



# IMAC One-Design

By Darrel Stebbins

## One-Design Aircraft for International Miniature Aerobatic Club Competition

IMAC, following the lead of its full-scale counterpart, has developed a 1/3 scale model of the International Aerobatic Club's new One-Design aerobatic airplane. IMAC's mandate, as promulgated by its charter members, is to replicate full-scale aerobatics with R/C aircraft. The planes flown in IMAC competition are required to closely resemble aircraft that have been flown in full-scale competition. Minor deviations are allowed, e.g., a 10% variation in

fuselage length, control surface area, etc., and 20% reduction in fuselage height and width.

There are presently four classes of competition in IMAC: in ascending order of difficulty, Basic, Sportsman, Advanced, and Unlimited. The aerobatic sequences flown are virtually identical with the sequences of the corresponding full-scale classes. The new class, to be known as the One-Design class, will be added to the competition

schedules as sufficient planes are built to justify a separate competition sequence. Meanwhile, the One-Design may be flown in any of the present classes.

The One-Design concept is an attempt to "level the playing field," to standardize the aircraft so that the winner of the competition will be determined by flying skill rather than (to use an auto racing term), "cubic dollars." In IMAC, the One-Design aircraft configuration must match exactly the plans herein reproduced, and the maximum engine displacement is established at 1.20 cubic inches. Type of construction, materials, and weight may vary; but exterior dimensions must follow the outlines shown on the official IMAC One-Design plans.

Matt Mrdeza was asked to build a scale



## IMAC ONE-DESIGN

Designed by:

Matt Mrdeza (mods by Stebbins)

### TYPE AIRCRAFT

Scale Aerobatic

### WINGSPAN

72 Inches

### WING CHORD

14-1/8" (Avg.)

### TOTAL WING AREA

1029 Sq. In.

### WING LOCATION

Low Wing

### AIRFOIL

Symmetrical

### WING PLANFORM

Double Taper

### DIHEDRAL, EACH TIP

1-3/16 Inches

### OVERALL FUSELAGE LENGTH

66 Inches

### RADIO COMPARTMENT SIZE

Ample

### STABILIZER SPAN

29-1/4 Inches

### STABILIZER CHORD (inc. elev.)

9 Inches (Avg.)

### STABILIZER AREA

252 Sq. In.

### STAB AIRFOIL SECTION

Flat

### STABILIZER LOCATION

Mid-Fuselage

### VERTICAL FIN HEIGHT

8-3/4 Inches

### VERTICAL FIN WIDTH (inc. rud.)

10-1/2" Inches (Avg.)

### REC. ENGINE SIZE

.90-2.1 cu. in. (2 or 4-stroke)

### FUEL TANK SIZE

20 Oz.

### LANDING GEAR

Conventional

### REC. NO. OF CHANNELS

4

### CONTROL FUNCTIONS

Rud., Elev., Throt., Ail.

### BASIC MATERIALS USED IN CONSTRUCTION

Fuselage ..... Balsa & Ply

Wing ..... Balsa, Ply, Fiberglass

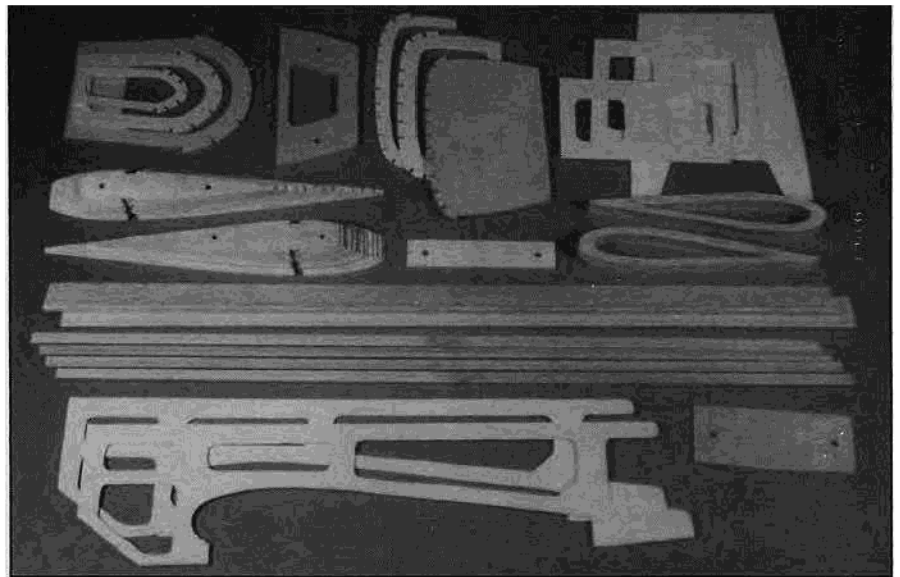
Empennage ..... Balsa

Wt. Ready To Fly ..... 160-240 Oz.

