Eva Profit and the Sesquiphib D. Transparency by David Pierce.

SESQUIPHIB D

This is really two articles in one, a construction article on a unique amphibian and a design philosophy article. Besides a sport airplane, the likes of which there ain't, I promise you some new design thoughts in a number of areas.

I call this model "Sesquiphib" because it is a sesquiplane and an amphibian. Name yours "Rover" if you want — no, don't! It is not "a dog." Performance is very good.

A sesquiplane is a somewhat rare configuration having one and a half wings. Call it a monoplane and a half, or three quarters of a biplane if you prefer. The "D" on the end of the name indicates mine is diesel powered (Davis conversion).

ABOUT THE AUTHOR

Francis Reynolds has been building models since 1930. He earned his pilot's license in 1939. Starting in 1946, he has had modeling articles in "Air Trails," "American Aircraft Modeler" and "Model Builder" magazines. According to a forthcoming book on model history by Charles Mackey, Francis was the first to fly inverted and do outside loops with control-line.

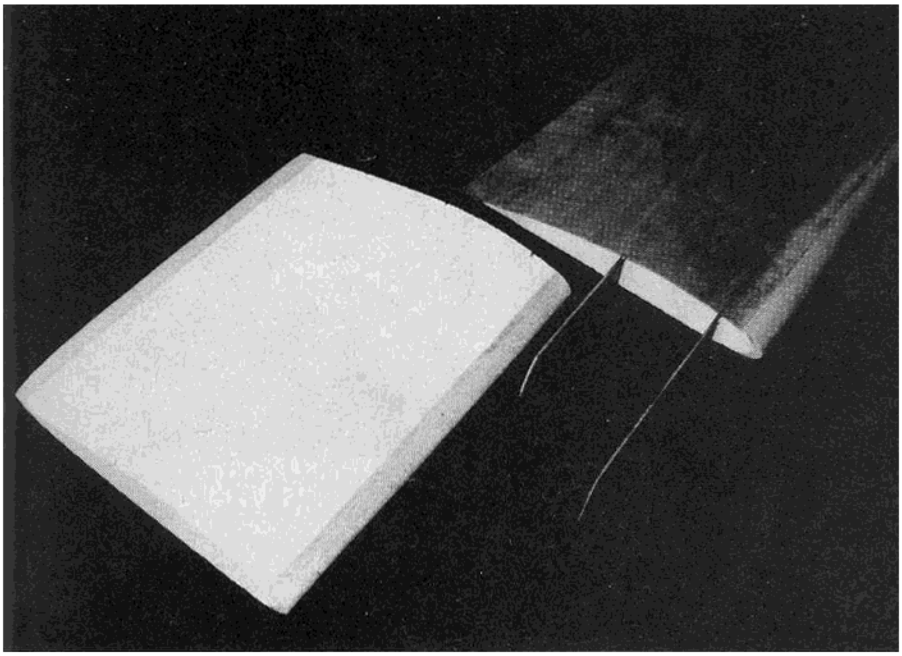
Francis won the National Championship in R/C sailboat racing in 1952 and an International Championship with an R/C model fire-fighting boat in England in 1960. The control system for that boat, which he co-invented, was then used on the BOMARC defense missile.

Francis lives on Lake Sammamish, east of Seattle and flies R/C seaplanes from his own dock. Since he "graduated" from Boeing in 1981, after nearly 40 years in engineering management, he is inventing, teaching inventing, lecturing and writing. He is also a consultant to other inventors. This work includes building models and developing prototypes of inventions.

Reynolds is a Registered Professional Engineer and an Associate Fellow of the American Institute of Aeronautics and Astronautics.

Besides having a strange name and an unusual wing configuration, this plane is unique in that the wheels, which make it an amphibian, do **not** retract when it is used on water. Normally it is a must to retract the wheels of an amphibian, because everyone knows that wheels in the water would create horrendous drag and probably prevent take-off. Normally this is correct thinking, but it assumes "normal" wheels. Sesquiphib is equipped with most abnormal wheels. They are very thin, and large in diameter. A thin disk acts like a fin or keel in the water, and has little hydrodynamic drag.

