SCALE *EDO* FLOATS

By GEORGE A. WILSON, Jr. . . . If you're going to take this water flying thing seriously, sooner or later you're going to try scale. The key word then becomes "EDO", the best known name in "water wheels".

INTRODUCTION

The world of scale modeling is no place for an uncompromising type of person! To start with, anything but full scale is a compromise. Once the scale-down factor is established, the aerodynamic, materials, and detail level compromises begin. The author was a virtual novice in this part of the hobby when the Cub-on-floats project began . . . and, after this project, he has developed a profound respect for those who feel at home in the scale parts of model building.

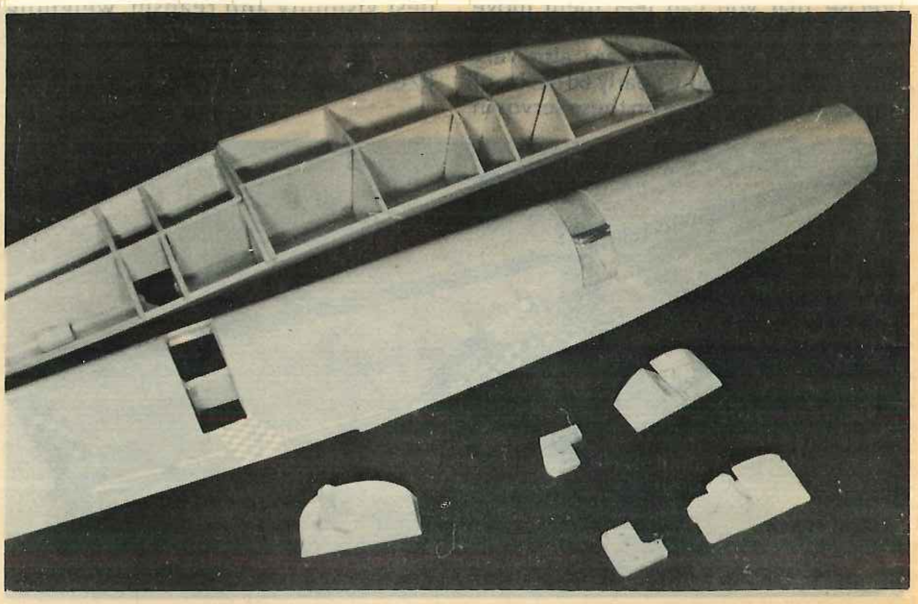
In this project there were several interesting interfaces; the Piper J-3 Cub itself, the Sig J-3 Cub kit (in which compromises had already been made), the original Edo float design, and my own version of the floats in miniature. The Edo Company was most cooperative in supplying drawings and information for this project. These were married to the Sig Cub, using a level of detail somewhat greater than that established by the kit plan. In the original model, no attempt was made to build the airframe itself as a scale, competition grade model. It was to serve as a vehicle for the floats. Those wanting to build a "next generation" of the aircraft/float combination can certainly improve both.

It was soon recognized that a "true scale" approach would require a miniature welded-tube fuselage. This would allow scale struts to be attached to the fuselage with scale fixtures, so the compromises began. It was decided to build a model that was within the capability of most serious modelers and to stick with balsa as a basic construction material. It was further decided that the design should be rugged enough to allow the model to be used for a reasonable amount of fun flying. With these decisions made, the design described in this article evolved.

GENERAL DESCRIPTION

From what I have been told, the Sig J-3 Cub kit has evolved through several generations. It is a 71-inch span, semi-scale version of America's favorite light plane, the Piper J-3 Cub. From the pictures in the magazines it is obvious that the Sig kit can be made into a magnificent model. It appears to be near scale in its outline. The Edo drawings used to scale the floats were outline type drawings. They should be good representations of both the J-3 Cub and floats. The discrepancies that turned up were "drafted" out and the overall result should be very close to scale.

Five channels of radio are called for: rudder, elevator, ailerons, motor, and water rudder retract. The original model used non-scale linkages for control surfaces and motor. The water rudder linkages are close to scale. If you are going the full-out scale route, it would be relatively simple to use cable type linkages to the control surfaces. If you go this far, consider an additional channel to operate a trim servo driving a scale-like jack screw for elevator trim. How to waterproof the scale control system may be troublesome. But, most scale jobs are flown on a no-probability-of-failure basis, aren't they?



Float parts during assembly. Construction is typical sheet-on-bulkhead balsa assembly. Inserts for strut mounts are hardwood. Fittings are three layers of 1/16 aluminum.