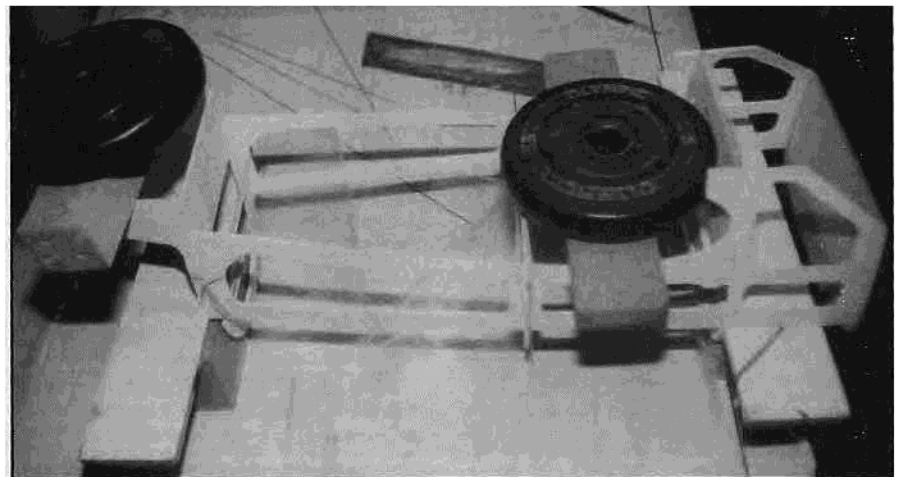
(10-15 Lbs.)

Wing Loading ..... .23-33 Oz./Sq. Ft.

model from the original plans of the IAC One-Design, to check the design parameters of the full-scale plane. He built a 1/3 scale model, working closely with Dan Rihn, designer of the IAC plane. The plane flew very well, with all moments and distribution of surfaces acting as had been predicted. A special aerobatic airfoil was designed for the plane, which also proved to be exactly what the designers had hoped for. Matt subsequently brought the model to the attention of IMAC and the design was reviewed with special attention to the modifications suggested by Matt after flying the scale model. IMAC suggested scaling up to a 72" wingspan, narrowing the fuselage at the front by 20%, decreasing the fuselage height somewhat, lengthening the fuselage by 10%, and adding area to the vertical fin and rudder. These changes were incorporated into the plans, and the prototypes built to the modified specifications.



Prepare a "kit" before starting construction.



Start fuselage by gluing fuselage doublers to formers.

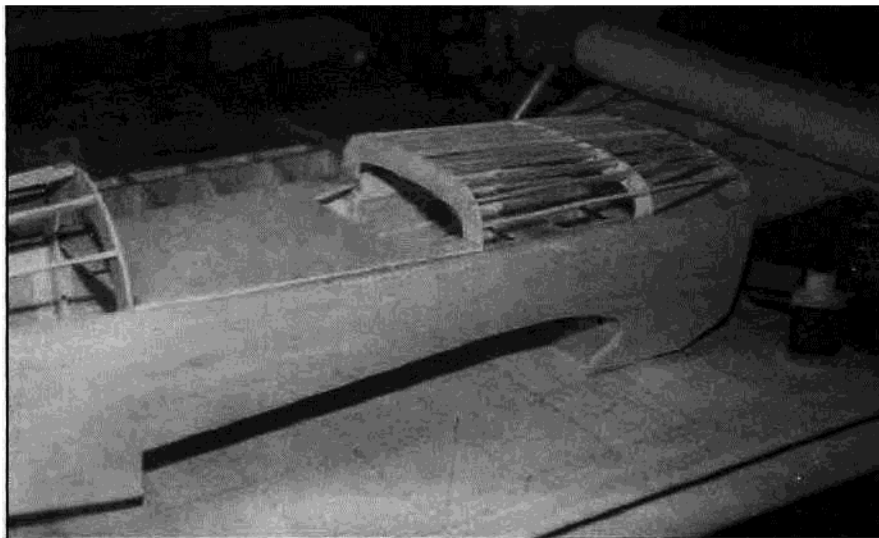


Laminate balsa fuselage sides to lite ply doublers.