Things that look different than we are used to may seem weird and ugly. Big thin disk

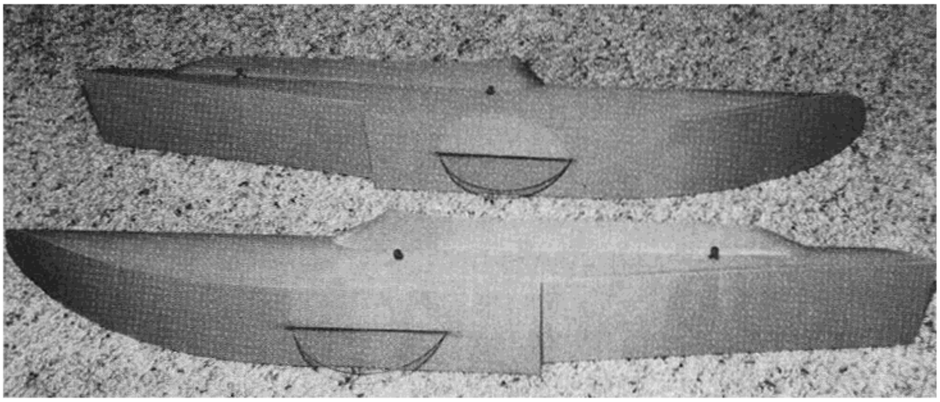


Lower wing cores with center joint spars. Lower wing is skinned with 1/64 plywood.

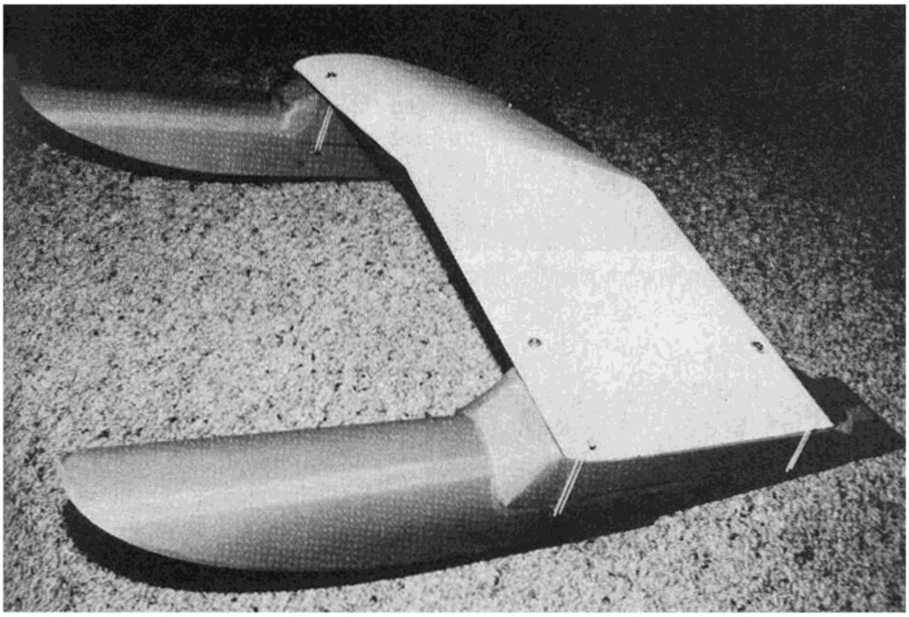
land. (If alighting on land is "landing" then alighting on water should be "watering.")

The polycarbonate sheet I used for the wheels is non-breakable. The wheel thickness required is related to the type of ground on the landing strip. Razor-thin wheels would work on concrete, but on very soft bare ground or grass we must have enough contact area to keep the disk wheel from cutting in and dragging. I designed Sesquiphib's wheels large enough in diameter to raise the float bottoms out of the grass, yet with the axles inside the floats. They are .08 (about 3/32") thick.

