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TWIN POND MASTER

Electric Seaplane For Two Speed 400 Motors

My good friend Bill Warner lives on a small lake. Several years ago I built an Ace "Puddlemaster" and Bill built a "Pond Side" (both are the same airplane, designed by Scott Hartman). Both airplanes flew just fine and we quickly learned the fun of seaplane flying. We also learned some of the advantages of electric powered seaplanes. The most obvious — there was no noise to bother the neighbors.

Since we are both scratch-designers/scratch-builders from the early days of U-control, we quickly began to seek ways to modify and improve the PM's performance. We were annoyed by the pitch trim change associated with the high thrust line. One thing led to another, and Bill decided to replace the single, pylon-mounted Speed 600 with two Speed 400's mounted on the wings. Bill went through two design cycles, reducing structural weight and adding improvements each time. After completing and flying his second Twin PM, and optimizing the battery selection, it became obvious to both of us that this was a real winner! With the wheel dolly taped in place it is even fun to fly off the runway. The Twin PM retains the same basic hull features, wing airfoil and tail shape as the original Puddlemaster, but there are

Ready to fly as a seaplane.

By Bob Hoey and Bill Warner

some significant changes in addition to the twin-engine arrangement;

(1) Wingspan and chord were increased.
(2) Strip ailerons were added.
(3) Dihedral was reduced.
(4) Fuselage was lengthened.
(5) Structural weight was reduced.

The two 7.2 volt Speed 400's are wired in parallel and powered with either a 7-, 8- or 9-cell, 2000 mAh NiMH battery pack. (8-cell works best). Flight times average eight minutes.

Fuselage:

The fuselage sides are cut from two sheets of 3/32" x 4" x 36" balsa. The sides are larger than 4" x 36" so you will need to add extension splices at the bottom and rear as shown on the plan. Use the fuselage side view for the pattern but add 3/32" to the height over the

TWIN POND MASTER

Designed by:
Bill Warner & Bob Hoey
(Original: Scott Hartman)
TYPE AIRCRAFT
Electric Sport Twin Seaplane
WINGSPAN
51 Inches
WING CHORD
9.25 Inches
TOTAL WING AREA
463 Sq. In.
WING LOCATION
High Wing
AIRFOIL
Flat Bottom (13% thickness)
WING PLANFORM
Constant Chord
DIHEDRAL, EACH TIP
1.25 Inches (upper surface)
OVERALL FUSELAGE LENGTH
39.5 Inches
RADIO COMPARTMENT SIZE
5" (L) x 3.5" (W) x 2.5" (H)
STABILIZER SPAN
16 Inches
STABILIZER CHORD (inc. elev.)
5.3 Inches (Avg.)
STABILIZER AREA
84.8 Sq. In.
STAB AIRFOIL SECTION
Flat
STABILIZER LOCATION
Top of Fuselage
VERTICAL FIN HEIGHT
6 Inches
VERTICAL FIN WIDTH (inc. rud.)
5.75 Inches (Avg.)
REC. MOTOR
Two 7.2V Speed 400's (direct drive)
BATTERY SIZE
8-Cell, 2000 mAh NiMH
LANDING GEAR
Removable Ply & Lite Ply
Taildragger Configuration
REC. NO. OF CHANNELS
4
CONTROL FUNCTIONS
Rud., Elev., Throt., Ail.
C.G. (from L.E.)
2.6" to 2.8"
ELEVATOR THROWS
1/2" Up — 1/2" Down
AILERON THROWS
3/16" Up — 3/16" Down
RUDDER THROWS
1" Left — 1" Right
SIDETHRUST
—
DOWNTHRUST/UPTHRUST
1.5° Downthrust (each motor)

BASIC MATERIALS USED IN CONSTRUCTION

Fuselage	Balsa & Lite Ply
Wing	Balsa, Ply & Lite Ply
Empennage	Balsa, Ply & Bass
Wt. Ready To Fly	40 Oz. (2 Lbs. 8 Oz.)
Wing Loading	12.4 Oz./Sq. Ft.

entire length to compensate for the sloping sides. Mark the bulkhead locations on the inside of each side piece. Start by gluing the 3/32" wing support doublers and aft fuselage extension doublers to each side. Also locate and glue bulkhead 3A to the aft side of bulkhead 3 with the upper edge exactly 3/4" below the top of bulkhead 3. Mark a centerline location on the bottom of each bulkhead. Sand a taper in the aft doubler as shown on the drawings.

Set the two fuselage sides upside down and on edge on a flat surface and glue the two sides together at the rear. Make sure that the upper edge of each side stays flat on the table and that the sides stay perpendicular to the surface while the glue is setting. Set bulkhead 3/3A in place with the upper section against the forward end of the wing doubler and bulkhead 3A against the bottom edge of the doubler. Squeeze the sides together and glue bulkhead 3/3A in place. Similarly glue bulkheads 4 and 5 in place. Maintain visual alignment of the centerline of the bulkheads during this process but do not attempt to hold the top edge of the fuselage sides flat against the table. A natural bow will occur along the upper corner of the fuselage as the sides are pulled into place. Glue bulkhead 3B in place so that the top end rests against the wing support doubler. Glue bulkheads 1 and 2 in place, being careful to maintain the alignment of the bulkhead centerlines.

