On the 'Wing... #153

Dave Jones' R-2, Part 3

Progress on this project has been slower than initially expected. Between some beautiful end of summer weather which had us out on the flying field at least twice each week, and the demolition and rebuilding of our huge deck, we managed to work on the R-2 fuselage and fin and rudder only in small increments. With a couple of snags in the construction procedure, this installment has been a long time in the writing, but it looks like we made the deadline for this issue!

Fuselage

With the help of a huge sheet of glass and a number of steel machinist blocks, metallic triangles, an aluminum template and layout grid, and a whole bunch of lead weights, construction of the fuselage was rather easy.

Using the aluminum sheet fuselage side template, we cut the two front sides from 1/8 inch plywood and the two rear sides from 1/8 inch balsa. The front and rear parts were then glued together so that further assembly could be completed using the layout grid to assure symmetry.

A nose block was glued on and bulkheads were then glued into position at the rear of the battery area, behind the receiver location, and at the aft end of the fuselage. See Photos 1 and 2. In the area of the tow hook, we constructed a reinforcing structure to spread the loads from the tow hook to a wide area of the fuselage sides. At the same time, we finished bonding the front and rear fuselage sides by fitting a balsa block which traverses the entire fuselage interior. This piece also makes the fuselage "crush proof" while gripping it for launch. Balsa sheet of 1/8 inch thickness was then used to form the bottom of the fuselage and ventral fin.

We used triangle stock to connect the plywood and balsa fuselage sides to the bottom sheeting. This makes a very strong structure, but initiated the first of our minor problems. We built the fuselage rather narrow and will be using older JR servos which are somewhat taller than those currently available. The balsa triangles, essential for achieving a nicely rounded cross-section, would not allow the servos to be mounted side-by-side. Additionally, the fuselage is too short for these servos to be placed in line. Our solution was to place the servos in the fuselage at an angle, as can be seen in Photos 3 and 4. The elevator servo is forward, the rudder servo toward the rear. The bottoms are barely clear of the triangles, and the total length of the servo installation turned out to be just short enough to allow receiver installation at the rear and a good sized battery pack to placed up front. And it looks cool, too!

The canopy was initially formed by using the aluminum fuselage template to mark the outline and our 24" jig saw to make quick work of the cutting process. This roughly formed piece was then tacked to the fuselage and the final shaping started. We began with a heavy duty razor plane, then moved to an 80 grit PermaGrit plate attached to an aluminum T-bar, and finally used a 220 grit PermaGrit mounted on a T-bar to get a good finishing surface. The canopy cross-section was checked with a series of plastic semicircle templates along the way.

To hollow the canopy and obtain a uniform thickness, we used a round router bit in a drill press. We set the distance between the router bit and the table to 1/8 inch, and then slid the canopy into the rotating blade. Work was slow, as we had to make sure that the exterior of the canopy