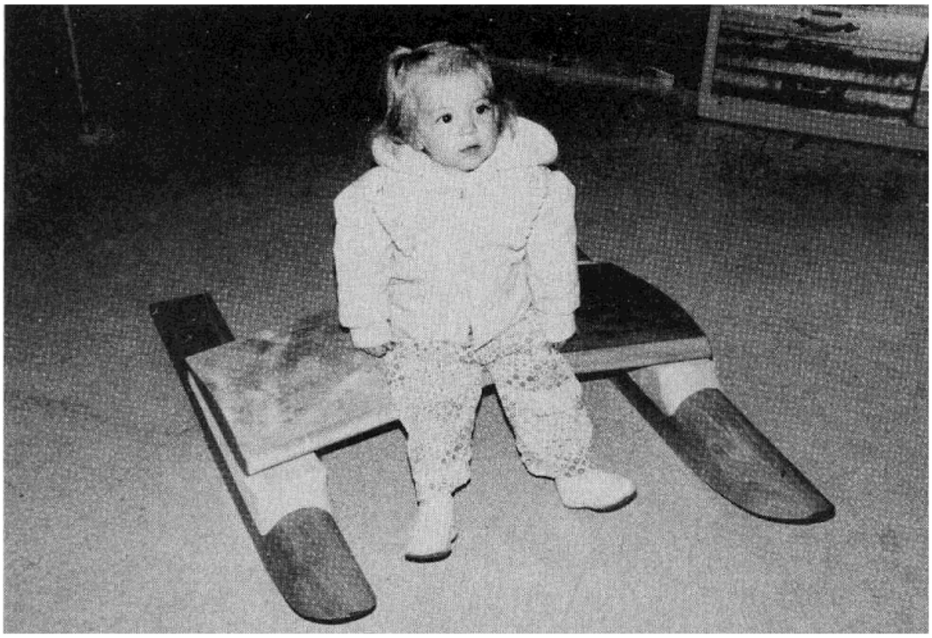
In a rolling friction test, I loaded these wheels to the gross weight of the airplane, pulled them over the lawn and compared them with a pair of 3" diameter standard balloon tire model wheels similarly loaded. I was a little surprised that the big thin disk wheels rolled **more** freely than the balloon wheels. I shouldn't have been surprised. Racing bicycles used thin big wheels probably fit this bill, so I chose to hide them in the floats and make them out of transparent plastic. You can find the clear wheels on some of the photos, but in the air they disappear. It looks like a seaplane --- until it lands on



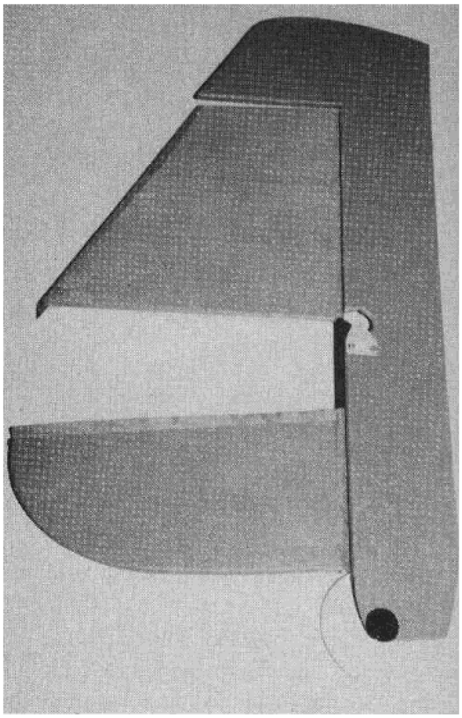
Completed float assemblies with wheels and fairings in place. Note the close fit of the polycarbonate wheels in the front slots.

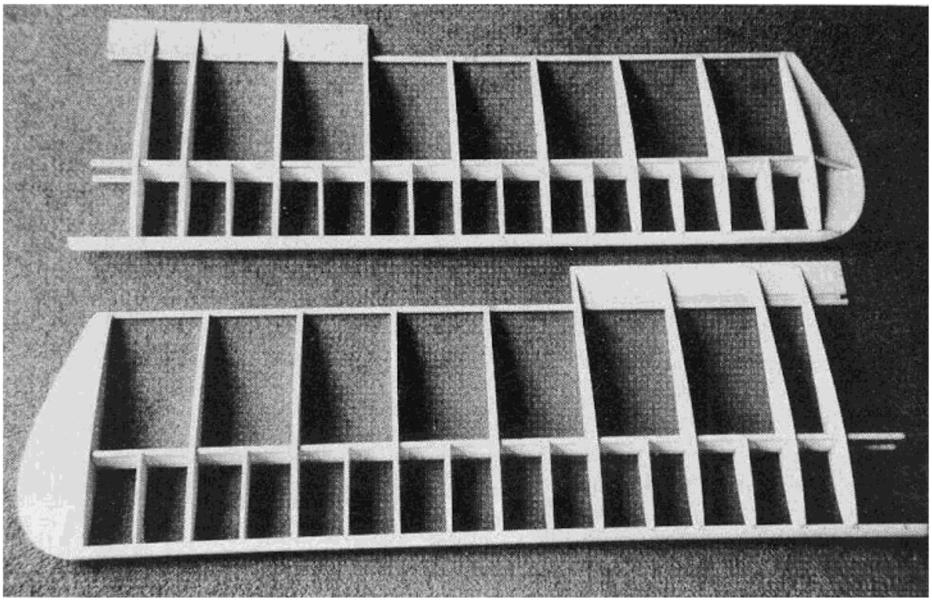


Floats attached to lower wing. On final version, floats are glued to wing.