Three prototype planes have been built, the first a test-bed plane to check out the basic features of the design, and the second to serve as the construction model for this article. The third, built by Matt Mrdeza, was built from the plans but included a smoke system and a much larger engine. This model would **not qualify** for One-Design

competition, but **would qualify** for any of the other four classes of IMAC competition.

The Prototypes have been flown extensively, and seem to exhibit no undesirable characteristics. #1 is being flown, at 11-lbs., with a Super Tigre 90; #2, at 12-lbs., has an ASP 1.08 installed; and #3, at 17-lbs., has a 3-W35 ignition engine.

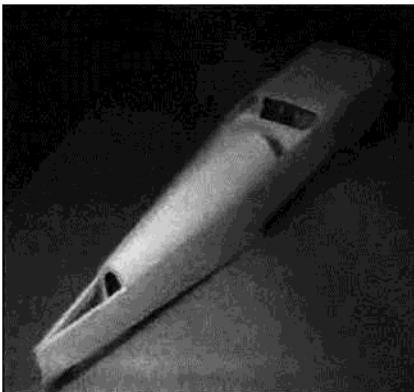


*Cockpit floor helps square up fuselage.*

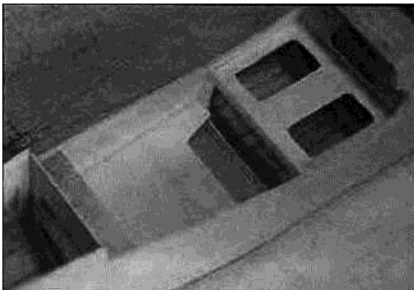
### CONSTRUCTION

Construction is mostly built-up balsa and plywood. Some parts — fiberglass cowl, landing gear, and canopy can all be fabricated from the information on the plans, but are also available from vendors (see list at end of article).

The first step is to create a kit for yourself. Doorskin plywood can be substituted for lite ply, at a slight penalty in weight. All 1/4" plywood should be aircraft grade. All balsa can be of medium weight, except the stringers which should be fairly stiff. Spruce spars are shaped from laminated 1/2" x 1/8" stock. The prototype planes were constructed with aliphatic resin glue (Pica Gluit), cyanoacrylate glue, and epoxy where appropriate. (I am allergic to regular cyanoacrylate, but can and do use Hot Stuff UFO — User Friendly Odorless — Thin and Thick CA, and their Accelerators with good success, and no ill effects.)



*Apply sheeting over upper fuselage stringers.*

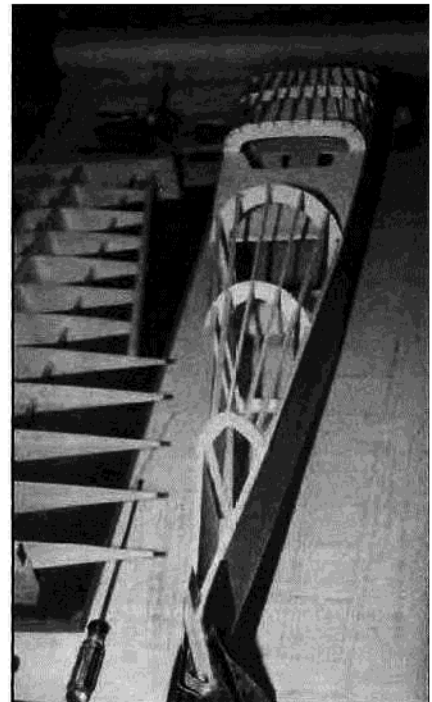


*Roomy radio and fuel tank compartment.*

### Fuselage:

Locate the 1/16" holes in the fuselage doublers very carefully, they ensure that the fuselage will be straight and square. Construction of the fuselage is started by assembling the fire wall F1 and formers F2, F3, and F4 to the lite ply fuselage doublers. Mark the horizontal reference lines and vertical centerlines on the formers before assembly. By threading lengths of 1/16" piano wire or welding rod through the holes in the doublers, the exact location of the formers is established. Fit the forward and aft lite ply fuel compartment floor formers in place to square everything up.