From a sheet of soft 1/2" balsa, cut a piece 5" long and 2-1/8" wide. Chamfer one side to 3/32" thickness to form the step. Position the front of the step (the 3/32" edge) 1-3/16" aft of bulkhead 3 and glue in place. From a sheet of soft 3/8" balsa, cut a piece 3-1/8" long and 5/8" wide. Chamfer this piece to a triangular cross-section to form the wing alignment block and glue across the top of the fuselage with the aft edge aligned with bulkhead 3.

Plank the bottom of the fuselage forward and aft of the step with soft 3/32" sheet with the grain running across the fuselage. You may have to wet the outside of the forward pieces to curve them around the nose. Locate the wing hold-down dowels and epoxy them in place. Fit and install the 3/16" sq. bottom and side stiffeners. Install two short 3/16" stiffeners on the aft side

Ready to fly as a land plane.

ABOUT THE AUTHORS

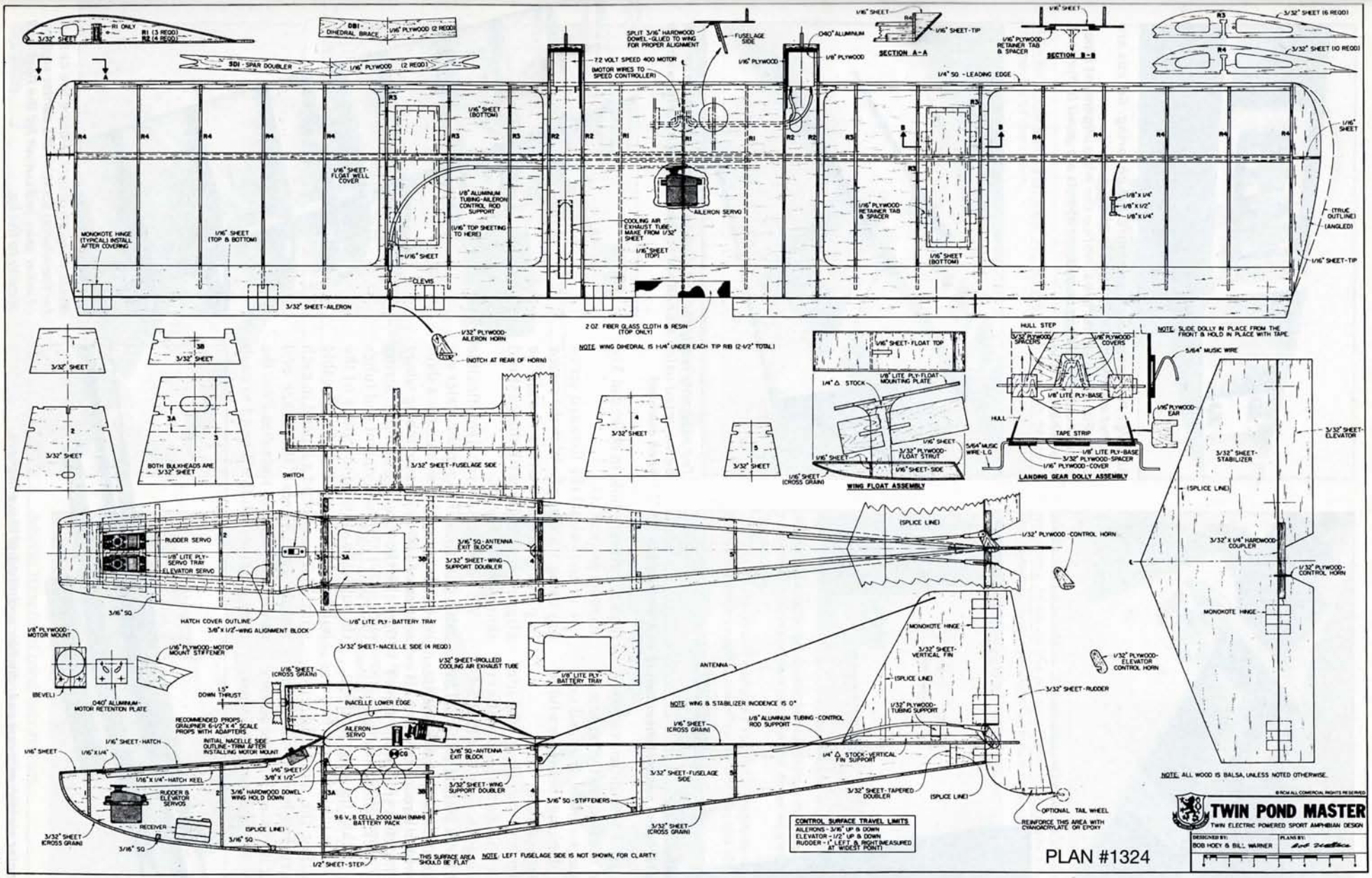
As a teenager in the Seattle area, Bob Hoey's modeling interest was control-line stunt and scale. He earned his pilot's license at age 16. Upon graduation from the University of Washington in 1955 with a BS in Aero Engineering, he reported to Edwards AFB, California, where he worked as an Air Force flight test engineer for 32 years. He occasionally found time to participate in some of the Southern California free-flight contests in the late 50's and 60's and also built a few indoor models to fly at lunch time in the Weight and Balance hangar at Edwards.

He developed an expertise in aircraft stability, control, and simulation, and was directly involved with the flight testing of the rocket powered research airplanes including the X-15, X-24B, and the Space Shuttle, as well as many of the Air Force fighters such as the F-104, and F-16.