To fit both land and sea gear to the model, small compromises were made in the location of the fuselage attachment locations. These primarily involve the land gear; it is a bit further aft than it is on the original. To bring the wheels back to their normal location, the gear can be angled forward during construction. In addition to being more nearly scale, this will tend to reduce ground looping when the plane is flown from land.

The overall structure should be water-resistant. The following pointers may help if you are not water-wise:

1. Seal the *inside* of *all* structures with dope (or similar sealer). This protects the structure in case you have an accident.

2. Seal the cabin area to help protect your radio. A gasketed cabin cover can be used under the wing or, second best, a gasket between wing and the fuselage can be used.

3. Seal the control linkage exits. In most cases, a couple of inches of fixed nylon tubing at the exit will do. The moving rod does not have to be too snug. Typically, 1/16 wire inside 1/8 O.D. nylon tube does fine.

The original model uses machined bell cranks to exit the aileron motion. One arm is inside the wing and the other outside. The shaft passes through the lower wing surface and acts as a seal.

The Sig kit was built as shown on the kit plans except in the areas of the landing gear attachments and the water rudder linkages. When building the airframe, study the plans carefully and check the fit of the wing to the fuselage. You have to cut an indentation into the center of the trailing edge. The plans state this but it is not too obvious. Otherwise all should be straightforward.

The original model was built with very little dihedral to make it scale-like. With aileron control it flies well. If you are thinking of three-channel operation, more dihedral is recommended.

Construction of the floats is all balsa. The struts and strut fastenings are metal and will require some novel techniques. All of the parts can be fashioned by hand. A drill press will assist in making clean holes for the clevis pins.

The water rudder is a tinkerer's delight. It is fashioned of shim brass and can be made to be very scale-like. In the original model it retracts, using the fifth channel in the radio. A 180-degree servo is used to make the diameter of the pulley on the servo reasonably small. Half a turn (180°) retracts the rudder. The rudder is pulled to the extended position by coil springs just as the real one is.

The practice in full scale is to use the water rudder only when taxiing at slow speeds. As speed is gathered, or as soon as the plane is into the wind for takeoff, the water rudder is retracted to minimize drag. It is extended again after landing and when the float is down off the step. This procedure seems to work well for the model also. Both the full scale airplane and the model exhibit all

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the expected traits of high wing lightplanes on floats. In short, they do not maneuver well in high winds. On the other hand, lightplanes are not intended to operate in high winds. The J-3 floatplane model is a joy to fly in a light breeze. The original ended up powered by a .35, and will take off from calm water. Many full scale versions of the J-3 floatplane have trouble doing this!

Over the last 20 years I have watched a number of Cub-like floatplanes roll after takeoff, and in most cases, crash immediately thereafter. In all of these cases, the motor was at full throttle to assure takeoff. Frequently the roll occurred within 10 feet of the shore just after the model was released for takeoff. Three things will help this condition. First, balance the model nose heavy to increase its stability. Second, build in a bit of washout in the wings to minimize tip stalling, and, third, remember that the model is a *scale* model of a full scale floatplane that is not meant to leap off the water. Most of the rolls after takeoff occurred (my theory) as a result of engine torque reacting on the *airborne* model with the elevator calling for a lot of up. If the model is set up properly (balance and washout) and it is urged off the water in a scale-like manner, it will fly like its full scale counterpart!

MODIFYING THE SIG KIT

The Sig kit provides a basic airframe that can be turned into a finely detailed scale model. In the case at hand, the airplane itself was treated as a vehicle for the floats. It was built for stand-off scale. In building the kit with the intention of installing the floats described in the article, the following things have to be done to the airframe:

1. **Float and land gear mounts** should be installed in the fuselage as shown in the float plans. Filler pieces are shown on the plans to fill the openings that are left when the floats are not used. The front filler piece acts as part of the land gear mount. The mounting pieces in the fuselage contain the blind nuts used to mount both types of gear.

2. Provisions for the **rudder retract servo** should be built in. The servo is shown on the plan in the most convenient location. If you are going full scale, it can be located most anywhere since it pulls on a cable that can be led most anywhere. Bear in mind that you disconnect this cable when you go to land gear. Don't hide the servo too well.

3. The **water rudder control cables** are quite scale-like. Mounts for the pulleys on the bottom of the fuselage should be built in. The bottom of the air rudder should be strong enough to accept the water rudder control arm assembly. The latter is attached using two 2-56 screws. (The original used the land tail gear from the Sig kit. This is easily removed during water operation. A scale tail gear would be an interesting challenge. It could be made removable as the original is.)