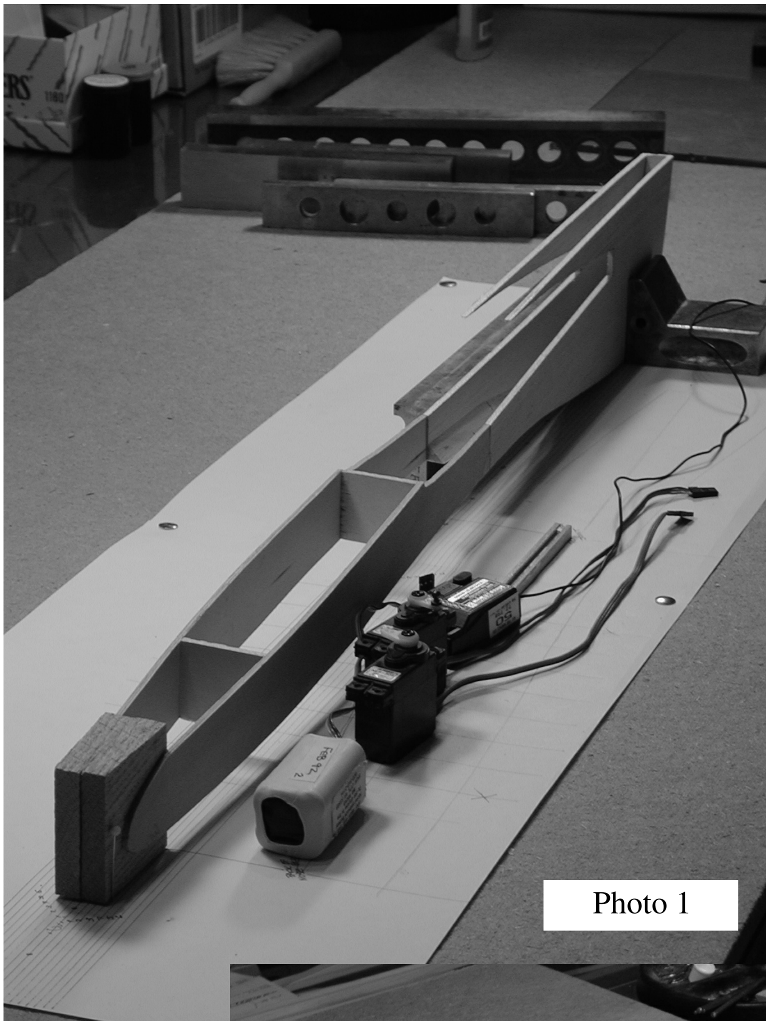

Photo 1

Left: The beginning of the fuselage framing. The sides are 1/8 inch plywood forward, 1/8 balsa sheet rearward. The nose is a laminated oak block, and there are only two 1/8 inch plywood fuselage formers.

Below: The radio gear will be battery forward, servos behind, receiver to the rear. The aluminum channel is one of our few remaining Airtronics adjustable towhooks.

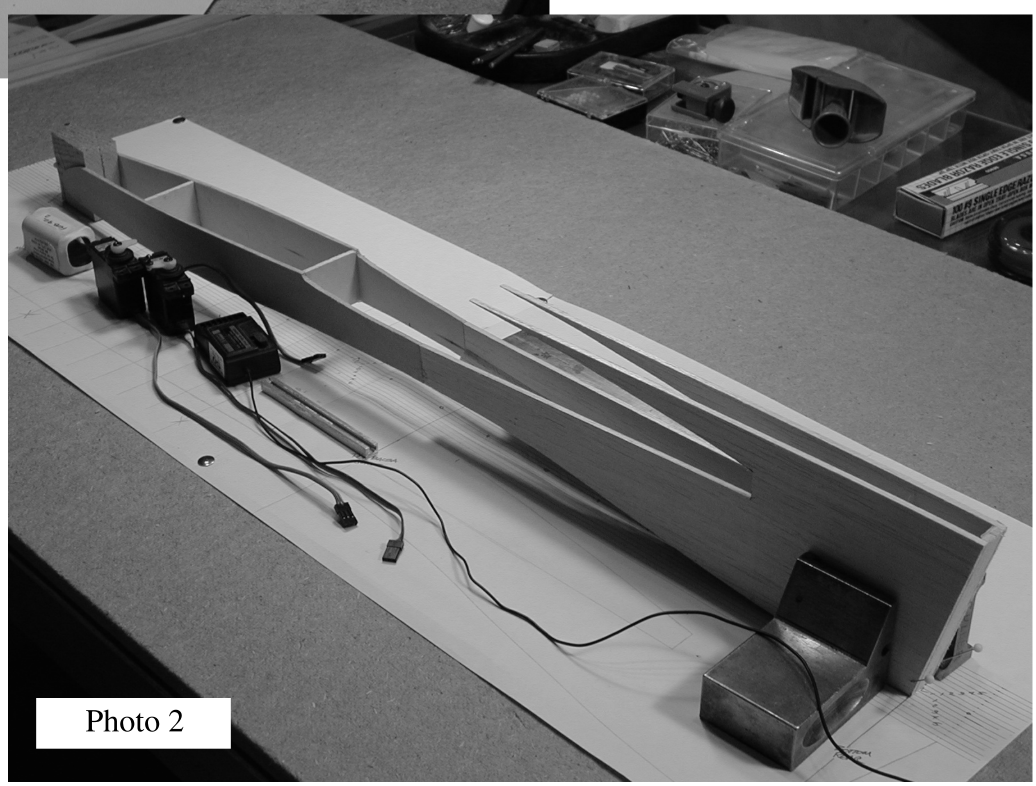

Photo 2

Left: The fuselage after the oak nose block and balsa canopy have been shaped. The servo tray is also in place. Plastic AddressOGraph plates were used as template material.