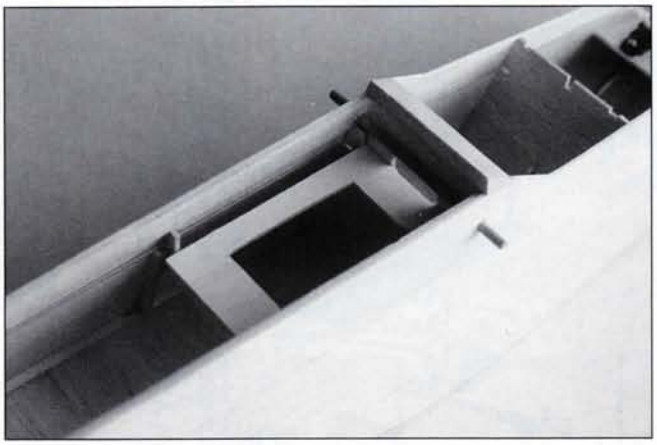
In 1968 he completed construction of a full-size all-wood sailplane and in 1970 earned his Diamond soaring badge. He constructed a 4-place BD-4 in 1979 which he and his wife continue to fly.

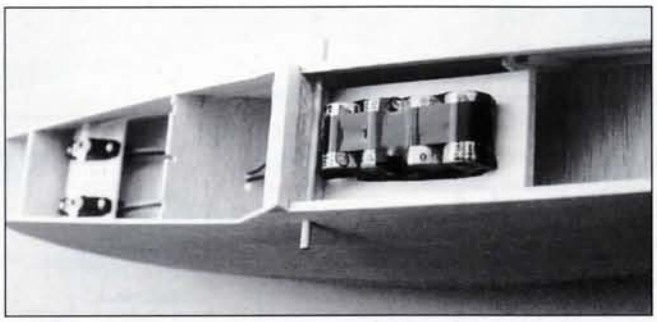
He retired as Chief of the Office of Research Projects at the Air Force Flight Test Center in 1987 and has since been working as a part-time consultant. Spare time is now spent building and flying R/C models. Bob's first model published in RCM was the Raven II (Plan #1160) in the January 1994 issue.

Bill Warner kept accruing pilot ratings after high school and hired on at Pacific Northern Airlines in Alaska when he was 19 (under an "age" waiver). He took a year off, attending the University of Puget Sound, then, in 1955, hired on with Western Airlines which became Delta. He retired at age 60 after 38 years of left-seat airline flying (pretty unusual!). He was flying Pacific routes in an L-1011. He designed a fun-fly airplane in the 70's called the "Dart Cart" (Plan #432), and has been active in model helicopters and pylon racing.

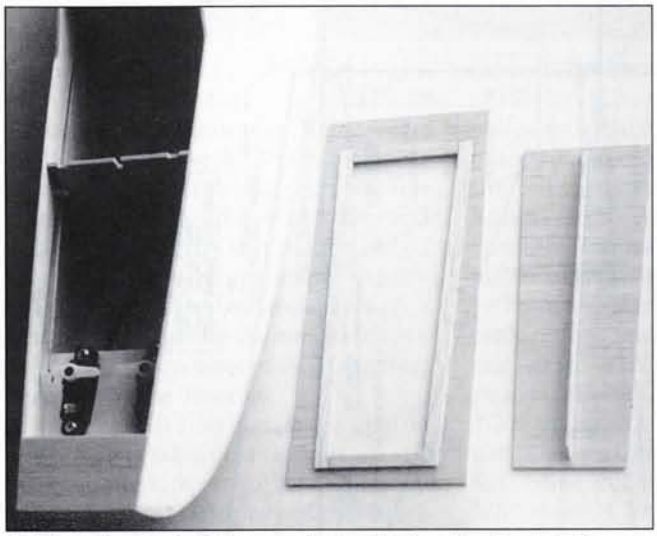


FULL-SIZED PLANS AVAILABLE SEE PAGE 169

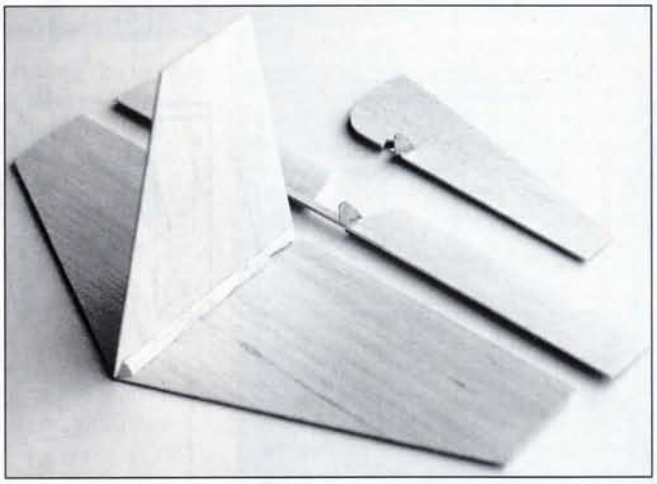




ABOVE: Forward fuselage before top covering. Servos are installed and the battery pack is in place.
LEFT: Fuselage center area. Notice the wing alignment block above bulkhead 3. Wing hold-down dowels are glued to the back of bulkheads 3 and 4.



Hatch and outer hatch support sheet before final installation.