FLOAT CONSTRUCTION

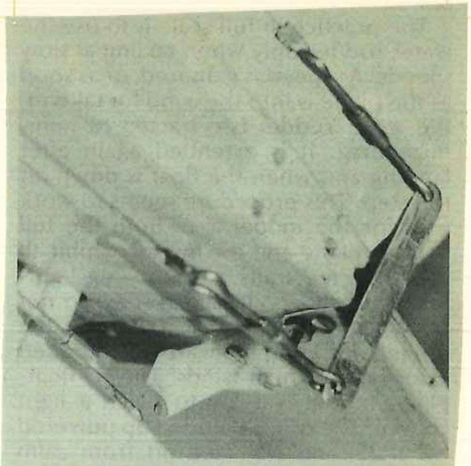
The floats are typical balsa-built-up construction and should present no difficulty for the experienced modeler. A keel is used with bulkheads on both sides. They are planked all over with balsa. Hardwood strut mounts are built into the balsa structure to assure good distribution of the landing and taxiing forces. The strut connectors are made from aluminum. The originals were covered with: fiberglass and resin on the fore-bottom; silk and dope on the after-bottom; and silkspan on the tops. Silver/butyrate dope was used all over with a final coat of clear butyrate dope all over.

JIG A JIG, JIG

The longer I am at the building of model airplanes, the more I resort to jigs. This project was a good example; I found three jigs almost necessities. The first is one to support the keel during construction. It is simple to build from softwood or plywood 1/2 to 3/4-inch thick. Cut two pieces a little longer than the float and about 3 inches wide. Saw 1/4-inch slots in one of them about 2-1/2 inches deep, spaced to accept the bulkheads. Then glue the slotted one to the top of the unslotted one to form an "L." The unslotted piece acts as a base, allowing the slotted piece to stand upright. This jig is used to support the keel while installing the bulkhead halves on the second side and during installation of the top sheeting. It will assure that the keel stays true. The keel is pinned to the jig as necessary with the bulkheads extending into the slots.

The second is a device to align the clevis fittings on the ends of the float struts. It is made from a piece of 1/4 x 3/4-inch hard wood a bit longer than the longest strut. Accurately drill four holes for 2-56 screws through the 1/4-inch dimension as follows: the first near one end and the other three at distances from the first to correspond with the distances between the clevis pin holes for the three strut lengths. These are given on the plan. Screws are put into the proper holes from the bottom and a nut installed on the opposite side. Set up for one strut length at a time. The screws should have about a 1/4-inch of extra length to accept the clevis parts during soldering. Cut the brass rod to the length shown on the plan, lightly flux the end pieces and slide them into the rod ends. Then mount them on the screws in the jig. This will position and align the ends. Solder the ends to the rods while the assembly is in the jig. Fit the inner struts to the model before installing the streamline tubing. The streamline tubing is mostly for scale appearance. It is epoxied in place using scrap wood to plug the ends around the brass inner struts.

The third jig is used to cut the spruce chine and top rails into their triangular shape. It is used with a tilting type table saw. A sketch is included to show how to make the jig. The 1/8 square strip is fed into the square opening, through the blade (fine tooth, finish type) and exits from the jig in its final form. A little care in adjusting the jig and your strips will have slight flats at the 45° tips of their triangular section. After building the jig, set the blade at 45° and place the rip fence almost touching it. Back the blade



Bellcrank at bottom of air rudder drives water rudder. Made up from sheet brass.

down to below the table and clamp the jig in place. Start the saw and run the blade up again, letting it cut into the foot and body of the jig. Now, try a trial strip; insert it until the blade starts to cut and pull it out. Check the shape and adjust the rip fence (left or right) as necessary. If a fine tooth blade is used, the strips cut with this jig will require only light sanding to finish them.

CONSTRUCTION SUGGESTIONS

This part of the article will not get to the step-by-step level but will offer some construction suggestions that may be helpful.

The strut mount blocks must be made accurately and are most easily fashioned with a table and a band saw. Cut a piece of maple (birch or other similar hard woods are OK) to the proper height and width and long enough to make all four blocks. Using a table saw, dado the groove for the 5/8-inch interfloat strut mount by cutting the full length of the piece. Cut into four separate pieces. At this point wait until the floats have been completed to the proper stage . . . see instructions that are given below. Mark the strut connector slots and outer surface curve using the floats themselves as patterns for the outer curves. Band saw the slots and curves. Be very careful with the slots and curves. The slots should fit the connectors snugly. Remember that it will be difficult to sand the hardwood once it is mounted in the floats; all but final trimming should be done before mounting.