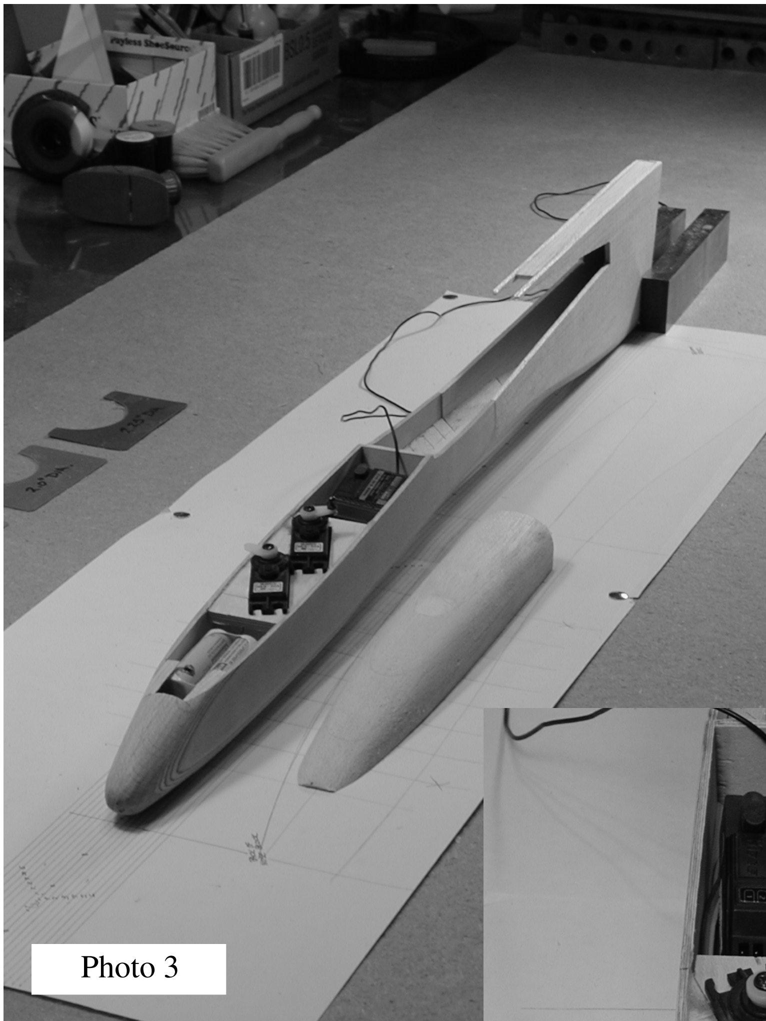

Photo 3

Below: Closeup of the servo tray and the rudder (front) and elevator (back) servos. The receiver fits snugly in the rearmost compartment.