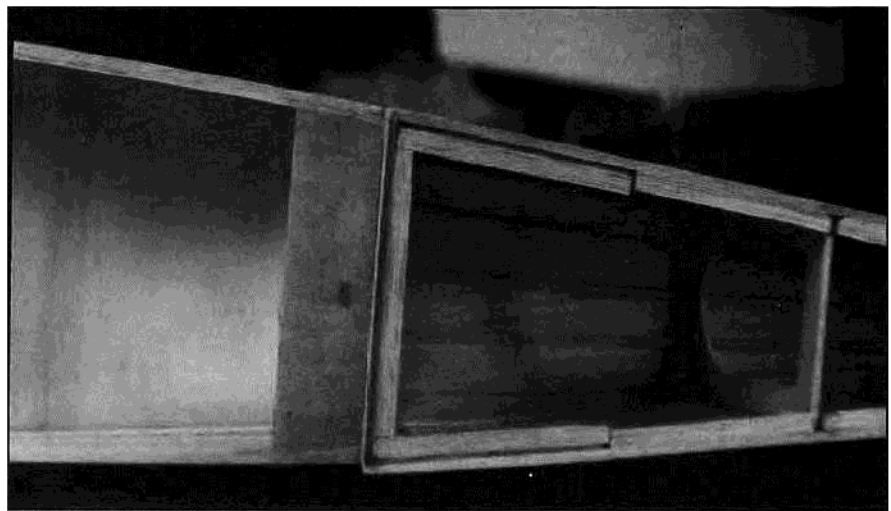
Glue up the fuselage sides from 3" x 3/16" medium balsa. Coat the contact surfaces of the lite ply doublers with a thin



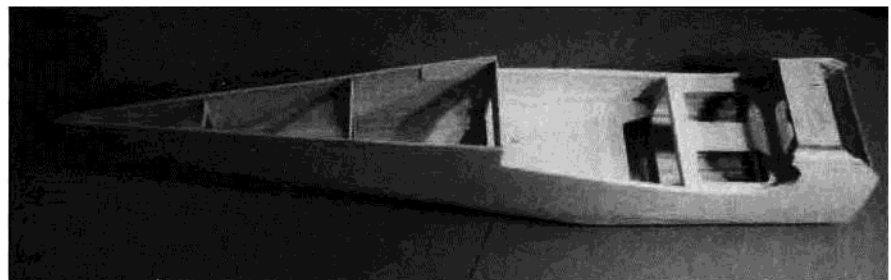
*Install stringers at upper fuselage formers.*

coat of aliphatic glue, pin and clamp the fuselage sides in place. If necessary, paint the outside surfaces of the balsa with a mixture of ammonia and water to loosen up the fibers and let it bend smoothly into place. Draw the tail ends of the fuselage together, with a temporary 1/4" tail post in place, and clamp the fuselage sides into exact alignment.

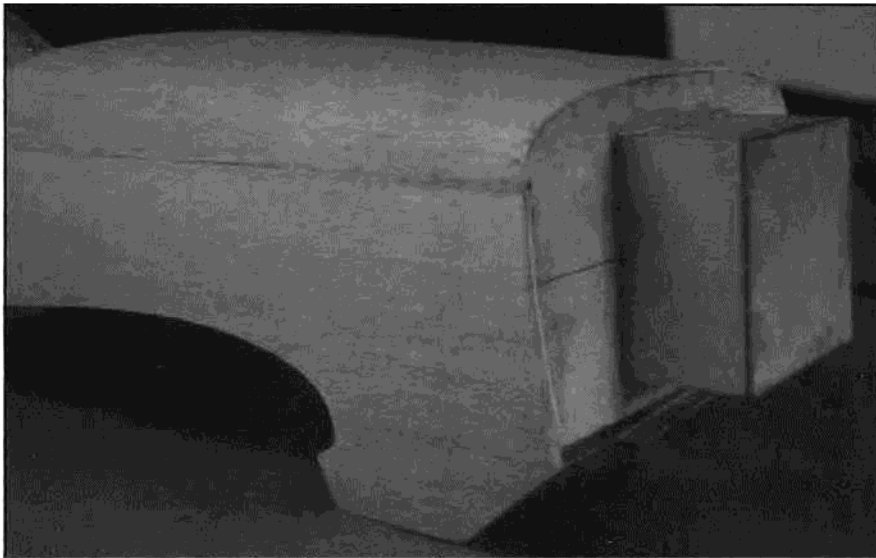
Glue formers F5 and F6 in place. Install the 1/4" aircraft plywood landing gear mount plate with Z-Poxy. Do not install the