Tail assembly ready for installation. Rudder and elevator will be mounted using MonoKote hinges after the surfaces have been covered.

of bulkhead 3B. These stiffeners should extend from the floor to the bottom of the slot for the pushrods. Trim and sand the bottom planking, being careful to retain the sharp corners.

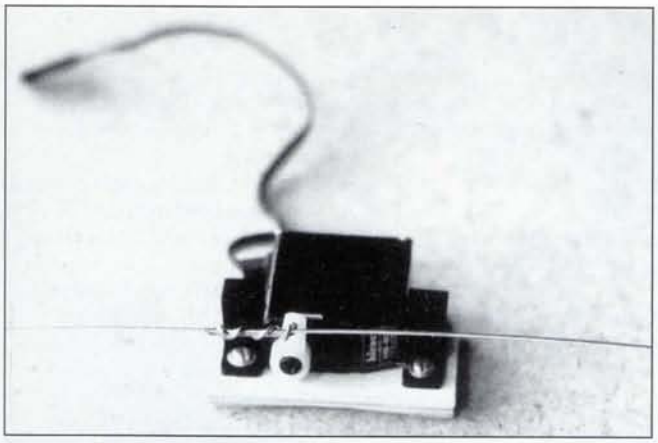
Cut the battery tray from 1/8" lite ply. Cut the hole to fit your battery pack. (Drawings show an 8-cell, sub-C size, 2000 mAh NiMH pack). The battery tray should fit into the notches on the top of bulkheads 3A and 3B. Trim these notches so that the top of your battery pack, when installed, will be about 1/4" below the wing platform. A piece of foam laid over the battery pack will allow the wing and wing hold-down rubber bands to hold the battery pack in place. Glue the battery tray in place. (Long narrow packs may require cutting a hole in bulkhead 3 to maintain proper C.G.)

Cut and install the forward servo tray using 1/8" lite ply. With the servos in place the servo arms should be aligned vertically with the pushrod slots in the bulkheads.

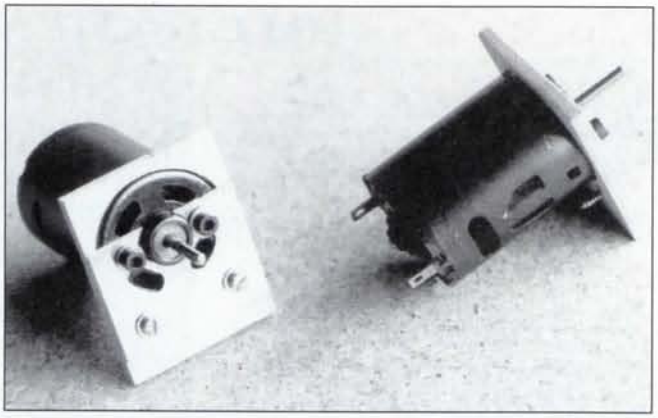
We used the Sullivan light, flexible cable pushrods. To keep the water out we ran the outer sleeves through a short section of 1/8" aluminum tubing where they exit the fuselage or wing. String the outer (yellow) control rod tubes through the slots in the sides of the bulkheads. Tin one end of each cable with solder and bend a Z bend in each tinned end. Thread the other end through the control rod tubes from the nose, then attach the Z bend to each

Basic wing structure. Notice the cutout for the aileron servo in the center section of lower skin, and cutout for the float well midway to the tip.

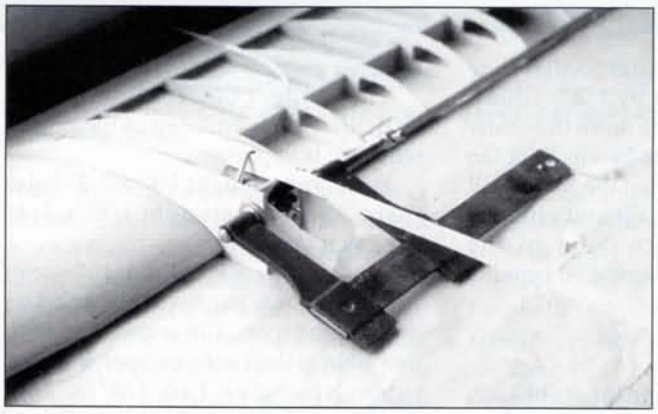
Wing spar center section with one spar doubler and dihedral brace in place.

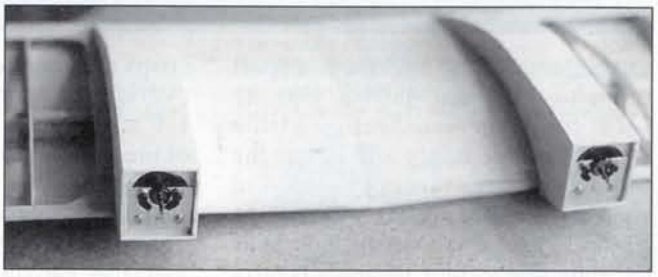


Aileron cable showing the 1/16" wire with Z-bend soldered to the center of the cable.