Author's granddaughter, Emily, applies a 1.0 "Emily weight" static load test.



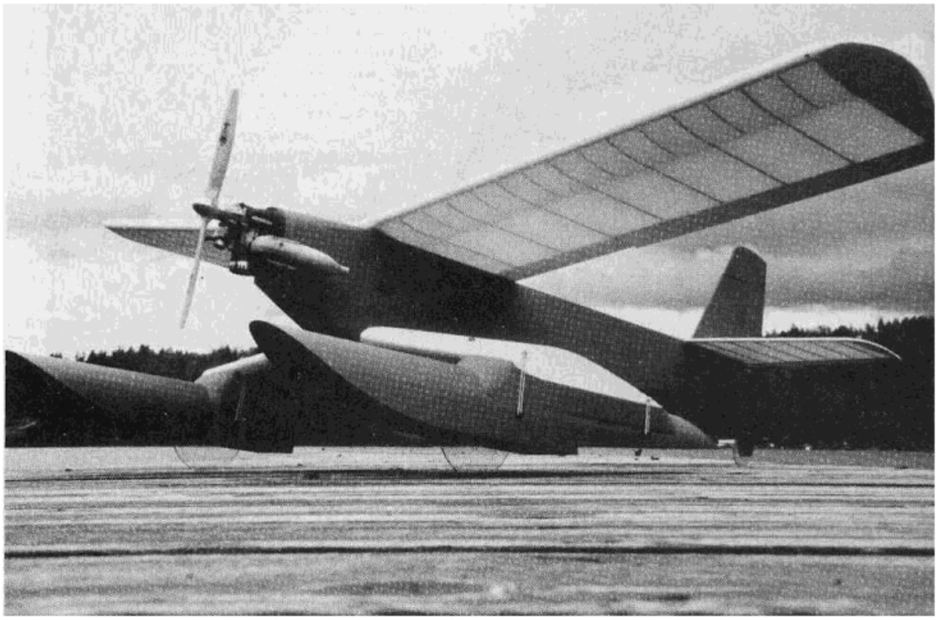


ABOVE: Upper and sub fins with aerodynamically balanced rudder. Note that plastic tail wheel becomes part of the water rudder. LEFT: Upper wing structure with fiberglass Arrowshaft spars and T.E. spar.

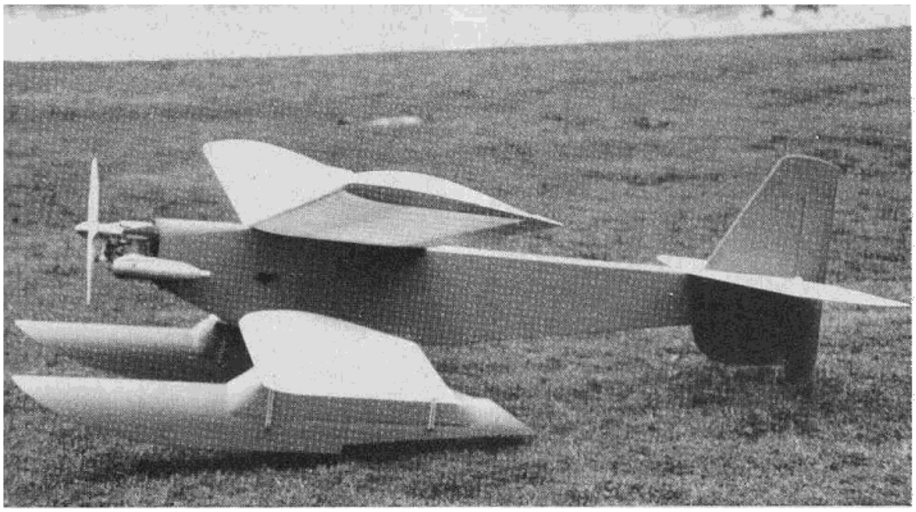
diameter wheels, not balloon tires. At 4½ lb. load per wheel, the disks didn't cut into my soft wet lawn, and the rolling friction was less than a pound for the pair.