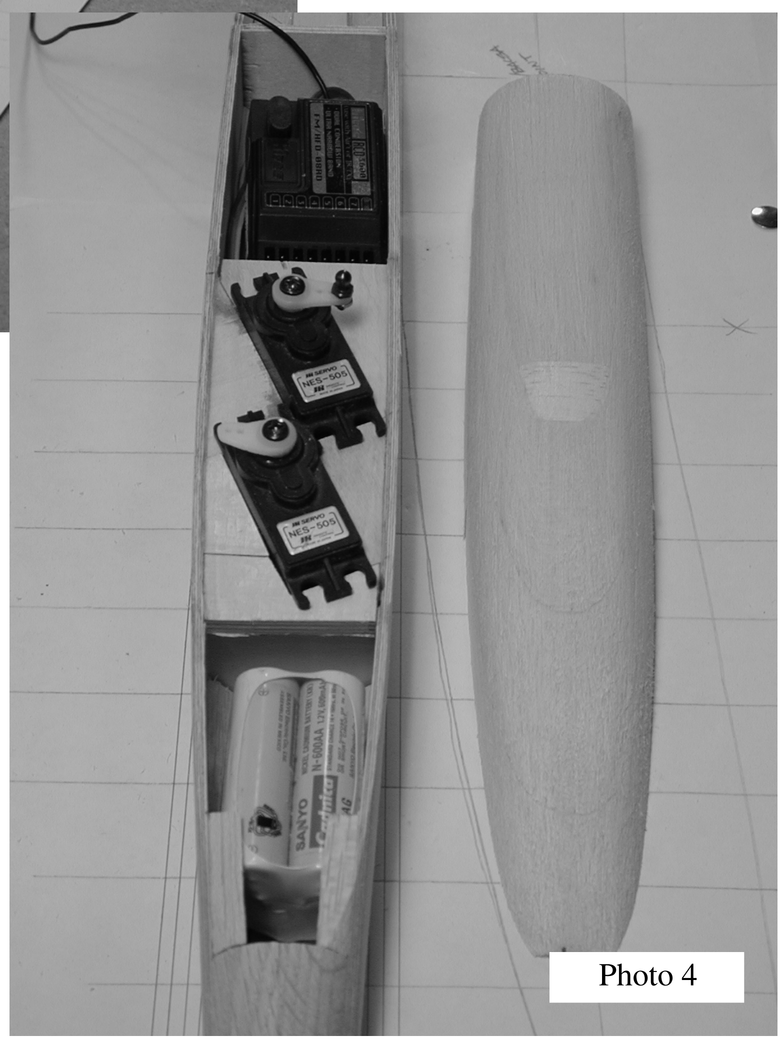

Photo 4

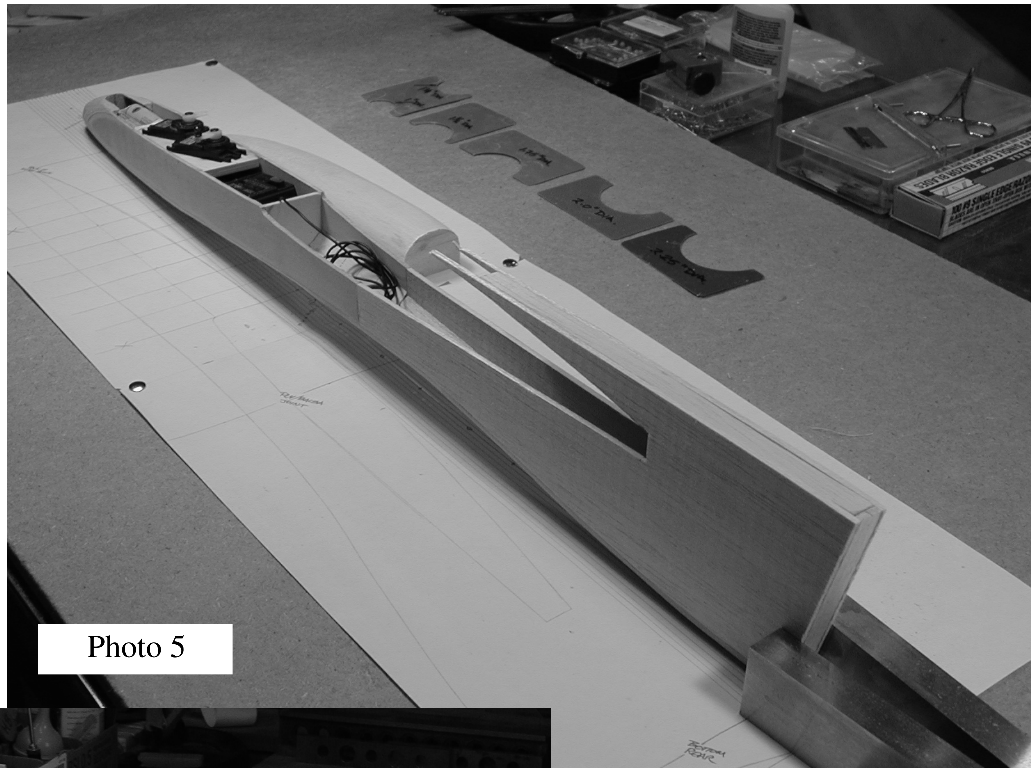

Photo 5

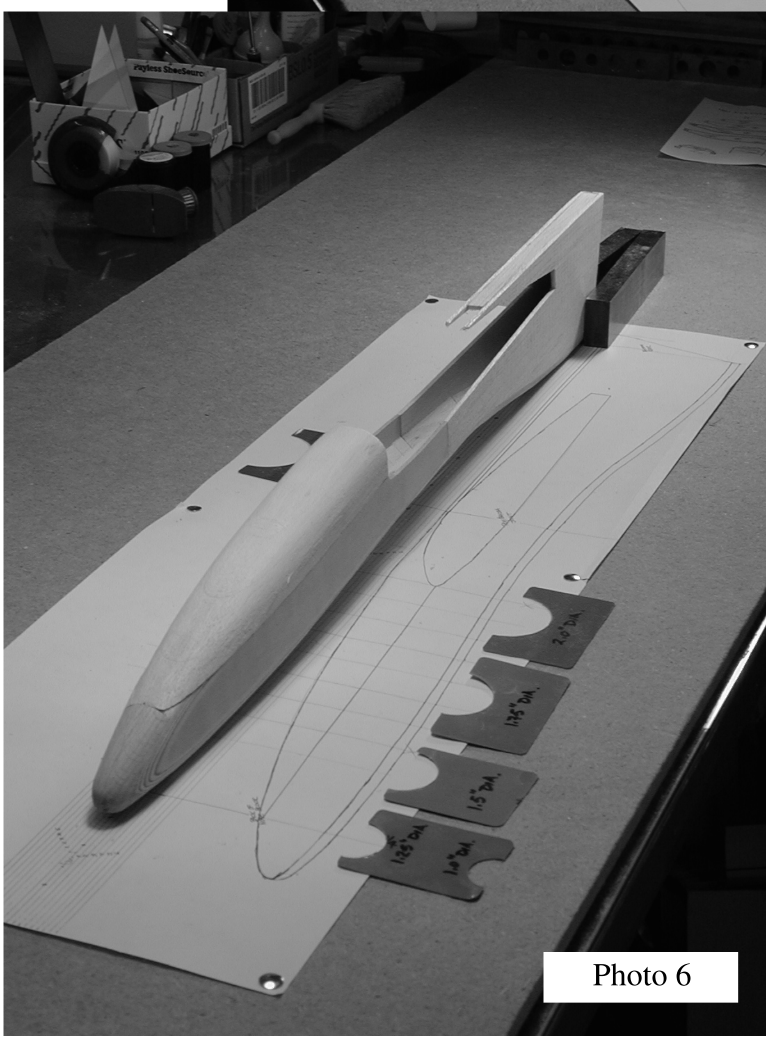

Photo 6

Above: rear view of nearly completed fuselage. As mentioned previously, the fuselage sides are plywood from about 1/3 of the wing chord forward, balsa sheet from that point rearward. This saves weight. A spruce tailpost strengthens the rear.