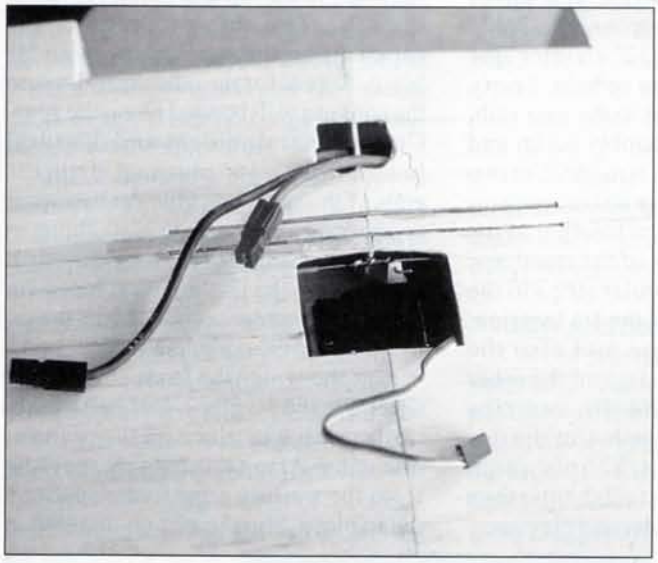
Motor mount details. Aluminum retention plates are bolted to mounting holes on the motors. Retention plates are then held to the plywood motor mounts with two screws below each motor.

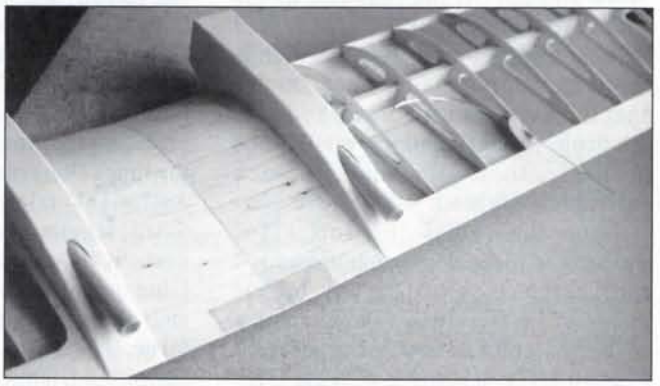




ABOVE: Completed motor installation in nacelles. Removing the two lower screws allows each motor to be slipped forward out of the nacelle.

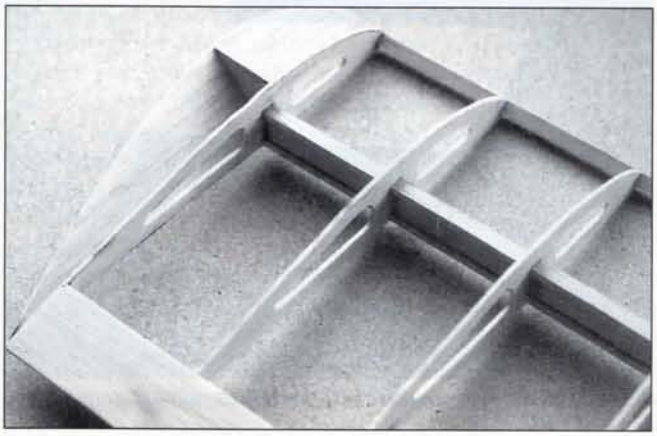
LEFT: The motors are aligned for 1-1/2 degrees of down thrust, then the motor mounts are glued to the nacelle sides.

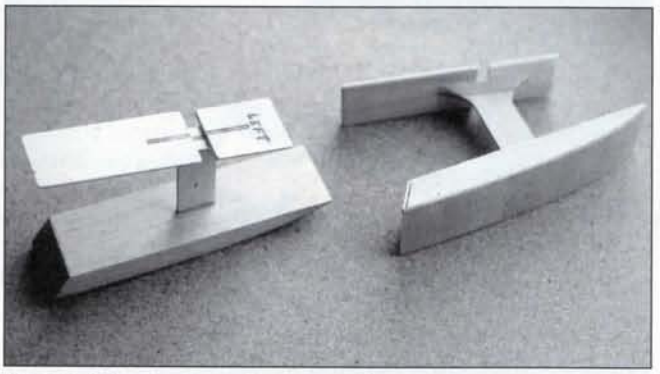




ABOVE: Cooling exhaust tubes. Also notice the aluminum tube and outer push cable cover for the aileron controls. The float mount well covering has been installed (visible underneath the alum. tube). Reinforcing fabric has been applied to the wing trailing edge at the center joint.

LEFT: Wing center section showing motor power wires and aileron servo installation.





ABOVE: Wing floats ready for covering.

LEFT: Wingtip installation — simple and light.

BILL OF MATERIALS

Balsa
7 — 3/32" x 4" x 36" — Fuselage, tail, ailerons, wing ribs, nacelles
5 — 1/16" x 4" x 36" — Wing sheeting, trailing edge, fuselage top, floats, hatch, wingtip
2 — 1/8" x 1/2" x 36" — Wing spars
4 — 1/8" x 1/4" x 36" — Spar caps
1 — 3/16" sq. x 36" — Fuselage stiffeners
1 — 1/4" tri. x 36" — Fin and float reinforcement
2 — 1/4" sq. x 36" — Wing leading edge
1 — 1/32" x 3" x 4" — Exhaust tube

Balsa Blocks
1 — 1/2" x 3" x 5" — Step
1 — 3/8" x 5/8" x 4" — Wing alignment block

Bass or Spruce
1 — 1/4" x 3/32" x 3" — Elevator spar
1 — 3/16" dowel — Wing hold-down

Plywood
1 — 1/8" x 6" x 12" lite ply — Floats, bat. tray, servo tray, gear dolly
1 — 1/8" x 6" x 12" — Motor mount
1 — 3/32" x 6" x 12" — Float strut, gear dolly
1 — 1/16" x 6" x 12" — Spar doubler, dihedral brace, motor support, float attach. tabs
1 — 1/32" x 6" x 12" — Control horns, pushrod support

