On the ’Wing... #151

Dave Jones’ R-2, Part 1

Yes, another construction project is on the building table! We’ve always had a particular fascination with this design, due mainly to its beautiful parabolic wing planform.

Dave Jones’ R-2 originated in the ’80’s, but its inherent beauty remains today. The R-2 was designed as a Standard Class glider under the initial rules for the class, so it has a 100" wing span and uses only rudder and elevator controls. The wing uses a lot of open framework, despite using the CJ-3406 (4% camber, 6% thickness), and so the wing sheeting is a bit thicker than what might otherwise be expected, 3/32" balsa. More about this later.

Planned weight for the model, as originally designed, is just 50 ounces. With 1500 square inches of wing area, the wing loading is a very low 4.8 ounces per square foot.

As is usual with a design two decades old, some modifications will be made as construction progresses. Here’s a list of the major modifications we have planned:

- Airfoil changed from CJ-3406 to CJ-25^{2}09
- Fuselage transformed to a more “Raven-like” contour
- Elevator modified to use fabric hinge
- Wing converted from polyhedral to dihedral
- Addition of ailerons

Let’s take a look at each of these in turn.

Airfoil changed from CJ-3406 to CJ-25^{2}09

As we mentioned at the start, the airfoil designated on the full size plans is the CJ-3406. This is a thin highly cambered section which was used on several other Western Plan Service designs. Over years of testing, Dave found that such airfoils offer no advantage over those with lower camber and more thickness. The CJ-25^{2}09 has 2.5% camber and is 9% thick. Because the lower surface is flat from 25% chord to 75% chord, a wing using the CJ-25^{2}09 across the entire span can be built on just about any flat surface which is large enough.

From a structural standpoint, this increased thickness means more rigidity. While we’ll keep the spar sizes the same (they match those on the Raven), the balsa sheeting will be reduced in thickness from 3/32" to 1/16". This cuts one third off the weight of the balsa sheeting.

The wing trailing edge consists of upper and lower surface sheeting with 1/16" plywood between for stiffness. This makes the trailing edge very blunt. As has become our usual practice, we’ll use 1/64" plywood between the skins. This is more weight saved, and will result in a more aerodynamically clean trailing edge.

Fuselage transformed to a more “Raven-like” contour

The fuselage of the *Model Builder* Raven is not only very slender, it is also shaped so that the tow hook is mounted close to the vertical CG. The R-2 fuselage is twice as deep, and the distance between the wing and the tow hook is nearly five inches. During launch, the tensioned tow line tends to rotate the aircraft so that a line drawn between the CG and the forward part of the tow hook forms an extension of the tow line. This force is quite strong, and tailless aircraft have little

damping in pitch. The result is that the wing is driven to an angle of attack above the stall point, leading to disastrous results. A method of overcoming this tendency is to move the tow hook more forward, but this places the weight and drag of the tow line well ahead of the CG, reducing launch height.

Additionally, the R-2 fuselage is straight sided when viewed from above. This is not aerodynamically clean. As well, there's room for a doored ballast box capable of holding one and a half pounds of lead.

Rather than a ballast box which resides in the fuselage on the CG, we're going to place ballast tubes in the center wing panel, as is done on the Raven. The fuselage will be made a bit wider in front of the wing so it has more of a streamlined teardrop shape. With the RC equipment of today, there's little need for such a deep fuselage, so a lot of slimming will be done in the vertical dimension. This will have the added advantage of placing the tow hook closer to the wing. An additional benefit is a substantial reduction in fuselage weight.

Using the Raven fuselage as a pattern, we've drawn up a new fuselage for the R-2 and constructed a template for cutting out the plywood sides.

Elevator modified to use fabric hinge

The rudder and elevator hinges as shown on the plans are complicated and somewhat labor-intensive affairs, due mainly to the fact that they are designed to be removable.

The rudder uses two 1/16" music wire pins to hold it in place — one at the bottom and one at the top — and has a semi-D-tube leading edge. It looks like it will be fairly light. At this point we've made the decision to build the structures as on the plans, but forego the ability to remove them.

The elevator is in two pieces which are connected with a rather large music wire and sheet metal control horn assembly. The elevator is removed by pulling out two 1/16" music wire pins through the outboard end of the center section. The fin must be off the model for the elevator to be removed entirely.

A more simple solution, and one which makes construction more accurate, is to construct the elevator and wing together, as if using foam core construction. When complete, the elevator will be cut free, faced as necessary, and a MonoKote hinge will be used. There is sufficient torsional strength if the connection between the two elevators is made as a spar, and the control horn may then be fabricated of plywood.

Wing converted from polyhedral to dihedral

The R-2 wing planform is so beautiful, we just hate to muck it up with a dihedral joint. So we're going to use straight dihedral. Since the R-2 wing uses essentially the same construction method as the Raven, this modification is pretty straight forward. We'll cover the details as we go through the construction process.

Addition of ailerons

Since a large portion of the trailing edge of the wing is sheeted with balsa, we've decided to reconfigure the sheeted area in order to add ailerons. This means extending the forward edge of the sheeting about 1.5", but we're going to remove some sheeting from the ailerons themselves to make them lighter. Over all, the weight should be about the same, but the distribution will be closer to the CG. Since we're using a thicker airfoil, we can place the aileron servos in the wing

forward of the inboard edge of the control surfaces. This has worked extremely well for us in the past.

This is an exciting construction project for us, as we're updating a beautiful design without going high-tech. In fact, some of the construction methods are straight from old free flight techniques. It will be a learning experience, that's for sure.

This will be a four part series. We'll get the wing and elevator completed in Part 2, and in Part 3 we'll construct the fin and the fuselage. In Part 4 we'll describe 'glassing, painting, and covering (yes, we already have the colors picked out), plus, of course, the flying!

We're always eager to hear about readers' projects. If you've built or are building something which you think may be of interest to other *RCSD* readers, please let us know. We're also on the lookout for suggestions for topics for future "On the 'Wing..." columns. Contact us at P.O. Box 975, Olalla WA 98359-0975 USA or by e-mail at <bsquared@halcyon.com>.

R-2 Specifications	
Span	100 inches
Root chord	17"
Wing area	1500 sq. in.
Airfoil	CJ-3406
Sweep	Apex of wing tip set back 12.75" from leading edge at root
Construction:	
• Wing	• Balsa ribs, spruce spar caps with balsa webbing, 3/32" balsa sheeting, 1/8" sq. spruce turbulator spars, and 1/16" plywood trailing edge core
• Elevator	• Balsa ribs and sheeting
• Fuselage	• Plywood sides, balsa block upper and lower
• Fin and rudder	• Open framework of balsa ribs with sheeting on root panel of fin, plywood trailing edge
Weight, projected	50 ounces
Wing loading	4.8 oz. per sq. ft.