Left: The fuselage awaits fiberglassing and painting. The cross-section templates are made from plastic cards for use in AddressOGraph machines.

contacted the table at a point directly under the router blade at all times. Things looked great after several minutes of cutting, so we finished off the inside with some 80 grit sandpaper attached to a dense sponge.

The exterior of the fuselage bottom contour was then shaped using the same basic techniques as the canopy.

As can be seen in the photos, the fuselage structure was beautiful from start to finish. We are extremely pleased with the final contour.

Elevator connection

The second difficulty came about when we tried to hook up the elevator halves to the servo. To explain our final solution in proper perspective, we have to quote a portion of Installment 2:

> "Since the center of the wing is bent to form the dihedral, it's somewhat difficult to fabricate and install a torque tube arrangement to drive the elevators. We chose instead to drive both elevators through a single servo using a forked control cable. This does pose some geometry difficulties when hooking up the connection to the servo. We'll cover both the problem and our solution in the next installment.
>
> "GoldenRods serve as the push-pull connections between the servo and the elevators. Because there is no area above the wing to run the pushrod assemblies, we drilled appropriately sized holes in the dihedral brace and leading edge sheeting. The photo of the completed wing may have enough detail that the elevator hookup can be discerned."

We were introduced to this problem in Dean Pappas' "R/C Pattern" column in *Model Aviation*, and thought we could get around it in some surreptitious way. We'll start by explaining the problem (elevator differential) and then describe our not so clever solution.

The forked control cable posed a severe difficulty when it came to making a connection which would deflect both elevator halves the same amount throughout their travel. Imagine a Y-shaped pushrod arrangement where the split sections drive the two elevator halves and the stem portion is attached to the servo output wheel. As the servo wheel turns, the stem moves in an arc, tilting the split end. The two elevator control horns then do not move the same amount. See Figure 1. As can be noted from this illustration, as the length of the pushrod is reduced, the angular difference caused by servo rotation becomes more pronounced and the differential increases. On a tailless model like the R-2, the pushrod is so short that the differential is unacceptable.

In a larger fuselage, the servo could simply be laid on its side. The servo arm would then rotate through a vertical plane and eliminate the problem at its source. Unfortunately, the servo we chose to use is too large to be placed in the fuselage in a horizontal position. There are also some mechanisms which can be attached to the servo output shaft to provide a linear rather than rotational output. We could not utilize this option because of minimal clearance with the canopy.

Our solution? We went back to the plan we had originally rejected — a torque tube arrangement. We successfully used a similar fixture in our Pioneer II-D, so it took only a short time to get something constructed for the R-2. Figure 2 gives the general layout of this assembly. Once the elevators were hinged to the main portion of the wing using small Klett hinges, the ends of the torque tube were inserted in the receptacles. A U-shaped stay was then bent from 5/32"