The steerable tail wheel is also .08" clear polycarbonate, and doubles as a water rudder. Polycarbonate sheet is available from plastic suppliers; 3/32" or 1/8" plywood wheels will substitute.

These disk wheels obviously don't absorb shock like inflated rubber tires, and they are rigidly mounted to the floats. This was a calculated risk that has worked out very well. After a number of flights, including land



On wheels (land).

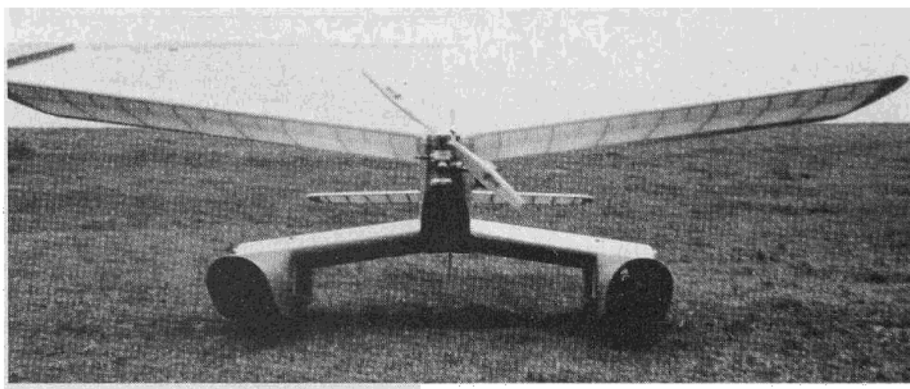


Still on wheels. But where did they go?

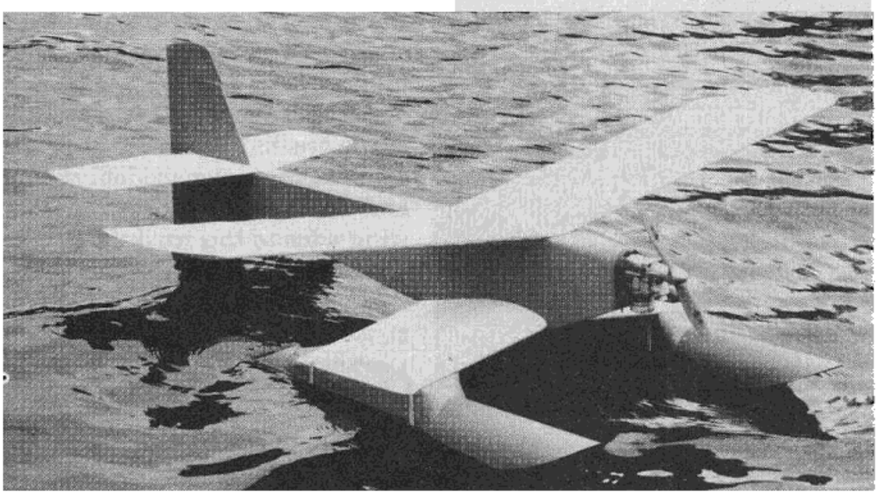
tell you to glue stick "A" to stick "B." You may well improve the design by gluing "A" to "C" instead. This is **a** design for a fixed-wheel amphibian, but the design details are not sacred. If you don't need an amphibian, leave off the wheels and build yourself a unique floatplane. You may also want to put thin fixed amphibious wheels on that

take-offs and landings, there is no sign of structural damage anywhere. One could spring-mount the wheels, but I didn't because of added complexity and weight. Design is an art of compromise.

This is not a model for beginners, so I'm not going to



Sesquiplane anhedral and dihedral. Neat.



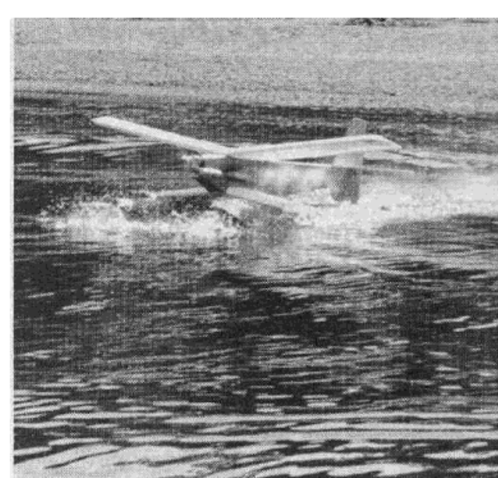
old seaplane you have. They could be added to any seaplane or flying boat.