Hardware
1 — 1/8" x 36" aluminum tubing — Pushrod support
1 — .074" x 12" music wire — Landing gear dolly
1 — .032" x 2" x 2" aluminum plate — Motor retention
3 — Sullivan light, flexible cable pushrods
2 — 7.2 Volt, Speed 400 motors (GR 1794, Hobby Lobby; or #m721, Magellan Technologies, Inc.)
8 — 2000 mAh, NiMH, sub-C size cells (Panasonic) (PM201, Magellan Technologies, Inc.)
6 feet of #16 gauge wire
1 — Speed controller — Jeti 50 or equivelant (JE500, Hobby Lobby)
2 — 6.5 x 4 Graupner props and adaptors (GR6070P and GR605323, Hobby Lobby)

servo. Bend the two 1/8" alum. support tubes to the shape shown. Cut the 1/16" balsa top rear sheeting a little wider than necessary and locate the two holes for the pushrod tubes. Cut and elongate the holes for a fairly tight fit for the 1/8" alum. tubing. Now slide the alum. tubing over the outer control rod tubes and position the outer control rod tubes so there is about 5/8" between the forward end of each tube and the servo arms at zero deflection. Mark and cut off the rear end of the control rod tubes about 5/8" forward of the rear end of the fuselage (which is the rudder/elevator hinge line). Double check that the outer control rods are the proper length and are positioned properly, then glue them to each individual bulkhead.

Glue the remaining top 1/16" sheeting in place between bulkheads 4 and 5, and on the top of the nose back to bulkhead 1 using cross-grain direction.

The hatch is assembled separately. Cut two 3-1/4" lengths of 4" wide 1/16" sheet balsa. Glue them together to make a 3-1/4" x 8" section with grain running crosswise. Mark the centerline, then mark the hatch dimension and carefully cut out the hatch. Glue 1/4" x 1/16" strips around the cutout so that they overlap the opening by 1/8". Glue a 1/4" x 1/16" balsa spine down the center of the underside of the hatch. Trim the ends of the spine so that the hatch will fit into the opening. Fit and glue the outer hatch support sheet to the fuselage. The spine should fit into the slot in bulkhead 3.

Tail:

Cut the outlines for the stabilizer, fin, rudder, and the two elevator halves from very flat, medium weight, 3/32" sheet balsa. Cut the 3/32" elevator spar from 1/4" x 3/32" pine or bass. Epoxy the two elevator halves to the spar stub, ensuring that the assembly is flat and the hinge line remains straight. Cut two 1/4" x 1/4" triangular balsa strips to 5-1/2" length. Mark the location of the vertical fin on the top of the stabilizer. Glue one of the triangular strips to the stab along one side of the fin location. Glue the fin in place and also the matching triangular strip on the other side. Make sure the fin remains perpendicular to the stab. Cut the two control horns from 1/32" plywood. Drill for the clevis attachments, then epoxy them to the rudder and elevator.

Wing:

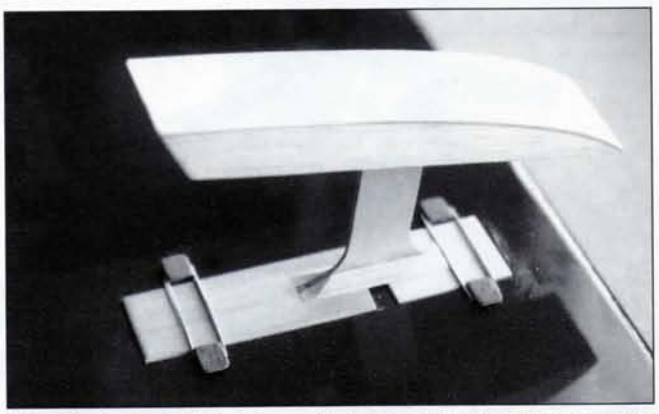
The wing construction is not difficult, but assembling in the proper sequence is important.

Select two, straight 1/8" x 1/2" balsa spars, and four, straight 1/8" x 1/4" balsa spar caps.

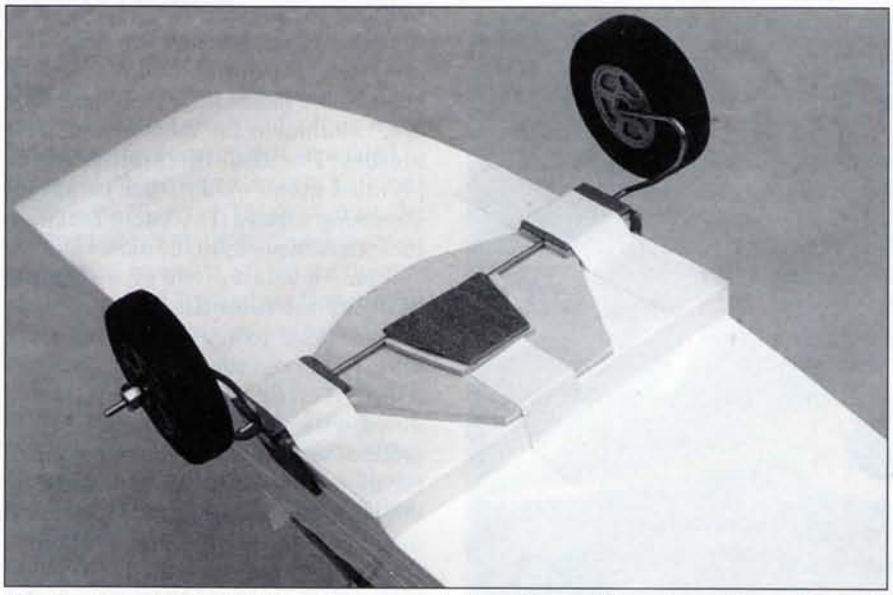
Lay a strip of 1/16" x 3/16" scrap sheet balsa on your workbench as a shim for the spars. Cover this shim with wax paper, then set one spar over the shim. Now glue two 1/8" x 1/4" capstrips to the top and bottom edges of the spar. The shim will center the capstrips on the spar, creating an "I" beam. Repeat for the other spar. Be sure the caps are well bonded along the span. Cut the spar doublers and dihedral braces from 1/16" plywood. Trim the ends of the spars and glue the two spars together on a flat surface, also gluing in the two spar doublers as a dihedral guide. Glue the two dihedral braces in place at the center section. Mark the rib locations on the completed spar.