*Triangle stock and stringers support sheeting.*



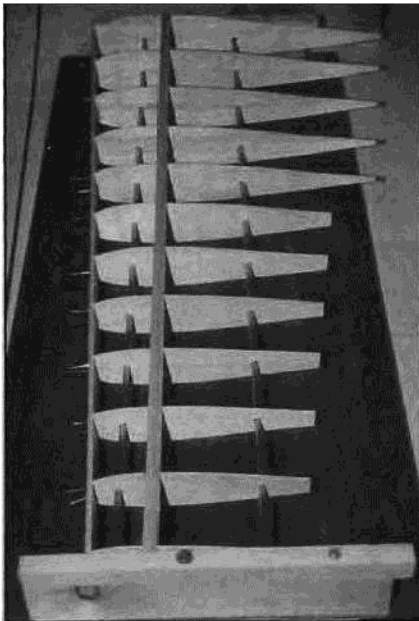
*Fuselage ready for bottom sheeting.*



**Plywood box used to extend fire wall location.**

slanted 1/8" plywood piece between the fire wall and the landing gear mounting plate yet — you will need to drill the wing dowel holes through that area. Install the full-length 1/4" x 1/8" balsa stringer at the top of the sheet balsa sides at this point. **Note:** That it is set back from the balsa side sheets 3/32" to allow the upper sheeting to butt with the lower fuselage sides.

Install the balsa cockpit floor and verify that the fuselage is square, that all the centerlines on the formers line up properly, and that the tail post is centered. If all is well, install the 1/8" x 1/4" stringers forward and aft of the cockpit. These add considerable strength, do not omit them. Place the slanted 3/32" balsa closers at front and back of the cockpit, shaped to conform to the projected outline of the underside of the sheeting. The 3/32" sheeting may be edge-glued before installation and trimmed to size, or installed as planking. If sheeting is used, paint the outside of the sheeting with an ammonia-water mixture if needed to get the



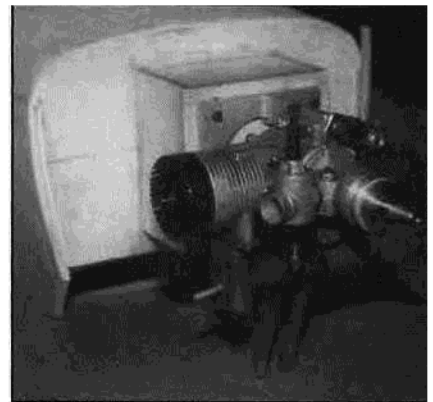
**Wing is assembled using the "RCM Wing Jig" (see article in Aug. 1967 RCM).**

sheeting to conform to the formers. Be sure to glue to both the stringers and the formers, using aliphatic glue. The sheeting stops at former F6.

Install the 1/2" triangular stock balsa between the formers behind the wing. Install tubing to route your antenna through the fuselage, and the tubing pushrod exists. Glue the bottom 3/32" sheeting in place, cross-grain to the length of the fuselage. Glue the 1/8" lite ply doublers in place on the side sheets from former F6 to the front of the tail post, to provide additional support for the horizontal stab, and glue in place the small 1/8" lite ply doublers to provide reinforcement to the tail wheel assembly. Laminate 1/4" and 1/8" aircraft plywood to form the wing mount plate and epoxy it in place. Epoxy balsa triangular stock at the plate, former F4 and the fuselage side doublers as shown. Sand everything smooth, and set the fuselage aside until you have the tail surfaces ready to install.