The sesquiplane configuration offers the advantage of supporting the pontoons of a floatplane in a low-drag manner while contributing to the lift. The anhedral or negative dihedral of the lower wing gets the plane well up and out of the waves. The upper wing has

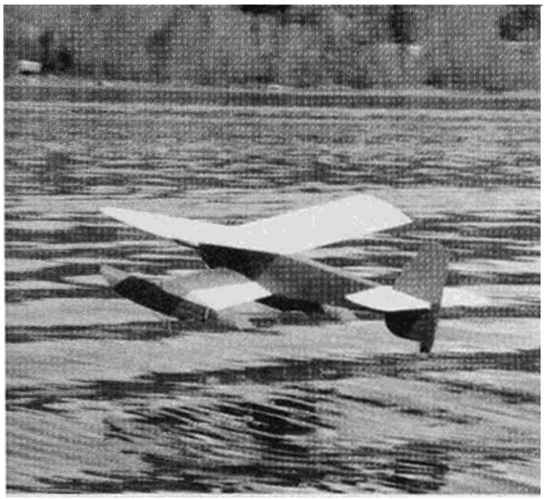
On the water (sea).

You guessed it (air).

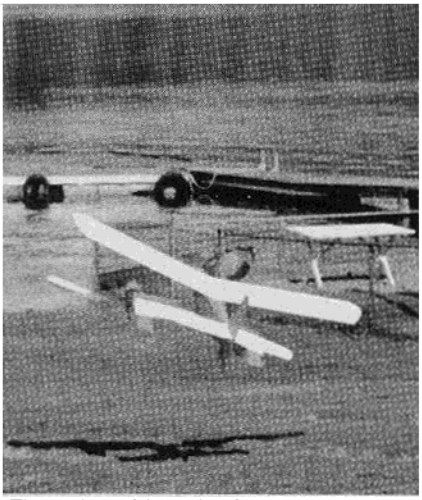
Sitting on a cloud.



Coming on to the step.



Airborne over the waves.



First take off from land.

Near touch down on land.

considerable dihedral for four reasons: (1) To counteract the effect of the lower wing anhedral and provide some positive roll stability. (2) To permit yaw-roll control by rudder in case of aileron failure. (3) To increase the effective inter-wing gap without cabane struts or an excessively deep fuselage. (4) To keep the wing tips well clear of the water when taxiing cross wind on a windy day. The prototype as shown in the photos has 8° dihedral. After building it that way I decided it looked a little much, therefore I've reduced it to 5° dihedral (per side) on the plans.

I like to fly aerobatics, so Sesquiphib was designed with plenty of negative lift capability. Symmetrical and the usual semi-symmetrical section wings are harder to keep true on a building board than flat bottom foils, however, and camber on the bottom requires a fitted mounting saddle on the top of the fuselage. Therefore, Sesquiphib's wings have modified semi-symmetrical sections that are flat on the bottom for the aft 3/4 of the chord. Since the forward quarter of the bottom is well curved, they have much better inverted lift than a Clark-Y airfoil.

Let's talk about wing mounting. The requirements for a good wing mounting system should be: (1) Reasonably rapid removal for maintenance access

SESQUIPHIB D
Designed By:
Francis Reynolds
TYPE AIRCRAFT
Sport Amphibian Sesquiplane
WINGSPAN
69 Inches (Top)
30 Inches (Lower)
WING CHORD
13 Inches
TOTAL WING AREA
1274 Sq. In.
WING LOCATION
Sesquiplane
AIRFOIL
Semi-Symmetrical
WING PLANFORM
Constant Chord
DIHEDRAL EACH TIP
2-13/16 Inch Top Wing
2-1/16 Inch Lower Wing (Anhedral)
O.A. FUSELAGE LENGTH
55½ Inches
RADIO COMPARTMENT SIZE
(L) 7" x (W) 3½" x (H) 5"
STABILIZER SPAN
28 Inches
STABILIZER CHORD (incl. elev.)
9¾ Inches (Avg.)
STABILIZER AREA
254 Sq. In.
STAB AIRFOIL SECTION
Flat
STABILIZER LOCATION
Top of Fuselage
VERTICAL FIN HEIGHT
9¾ Inches Above Fuse.
4 Inches Sub Fin Below Fuse.
VERTICAL FIN WIDTH (incl. rud.)
8 Inches (Avg.)
REC. ENGINE SIZE
.61
FUEL TANK SIZE
12 Oz.
LANDING GEAR
Twin Float Amphibious
REC. NO. OF CHANNELS
4
CONTROL FUNCTIONS
Rud., Elev., Throt., Ail.
BASIC MATERIALS USED IN CONSTRUCTION