Cut the wing ribs from 3/32" balsa sheet. Pin the 1/16" x 1-1/4" balsa lower trailing edge in place on the plan for one wing. Also fit the lower sheeting from the trailing edge to the spar and pin in place. Slip the ribs on one spar in

Wing float setting next to the float mount well. Notice the plywood hold-down tabs around the float well.



Wing floats are held in place with two small rubber bands across the hold-down tabs.



Landing gear dolly installation. Note gear wire bent to provide spring action and to soak up landing forces.

their proper sequence. The lower sheeting forward of the spar should extend forward of the leading edge for later trimming. Glue the spar to the lower sheeting (notice that the spar sits flush with the bottom of the wing) and glue the ribs in the marked locations on the spar and trailing edge. Turn the wing and repeat for the other side. Trim about 1/16" from one edge of the 1/4" sq. leading edge where it will lay on the lower sheeting. Fit and glue the leading edge to the wing ribs and sheeting. Repeat for the other wing.

Carve or sand a taper to the lower trailing edge to match the wing rib contour. Glue the upper trailing edge in place, while holding each wing flat to the workbench. Now is the time to build the well for the wing floats. Refer to the plans, then cut the holes in the lower sheeting, forward and aft of the spars, where the floats will seat. Glue 1/16" balsa sheeting over the well on the inside, overlapping about 1/8".

Before sheeting the top of the wing, bend and install the 1/8" alum. tubing for the aileron pushrods where they exit the wing. Cut a hole in the center section of the lower skin where the aileron servo will mount. Install the outer control tube inside the alum. tubing, feeding it inboard to the aileron servo location, but do not glue in place yet.

Holding one wing flat on the workbench, install the 1/16" top sheeting from the center rib to beyond the nacelle location. Repeat for the other wing. Shape the leading edge.

Cut away the skin and center rib to make room for the aileron servo. Cut a slight "V" in a piece of 3/32" x 1" x 1-7/8" balsa to fit the dihedral of the top wing skin at the aileron servo location. Glue in place, then glue a piece of 1/8" x 1" x 1-7/8" lite ply over the balsa. Fasten the aileron servo in place using either servo tape or flat-mount adapters.

Make a "Z" bend in a short length of 1/16" music wire. Place against the center of the aileron push-pull cable and wrap with thin copper wire to hold it in place, then solder the music wire to the aileron cable. String each end of the push-pull cable through the wing tubing and fit the "Z" bend to the aileron servo arm. Slide the yellow outer control tubes in or out on each wing to provide sufficient clearance for full servo arm travel, then glue them in place.

Nacelles And Motor Installation:

Cut out four nacelle sides from 3/32" sheet balsa. Note that the lower forward portion of the nacelle sides is cut initially to match the lower wing surface. It will be trimmed later. Carefully cut the motor mount bulkhead from 1/8" plywood. The best method is to cut the outer dimensions oversize, drill and sand the hole for a loose fit around the motor, then trim to the correct outer dimensions. Set one wing flat on the workbench. Position and mark the outboard nacelle side location on the wing. The forward segment should rest on the workbench. Repeat for the other wing and nacelle. The outboard sides of the two nacelles must be no less than 10-3/4" apart to provide adequate propeller clearance. After trimming to match the wing surface and locating square with the wing leading edge, glue the two outboard nacelle sides in place. Using the motor mount

bulkhead as a guide for spacing, glue the inboard nacelle sides in place. Do not install the motor mount bulkhead yet. Cut the motor retention plate from .032" aluminum and mount them to the motors. Position the motors in the plywood motor mount, then install the mounting screws (two each) that hold the retention plates to the motor mount.

Place a small piece of wax paper between the retention plate and the motor mount to keep from gluing the plate to the bulkhead. Again, set one wing flat on the workbench and hold it down with weights. Tape a straight piece of wood with a shim to the top of the motor to set the motor alignment. Put shim blocks under the motor until the upper edge of the motor mount is flush with the top of the nacelle sides. Now set the motor alignment at -1.5 degrees by blocking the forward end of the alignment tool so that it is 3/8" lower than the motor shaft height at a distance of 1 foot ahead of the motor. When the motor is properly aligned, epoxy the motor bulkhead to the nacelle sides. Repeat for the other wing. Glue the 1/16" plywood stiffener to the inboard nacelle sides and to the wing leading edge and motor bulkheads.