**Tail Surfaces:**

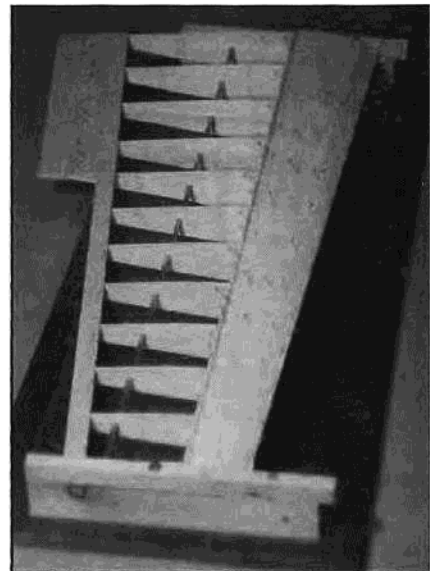
Just standard tail surfaces construction; carefully cut the sticks to the proper angles, pin them in place over the plans (don't forget to protect the plans with wax paper), and



**ASP 1.08 installed on extended fire wall.** glue them together with aliphatic glue. The 1/4" plywood blocks are support for the tail rigging wires, and are drilled for 3/32" brass tubing inserts. Glue the tubing in with thin CA. Round the leading edges; sand the control surfaces to profile as shown on the drawings.

**Wings:**

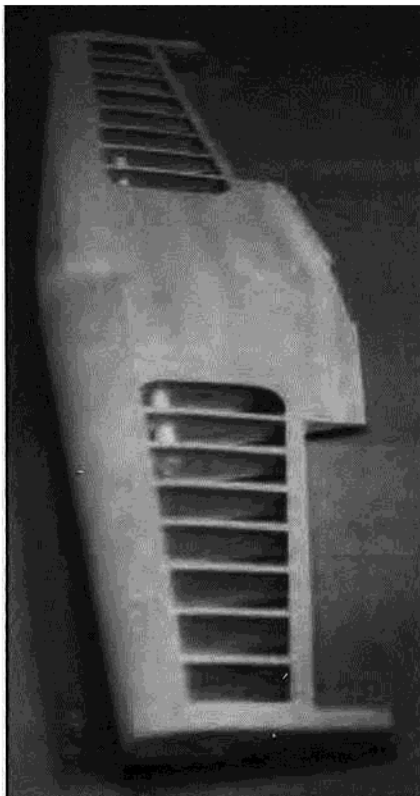
The wings are built in a wing jig, similar to the one detailed in the August 1967 RCM. Glue R6S on rib R6 and R7S on rib R7, as shown on the plans. Space the alu-



**Add leading and trailing edge sheeting with the wing in the jig.**



**Shear webs, paper tube for aileron leads, and capstrips are all glued in place.**



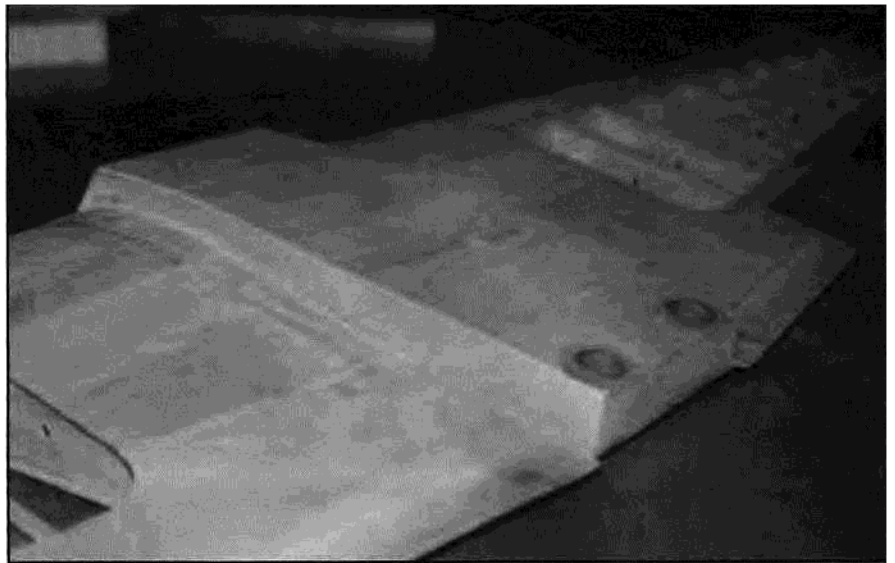
*Wing joined and center section sheeting installed.*

minum dowels as shown on the plans; thread the wing ribs on the dowels and lock the dowels in place. You will be building two wing halves, they are identical but reversed, so build a right wing and a left wing in the jig.

