the ground and in the air, were replaced by Dave Brown 2-1/2" Lite wheels; motor tests indicated that switching to a Master Airscrew 9 x 6 propeller would produce an ounce or two more thrust. On subsequent flights, I was somewhat surprised to find that a 10 x 7 was even better. Most importantly, the throws of the wing tilt were increased, with low rate set at 60%, and I decided to use high rate for take-offs and landings.

Back to the field to find that "Pou-Pou" would ROG after a reasonably short run, was great fun to fly close and low with tight turns and gave flights of six to eight minutes. Loops require an initial shallow dive, and tight turns a bit of extra throttle and quite a bit of back stick. It is truly what is today described as a "park flyer."

Further small adjustments have been made and the present wing settings, measured at high rate and from neutral, are: +5 degrees up and -3.25 down. At neutral, the bottom of the wing (not its chord line) is at +1.6 degrees to the tail. The rudder throw at high rate is 1" each side, with low rate at 60% of this. I find it essential to use high rate for the tilt wing for take-offs and landings.

The propeller torque is quite high for a small model. Rather than use side thrust, I decided to try increasing the washout at the right wingtip by about one degree. It worked!

Should you decide to build a "Pou-Pou," I wish you Happy Tilting.