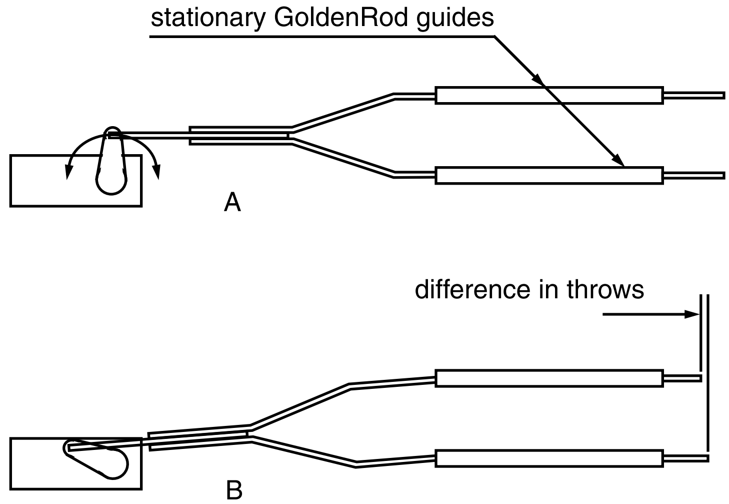

Figure 1

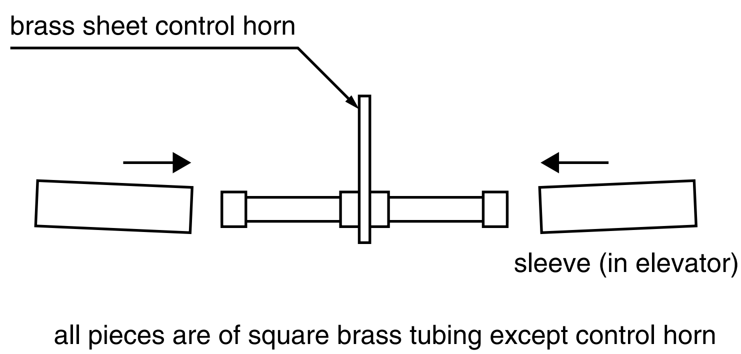

Figure 2

music wire, slipped over the control horn, and the ends inserted into the trailing edge of the wing center section. This stay prevents the assembly from sliding side to side and removing itself from one elevator side.

The pushrod is connected to the servo arm by means of a standard clevis, and a similar clevis connects the aft end of the pushrod to the single elevator control horn. In the end, we used only one of the two elevator pushrod tracks we had initially set up. With the single pushrod, we don’t have to worry about elevator differential, and the parts at the elevator end are fairly maintenance free over the long term.

The finished wing and fuselage were set up in a machinist block jig and permanently attached to each other with 30 minute epoxy.

Fin and rudder

Both the fin and the rudder are of the same parabolic shape as the wing, and both use nicely streamlined symmetrical airfoils. The only straight lines in these structures are the trailing edge of the fin and the leading edge of the rudder. Rather than exercising our brain cells to develop a jig which would use the building table as a base and involve a large number of negative ribs and blocks of varying thickness, we decided to use a jig of the type often used to construct wings for control line stunt ships.

As can be seen in Photo 7, we used a large piece of 3/4 inch pine as a base and added custom cut pieces of 3/4 inch pine. These pieces were quickly cut on a table saw using just a few measurements. Each block was shaped to follow the rough outline of the flying surface, allow room for hinge point fabrication in place, and create slots of 1/8 inch width for the ribs.