The keel is cut from medium (harder rather than softer) balsa, the bulkhead positions marked and bulkhead halves are cemented to one side. Be very careful when locating the bulkheads next to the strut attachment blocks. It would be well to use a strut mounting block as a gauge for spacing these bulkheads. Now pin the keel to the jig with the bulkheads projecting into the slots and install the other halves of the bulkheads.

Again attach the keel to the jig with the float top projecting above the top of the jig. Add the top center planking; a piece 1 inch to 1-1/2 inch wide works well. Then add several narrower pieces on each side with the keel still in place on the jig. The balsa planking may be wet on the outside with water that has had a bit of ammonia added to it. This will help it bend easily. (I use Titebond or similar alphabetic resin glue for planking and most other seaplane construction. A coat of dope on the *inside* protects the joints well even when they get soaked. In any case, the interior must be *thoroughly* dry before repairs are made.) Finish planking the sides. Cut away the planking to accept the strut mount blocks. Complete the strut mount blocks. (See details in a preceding paragraph.) Install the mount blocks very carefully. Dope the inside of the structure *and* the inside of the balsa that will be used to plank the bottom. Plank the bottoms. Add the nose block and stern bulkhead doubler. Sand. Cut the interfloat struts from 1/2-inch streamlined tubing and cut the lengths of 5/8-inch streamlined tubing that go through the strut mount blocks. Invert the floats on your work surface and assemble (no glue) the 1/2-inch and 5/8-inch tubing parts for the interfloats struts into their proper locations. Align the floats and slip slivers of balsa into the strut blocks to locate the 5/8-inch tubing parts. Then, with everything aligned, epoxy the 5/8-inch pieces in place. When the epoxy is cured, disassemble the floats from the interfloat struts. Add the strut connectors. Add the chine and top strips. Cover. Finish. Add the water rudder on the right float. Add the cleats and pulleys and the floats are finished! If I made it sound easy, don't be too sure!

STRUT AND STRUT MOUNTS

The main struts are assembled as described in the section on jigs. The only other problem with them is to fashion the strut ends. These can be made using a lathe and milling machine (or attachment). If you have tools like this, you do not need further instruction. If you are going to make the fittings by hand using files, a drill and a razor saw, take heart! It is not difficult.

First, locate some 5/32 diameter brass rod to fit the I.D. of the brass strut tubes. The 3/16 diameter rod is not hard to find; you may have to get someone to turn 3/16 diameter down to 5/32 diameter.

Cut six lengths slightly longer than twice the length of an end fitting. File a flat on one side of each of these. The flat should be centered and be a 1/2-inch long. File to 1/32 of the center. Turn the piece over and file a corresponding flat on the opposite side. This should leave a 1/16 thick flat section centered in the middle of the piece. Mark the center and using a razor saw, cut the piece in two. This gives you two unfinished ends. Round the ends (see plan) and drill with a #43 drill for the clevis pin hole. Really simple! The end pieces will slide in and out of the tubes to allow the strut lengths to be set using the jig described elsewhere.

The strut connectors (on the floats) and the strut mounts (on the fuselage) are made by layering three pieces of 1/16 aluminum; soft or half-hard aluminum for the fuselage mounts and hard for the float connectors. The latter are epoxied together and the fuselage mounts are fastened together with aluminum rivets. The plans give the details on how to shape the individual layers of these parts.

The fuselage mounts are removable and allow easy conversion to land gear. If you are planning a floatplane only approach, these mounts could be neatly buried in the fuselage. In either case, use the dimensions shown on the plan. The strut lengths were developed by Descriptive Geometry techniques and the original went together without having to drag any holes or change any strut lengths. (When this happened, I was mighty happy!) Note that the strut lengths can be varied if necessary by resoldering the end fittings.

The fuselage mounts should be from half-hard or soft aluminum to allow them to be bent easily. Hard aluminum can be used for the float connectors since bending is not required. Hard aluminum machines/files better and should be more durable. The float connectors are easily made as detailed on the plane. Sandblast or rough the surfaces with a file before the laminations are epoxied together.