Fuselage	Balsa, Ply, Foamboard
Upper Wing	Balsa, Fiberglass Tubing, Fmbrd.
Lower Wing	Foam, Ply
Empennage	Balsa, Aluminum Tubing
Amphibian Gear	Foam, Ply, Plastic Sheet
Wt. Ready To Fly	**138 Oz. (8 Lb., 10 Oz.)**
Wing Loading	**18 Oz./Sq. Ft.**

and for transportation and storage. (2) Controlled knock-off of the wing in a crash. In my opinion many R/C model designs fall short rather badly on point two. Let's face it, most of our models eventually crash, sometimes from equipment failure and sometimes from pilot error. So designing to minimize crash damage makes sense. If the wing and fuselage remain rigidly mated in a crash, much higher forces are imposed on one or both, depending on the nature of the crash. If it is a straight dive, the fuselage suddenly stops and the kinetic energy of the wing adds to the crush force on the forward fuselage. In a spirling crash where a wing tip strikes first, if the wing-fuselage joint doesn't give, a severe wrenching force is imposed on both the wing and the fuselage.

The old system of attaching the wing with rubber bands is actually very good, which no doubt accounts for its continued use, in spite of its haywire appearance. In a crash the rubber bands will stretch and break (if we don't use too many), greatly reducing crash damage to the model. On the other hand, many R/C designs call for bolting the wing on with 1/4" diameter nylon screws. Nylon is apparently used because "it will shear." Good thinking; but then the designer gets worried about losing the wing in the air, and uses nylon screws that are much too large. Don't use 1/4" nylon surfaces it is used on, and hardly shows. To install these figure-8 hinges, first cover and finish all surfaces. Pierce through both the trailing edge of the fixed surface and the control surface with a pin, about 1/4" from the edge of each surface, wherever you want a hinge. Cut off a piece of monofilament 10"-12" long (I use .020" diameter for most models). Push the filament through one of the holes, wrap it back through the gap, poke it through the hole in the other surface, push the other end of the filament through the gap, pull it tight and tie a square knot on the bottom, as shown in the sketch. Pull the knot over a pierced hole and clip off the ends close to the knot. Now line up the surfaces so they are in the same plane and touch a very small drop of CA to the knot (to keep it from untying), and also a drop to both sides of each hole where the filament enters. The glue will keep the surfaces from slipping out of alignment and will also seal the holes. You are finished. Each hinge takes less than a minute; they are very strong, last forever, and operate freely. If you are careless and get glue into the hinge, no problem. It flexes free readily; quite different from a "glued solid" conventional hinge. These figure-8 hinges are simple, neat, very cheap and almost weightless. Try them; you will like them. Mine usually come out with no gap or up to .02 gap. This is so narrow that I need not cover the gap, another savings in time.

Considerable thought went into the selection of materials used in Sesquiphib. Balsa is hard to beat for the bulk of model airplane structures, but in seaplanes it has the bad habit of sopping up pounds of water and giving it back only very slowly. Careful sealing obviously helps, but balsa seaplanes always gain considerable weight anyway. Reducing the use of balsa, Sesquiphib uses several alternate materials. These are better than balsa for their selected applications, in addition to reducing water absorption.

ABS-faced foamboard, sold under the name Artcor® at art and plastic supply houses, absorbs no water and is excellent for applications like bulkheads and shear webs. Don't use paper-faced foamboard on seaplanes. I did once, and it absorbed water in spite of having been painted.

When foam core wings were the latest thing, I built a lot of them; but I have concluded they take longer to build than an open framework fabric covered wing, and they are usually heavier. Floats mounted on a wing apply wrenching loads to the wing, however. Sheeted foam core wings have much better torsional stiffness and strength, hence Sesquiphib has a 1/64" plywood covered foam core lower wing and a lighter framework upper wing. I recommend the iron-on fabrics since they are so much stronger than the film coverings.

The spars in Sesquiphib's upper wing are made from .28 diameter (Glashaft #B25) fiberglass arrowshafts (available from archery supply houses and some model supply houses). The shear webs between the upper and lower spar tubes and between the ribs are 1/8" thick Artcor® foamboard. You could substitute balsa. I use SloZap® in gluing foamboard. Don't use thin CA, it will attack the foam.