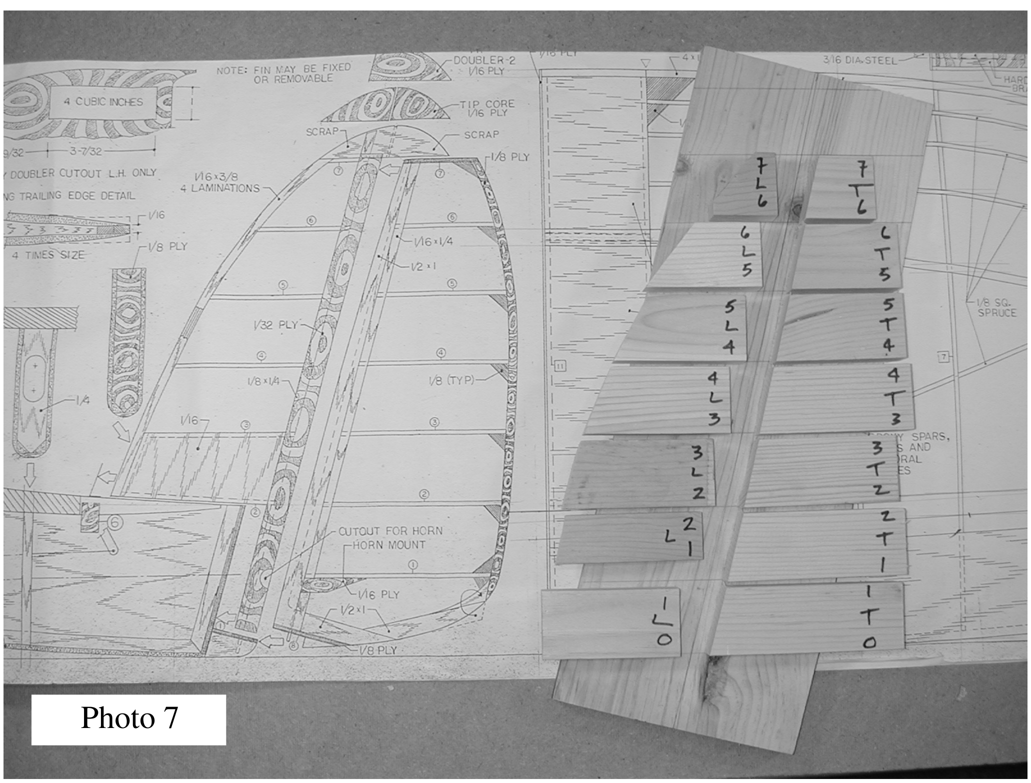

Photo 7

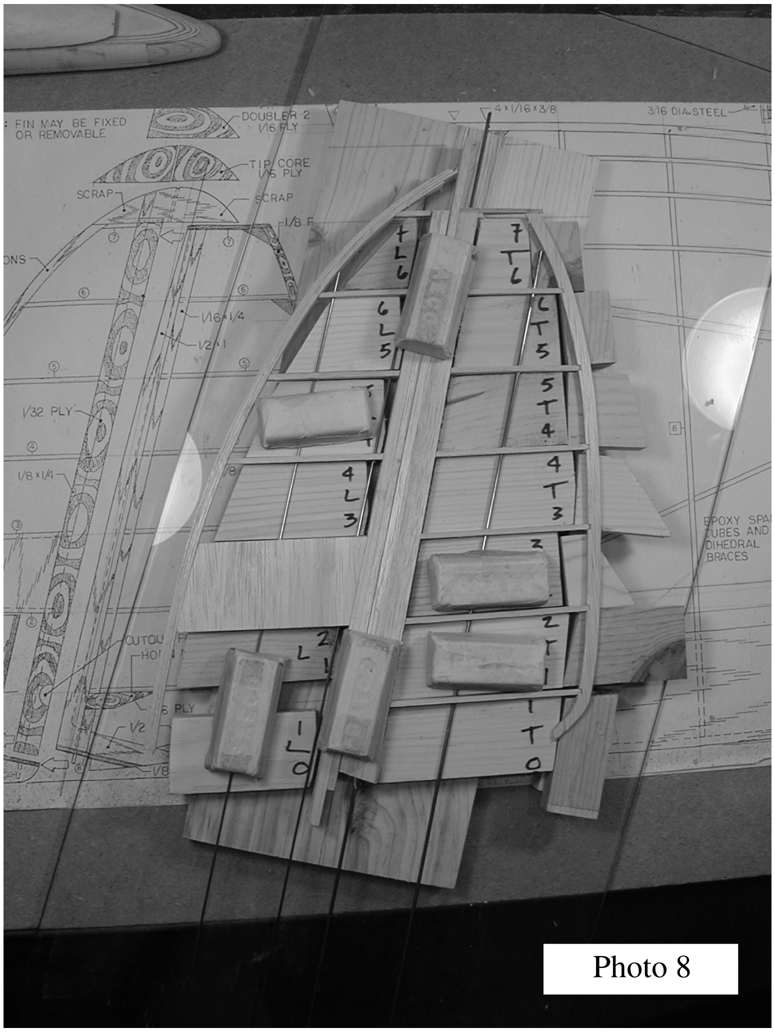

Photo 8

While cutting out the ribs, we drilled two holes in the centerline of each rib in such a way that it could be slid onto separate lengths of 3/32 inch piano wire. The music wire was then placed across the blocks and the ribs were inserted into the predetermined gaps.

Lead weights were strategically placed to temporarily hold the music wire firmly on the blocks. The trailing edge of the fin and the leading edge of the rudder were then glued to the ribs to act as anchors for the rest of the fabrication process. The leading edge of the fin was laminated exactly as we had the leading edge of the wing, and glued in place. We chose not to use the music wire hinging of the original, and rejected the hollow tube leading edge for the rudder in lieu of a more simple box structure. The plywood trailing edge of the rudder was cut using an aluminum template and reinforced with a number of balsa gussets. Photo 8 shows the completed fin and rudder structures in the jig.

Once everything was glued together, the parts were removed from the jig and large Klett hinges were used to connect the fin and rudder assemblies. Photo 9 shows the completed fin and rudder in place on the fuselage. After covering, mylar hinge gap seals will be installed to prevent air leaks.

Completed framework

Photos 10 and 11 show the completed R-2 framework.

We’re extremely pleased with the lines of the completed fuselage, especially the ventral fin which shows well in Photo 10. We were a bit concerned about this area, as it underwent a complete change of outline during the design process. The fin has to be deep enough to drive the wing to a negative angle of attack upon contact with the ground, yet be both streamlined and smoothly integrated with the fore portion of the fuselage which is based on the *Model Builder* Raven.

We’re very eager to start ’glassing, painting, and covering.

Next installment

The final installment in this series will cover fiberglassing and painting the fuselage, covering the wing and fin-rudder assemblies, and test flying. As was true with our last project(s), weather is going to be a large factor in the timing of Part 4 of the R-2 saga, as that will determine when the test flying occurs.

In the meantime, we’re always open to suggestions for future columns, and always eager to hear of reader projects. We can be contacted at P.O. Box 975, Olalla WA 98359-0975, or at <bsquared@appleisp.net>.