The fuselage float strut mounts are made from layers of soft aluminum that are aluminum riveted together. Bending the ends is tricky because the layers shift as they are bent. The bottom two layers have to be trimmed to match the top one after bending. Specific instructions for this operation are difficult because they will vary depending upon the vise or brake that you use. In any case, experiment first. The locations of the clevis connections are critical to the whole strut assembly and must be done accurately. The notches in the center layer are best cut *after* bending and the clevis pin holes should be drilled last. The fuselage mounts are attached to the fuselage with two 6-32 screws. Long (at least 1 inch) flat head or binderhead screws are recommended; flatheads will be the least obvious and will require countersunk holes in the aluminum mounts.

Two inches (approximately) of the outer ends of the interfloat struts are plugged with pine or similar softwood. This allows final assembly with a headless woodscrew through the float strut mount blocks and into the interfloat struts. These can be removed to allow disassembly for storage.

The cross ties are made after mounting the floats for trial assembly. They are made using standard R/C control rod techniques.

WATER RUDDER

The water rudder/air rudder combination is effective but the water rudder is a little tricky to make operational. The full scale aircraft uses coil springs in series with the control cables at the air rudder end (see plan). The original model required such stiff springs, they were eliminated. The cables should be .015 inch (or thinner) stainless, standard wire. Other material was found to be too stretchy. Typically, U-control cable can be used. The cable ends can be made up using brass or copper tubing ferrules. If brass is used it should be soft: heat it red hot and let it cool slowly if you have standard hobby shop tubing. Pass the cable through the ferrule (the I.D. should be just large enough to handle three passes of the cable), through the piece it is being connected to, and back through the ferrule. Tighten things up at this point. Then feed the loose end of the cable back through the ferrule until only a small loop remains. Now squash the ferrule. This makes a good tie. If you cannot make the last pass through the ferrule, the tie will still be adequate. The retract cable on the original was made from braided fishing line. This material is easy to thread into the fuselage and around the servo wheel.

Turnbuckles are used on the full scale aircraft and are equally functional on the model. The cables will have to be real snug to work well. Do not forget to safety wire the turnbuckles after they are adjusted correctly.

The retract servo is a 180° unit. With a wheel-type output, it neatly does its appointed job. The retract system worked without any problems.

The servo wheel was made from three circular layers of 1/32 plywood. The center layer is 1-1/4 inch diameter and the outside layers are 1-1/2 inch in diameter. Cement these layers together and attach them to a nylon servo wheel using two 2-56 self-tapping screws. Cut a notch in the outer rim and add another self-tapping screw (not fully screwed in) to act as an anchor for the retract cable. The cable passes through a formed piece of 1/8 brass tube in the cabin floor (as the one in the full scale aircraft does). It then wraps around the servo wheel, exiting at the notch and ending at the anchor screw.

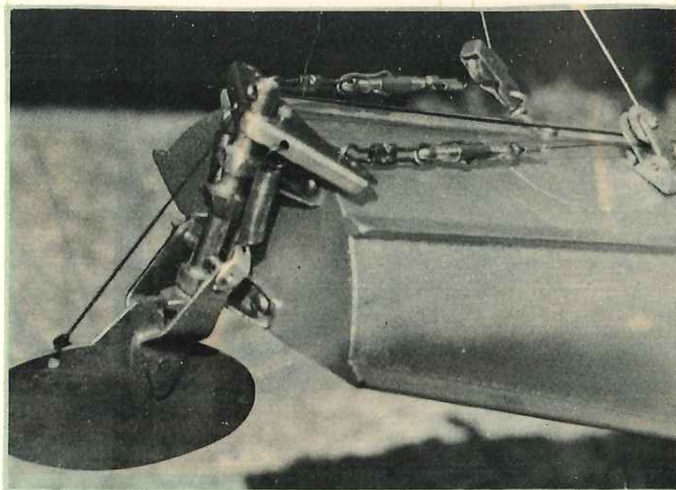
The details of making the rudder assembly from shim brass are omitted. Too much depends on tools you have available. The one made for the original model looks and acts like the full scale device. It took about eight hours to cut, bend and solder.

A neat way to make brass parts look like aluminum is to have them plated with "Bright Metal Alloy." This is used by many companies to give a silvery appearance to fabricated parts. The original water rudder was plated while assembled. A light nickle plate would probably work as well.