Now is the best time to string the motor wiring through the wing. Use #16 wire. Strip away a 1/2" length of insulation from the center of each of the two power wires. Solder a short length of wire (long enough to be connected to the controller while mounting the wing) to the stripped center segment of each wire. Solder connectors to the other end of the short segments. Use heat shrink tubing over the solder joints. Cut a small hole in the center section of the lower wing sheeting forward of the spar. Cut holes in the top wing sheeting inside each nacelle. String the wires through the holes in the ribs and up into the nacelles on each side. The power wires can now be soldered to the motors, allowing enough slack in the wires so that the motors can be removed (slipped forward) by unscrewing the two retention plate screws.

Trim the lower forward portion of the nacelle sides and cover the top and bottom of the nacelles with 1/16" balsa with the grain running crosswise.

The cooling air exhaust is made from 1/32" sheet, soaked in water, then wrapped around a 1/2" dowel. This keeps the water out, and also adds that turbo-prop look. Cut the 3/4" wide strip ailerons from 3/32" sheet and glue the 1/32" plywood horns in place. Cut the wingtips and the 45-degree tip rib from 1/16" sheet and glue in place.

Cover And Assembly:

Before mounting the tail assembly, trim the aft fuselage sides to ensure that the tail incidence is correct. Use a straightedge to establish a line at the tail mounting position that is parallel to the wing mounting surface. You will likely have to trim 1/16" or so from the forward part due to the fuselage bow mentioned earlier. Also ensure that the stab will mount flat and the fin vertical. Now glue the tail assembly on the fuselage.

Cover the airplane with your favorite film covering. We used MonoKote. Electric airplanes don't have to worry about oil or fuelproofing, but seaplanes still have to worry about waterproofing. Seal everything that might leak or soak up water. Wrap a sheet of wax paper around the wing where it mates with the fuselage. Spread some silicone RTV sealer all around the fuselage wing mount area, especially at the leading edge, and mount the wing with #64 rubber bands. When dry, remove the wing and wax paper and trim the sealer with a sharp knife.

All control hinges were made using MonoKote which seem to work very well. You can now measure the clevis location for neutral control surface deflections and solder the cable pushrods to each threaded clevis fitting. Add a short 1/2" width of 1/32" plywood under the rear end of the elevator and rudder aluminum tubes for support.

Assemble the float top and sides from 1/16" sheet balsa. Add the cross bulkhead at the angle shown, then plank the bottom with 1/16" sheet cross-grain. Glue the 3/32" plywood struts in place. The mounting plates are cut from lite ply. Notice that there are two plates on each strut: one forward and one aft of the wing spar. Glue the strut to the plates, then add a 1/4" triangular brace to each side at the top of the strut. The plates should fit loosely into the wells in the wings.

Prepare the float hold-down tabs by cutting eight 3/8" x 3/8" tabs and eight 3/8" x 3/16" spacers from 1/16" plywood. Glue one spacer to each tab. Locate the tab locations on the bottom of each wing and remove a small area of the covering to allow each tab/spacer to attach to the balsa sheeting. Glue the tabs in place at the edges of the float wells.

Wheel Dolly:

The wheel dolly allows the Twin PM to be flown from normal R/C runways. Cut the wheel base from lite ply. Cut

the two ears and the three cover plates from 1/16" ply. Cut the spacers from 3/32" ply. Bend the .074 (5/64") landing gear wire to the shape shown, ensuring that the two axle stubs are properly aligned with each other. Tape a piece of wax paper to the bottom of the hull, wrapped about 2" up the sides. Set the base in place on the hull with the rear edge aligned with the step. Epoxy the two ears to the base directly over the hull using tape or rubber bands to hold them firmly against the fuselage sides. Trim the spacers to the shape of the landing gear wire and glue to the base. Finally, glue the covers in place over the wire and install the wheels (3" wheels for grass, 2" for hard surface).

The entire assembly will slide in place from the front. Use three strips of tape, one on each side and one down the middle, to hold the dolly in place on the hull. If you plan to do a lot of land flying, add a wire skid, or even a tail wheel to the bottom of the rudder. You may also want to reinforce that lower MonoKote hinge on the rudder with one that will better handle the landing loads.

Flying:

Install the props. We use the Graupner 6-1/2 x 4 scale props with adapters. Install the battery pack then connect the motor wires in the wing to the controller, and the aileron servo wire to the receiver. When flying off of water, run a thin layer of petroleum jelly all around the fuselage wing mounting area to help seal the wing joint. Hold the hatch in place with a strip of waterproof tape all around the opening. Do a good range check to ensure that the controller, receiver, and both motors are behaving properly. The rpm of the two motors may be slightly different. This is not a concern unless the difference is more than about 300 rpm. Also be sure that the C.G. is on the forward edge of the wing spar. The handling qualities of the Twin PM are fairly docile. A little aileron-to-rudder mixing will help coordinate turns. It can be taxied on the water with ease and is even capable of some impressive, high-speed "step" turns. With the flat-bottom wing, the model is not fully aerobatic, but it can do successive loops and rolls. Splash-and-go's are great fun. There is no noticeable trim change with power, so go-arounds are less stressful than with the original PM. The flying qualities are the same for the land and sea versions.

W hope you enjoy your Twin Pond Master as much as we do ours. Have fun!