Photo 9

References

Kuhlman, Bill & Bunny. “Our Pioneer II-D at 60 Acres.” *RCSD*. March 1996, pp. 16-17.

—. Full size plans for a quarter scale model (129.5" span) of Jim Marske’s Pioneer II-D can be purchased from Harry Volk, Cirrus Aviation, P.O. Box 1375, Nanton Alberta T0L 1R0, Canada. (403) 646-1188. Price is US$35.00, including packing and postage.

Model Builder Raven plans from Bill Northrop’s Plans Service, 2019 Doral Court, Henderson NV 89014-1075; (702) 896-2162 M-F 10A-5P Pacific, FAX (702) 897-7775 any time.

Pappas, Dean. “R/C Pattern.” *Model Aviation*. April 1998, pp. 40-41.

Photo 10

Photo 11

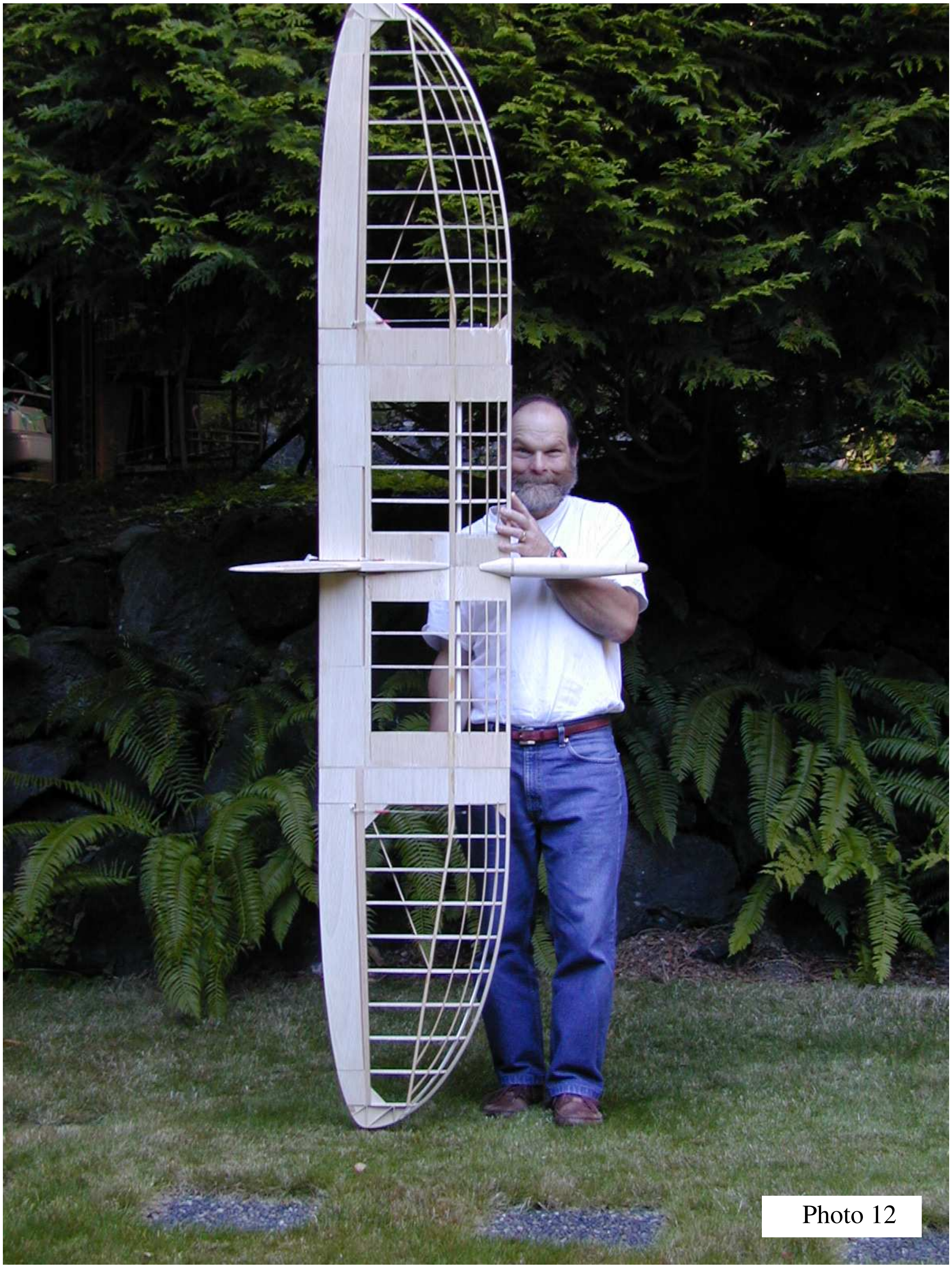

Photo 12