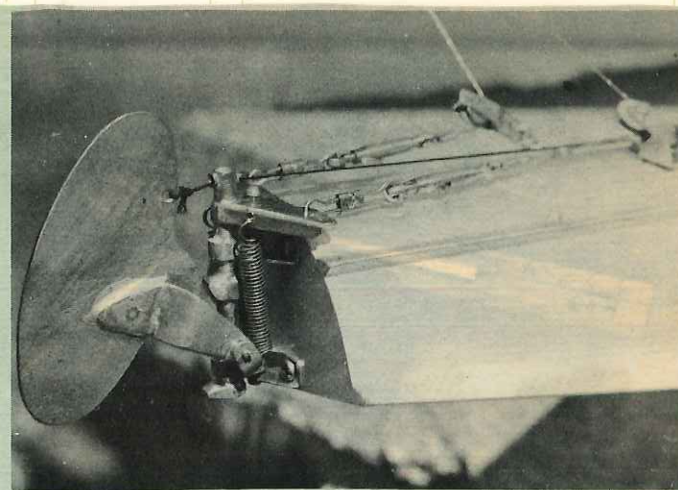
RESULTS

As was said before, the original model was not built as a spit-and-polish scale job. However, the potential exists to produce a super scale model using the Sig kit and the plans with this article. The model looks and acts like its full scale counterpart. It is strong enough to be used for fun flying. On the other hand, it is not a machine built for violent maneuvers or for rough weather flying. Bear in mind that the full scale version has the same limitations.

Water takeoffs are clean, easy, and with little (if any) ballooning. The spray



Close-up of water rudder in down position. Turnbuckles are functional. Rudder assembly made from shim brass, soldered.



Water rudder in retracted position. Retract operation is very smooth. Springs pull it back to the down position.

from the floats is minimal and clears the propeller under normal conditions. With reasonable power (a .35), there is no problem with engine torque tilting the model to the left directly after takeoff. Use of the water rudder as in the full scale aircraft is recommended; use it only during medium and slow speed taxiing. Retract the rudder during takeoffs, landings and while in the air.

The ailerons are effective as set up on the kit with the dihedral near full-scale. The original model uses about one degree on each side. The experience of others who have built in more dihedral is ineffective ailerons and a tendency to yaw in the direction opposite to the applied aileron. This can be offset by differential up/down motion in the ailerons. Try using twice as much up as down. This can be done by relocating the aileron horns.

If you are going the three-channel route without ailerons, three or four degrees under each wing is recommended. The model should perform well in this configuration.

The model did need more right thrust than shown on the kit plan. A tapered shim behind the motor mount made from 3/32-inch plywood did the trick. The base of the motor mount in the original is about 2-3/4 inches in diameter; the shim tapers to nothing on the right hand side. A bit of down thrust was also used. This will vary depending on what motor you install.

The angular difference between the stabilizer and wing are as called for in the kit. The fore and aft balance was set at the forward-most position shown on the plan. From conversations with others who have flown J-3 Cubs, it is strongly advised that this balance point be used. About five ounces of lead was bolted to the motor mount for balance. This was OK for both the land and sea configurations. From what I was told, as the balance point is moved back, the model tends to become very difficult to handle; it develops a mind of its own!

The vital statistics of the original are summarized in the following table. Note that the original test flights were made with an ST 46 motor installed. This turned out to be more than enough power.

Span		71.0 in.
Wing Area (effective)		4.4 sq. ft.
Motor		0.35 cu. in.
Balance Weight (nose)		5.0 oz.
	LAND	**SEA**
Weight (dry)	5 lb., 4 oz.	6 lb., 7 oz.
Wing Loading	19.2 oz./sq.ft.	23.5 oz./sq.ft.
Landing Gear Weight	6 oz.	1 lb., 9 oz.

The effective wing area does not include the area over the cabin and is therefore conservative. The wing loadings, as a result, are a bit high. If you build the tail very light, the loading could be reduced. Eliminating weight in the tail allows reduction of balance weight in the nose; you win twice!

You should have no trouble flying this model off the water if the wind is light. As with any high wing type on floats, be careful in crosswind conditions. The wind on the side of the fuselage, vertical tail, and under the wing will flip over a model of this sort with ease.

ACKNOWLEDGEMENTS

This project owes its existence to the people at Edo, who made their drawings and information available. These documents made the whole thing possible and insured scale fidelity.

Ron Dix provided the jig design for cutting triangular strips from 1/8 square spruce. Charlie French came up with the plain shanked 2-56 clevis pins made from #4 machine screws. Art Kramer, of Coverite, was very helpful with covering suggestions. My land test pilot was Bob Machado and Bob Kircher did the job from the lake at Brimfield. To all of them and the many others who assisted. Thanks! ●

PHOTOS BY THE AUTHOR