There are several advantages to these arrowshaft wing spars: They are very strong and stiff, yet light. The wing is easier to build, since you drill round holes in the ribs instead of cutting slots. And the spars can be below the wing surface, leaving an esthetic and aerodynamically smooth airfoil contour. If you can't get the arrowshafts, substitute 1/4" hardwood dowels.

I also used fiberglass arrowshaft tubing for the wing trailing edge, and aluminum tubing arrowshaft for the aileron torque tubes, turning inside fiberglass tubing. The aluminum tubing is very stiff in torsion, therefore there is less chance of aileron flutter. The leading and trailing edges of both the fin and stab on Sesquiphib, and the elevator connecting torque tube are all made from the same .22 OD aluminum tubing arrowshaft (XX75® 1416). It is one strong stiff empennage! It weighs 3/4 of an ounce more than it would have, had I used all balsa. Take your choice. Beware of substituting metal tubing for the wing spars. That much metal could foul up the receiver antenna pattern.

We are down to the floats. I've designed, built, and flown twelve R/C seaplanes or flying boats since 1968. Foam core floats or hulls were used on half of these and built-up floats on the other six. Both have their advantages. Built-up floats will usually be lighter, but foam core floats are probably stronger, and foam can never sink if the pontoon is punctured or split open.

I chose foam core float construction for Sesquiphib partly because with foam it was easy to mount the main wheels. The wheel slots in the foam cores aren't lined. The white bead foam is closed cell, so water in the wheel slots can't go very far. Building sealed wet wells in built-up floats would have taken longer. Dope the Sig 1/64" ply float skins inside and out with Balsarite before skinning the floats. This plywood wraps around the floats very nicely. I used Robart 007 Spray Adhesive. (Why is it that skinning an airplane means **adding** a skin, while skinning an animal is **removing** same?)

The slots through the float bottoms were made just slightly wider than the plastic sheet wheels, to support the wheels laterally and to minimize planing drag. Make sure you make the wheel axles readily removable. To dry things out inside, or in the event that sand gets into the wheel slots, pull the wheels.

To greatly simplify things you could mount the wheels beside the inner faces of the floats instead of inside floats, but it would be less elegant.

Cover the skinned floats with iron-on fabric, then cement the bare hot wire cut, rigid blue foam, mounting saddles to the top of the covered floats. The integral mounting saddles are then also covered with fabric directly over the blue foam. It works fine at medium iron heat, and the results look good. The blue foam saddles are standing up very well under wear and tear.

In the event that your plane ends up tail heavy, drill the float bottoms at the bows, poke steel rods into the foam, and cover the holes.

Sesquiphib could be powered with a .60 glow engine or a .60 to .90 4-stroke, but I chose a .60 diesel because several engine experts who tested them, and a friend who uses them, said the Davis Diesel conversions of Schnuerle ported glow engines equal or out-perform the glow originals, are quieter, swing bigger props, burn less fuel, idle beautifully, **and** obviously require no glow plug battery.

Inverted engine installation was a natural for Sesquiphib's lines, but my experience with inverted glow engines hasn't been too good in the starting and idling departments. Glow plugs don't glow when immersed in fuel. But a diesel has no glow plug, so diesels should work as well inverted as upright. One must avoid hydraulic lock due to excess fuel in the cylinder, however.

Fortunately, in a crash on water, the prop hits first, and it must stop the engine before water gets into the cylinder. I have crashed into the water at high speed and high throttle a number of times, and have yet to damage an engine.

Now that I have run a Davis Diesel, I too am a fan. Converting my old O.S. Max .61 FSR took only a few minutes. It started easily. Look Ma, no glow battery! Yes, it runs inverted. It idles like a dream, takes throttle beautifully, and spins a club I would expect on a Quadra. It hauls this nearly nine pounds of airplane but good.

Sesquiphib flies fine. On the first flight I trimmed the controls and got acquainted with it. In the second flight I did some aerobatics, touch-and-goes, taxied to shore, carried the plane over the beach (it won't taxi on sand), then taxied it up a 10% grade lawn at low throttle and shut off the engine. The disk wheels work fine, and on the water I don't know the wheels are there. It has normal hydrodynamic performance.

On the fourth flight I got bold enough to fly from the lawn, out over the water and back to my small lawn. No problem. I can make long low final approaches over the water toward the shore, using throttle, and set it down on land. If the engine dies, I simply land in the water.

Amphibians are neat! May all your floats sprout wheels. □

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