The two-piece leading edge is formed of a 1-1/4" x 3/16" balsa strip, with 3/32" wide by 1/16" deep slots spaced to accept the wing ribs and a 1-1/4" x 1/2" nose piece. This assembly provides exact spacing for the ribs, and support for the leading edge sheeting. A table saw makes quick work of cutting the slots. The trailing edge is cut from 1-3/4" x 1/2" stock, with the front edge rabbeted out top and bottom 3/32" x 3/32", then slotted like the leading edge to accept the trailing edges of the wing ribs. Again, this provides exact rib spacing, and support for the trailing edge sheeting. At the ailerons, the trailing edge of the wing and the leading edge of the aileron are also slotted for the wing ribs. Both are cut from 3/8" x 3/4" stock.



*Stick construction used for vertical fin and rudder.*



*Bottom fairing is now glued on wing, and cardboard tubes for wing bolt access installed.*

Start construction with the wing ribs spaced on the aluminum support dowels. Install and glue the slotted leading edge piece, placing aliphatic glue in the slots, then firmly seating the ribs into the slots. Block or pin the leading edge strip in place, using a straightedge to ensure that the leading edge is truly straight, and making sure the tops of the ribs are all aligned. Check the trailing edges of the ribs to make sure they are also aligned properly, then install the slotted trailing edge at the center four rib spaces and the narrow slotted trailing edge strip at the aileron space ribs. Again, place glue in the slots, then firmly seat the ribs in the slots.

The spars are laminated with Z-Poxy from three thicknesses of 1/8" x 1/2" spruce, tapered as shown. The top spar can now be glued in place, using aliphatic glue or slow CA. When all the adhesives have set up, release the dowel holding blocks and flip the wing over, clamp the wing into the jig again and install the bottom spar. Install the 1/16" plywood leading edge doubler in the space between R1 and R2, at the center of the wing. Cut the wing shear webs from 3/32" sheet, fit snugly to the ribs and flush with both top and bottom spars; glue them at the rear side of every rib space except at the center space (which will later have a 3/16" plywood spar joiner installed when the wings are joined). Shape the leading and

trailing edges to match the ribs.

All of the ribs must be flush with the leading and trailing edge strips; use a long sanding block with the fine sandpaper to smooth any irregularities. Shape the tops of the strips to conform to the rib profile prior to installing the leading and trailing edge sheeting. Note that at the center four ribs, where it meets the tapered trailing edge, the ribs should be flush with the recessed rabbet in the trailing edge, not the top of the trailing edge.

The 3/32" balsa leading and trailing edge sheeting should be installed with aliphatic glue. The leading edge sheeting is glued to each rib, the leading edge strip and the spruce spar. The trailing edge sheeting is glued to each rib and the trailing edge strip. At the center four ribs, the sheeting should be glued into the rabbeted groove. Fit and install the center wing sheeting at the center three bays. Install the paper tubes for the aileron servo wires. Fit and install the 3/32" x 3/8" balsa capstrips at the remaining wing ribs. This will be the top of the wing.

Flip the wing over again and install the filler blocks at the center bay trailing edge. Make this flush with the top of the ribs, so that the center wing sheeting will cover the blocks. Repeat the above two paragraphs to install the bottom leading and trailing edge sheeting. The bottom center wing sheeting



*Horizontal stabilizer and elevators also use stick construction.*

and capstrips are installed after the wing halves are joined.

Build the other wing half, making sure you have a right wing and a left wing.

To join the wing halves, block the panels flat on a straight, flat surface, with the underside of the wings up. The top of the wing forms a straight line, the taper of the wings provides a 1-3/16" "dihedral" under each wingtip. Cut a wedge-shaped filler to connect the center wing ribs, coat it with Z-Poxy and glue the wing halves together. Use clamps to hold the ribs tightly to the filler. Cut a 3/16" slot from top to bottom through the center ribs and filler at the rear of the spars, and epoxy the 3/16" plywood spar joiner in place.

The bottom center wing sheeting and the capstrips can now be added. Glue the wingtip blocks in place and glue on the leading edge nose strips. Shape the tips and nose strip as shown on the drawings. Use a long sanding block to smooth the wing sheeting, leading and trailing edges, capstrips, and tip blocks. Install the 1/4" x 3/8" spruce servo plate bearers, and the 1/4" square balsa and 3/16" x 1/2" spruce servo cover plate supports. Epoxy the 1/8" x 2" x 5-1/2" plywood reinforcing on the bottom of the wing at the center of the trailing edge.

Trial fit the wing to the fuselage. Sand the leading edge flat area where the wing contacts former F2 and trim the trailing edge flat where it meets former F4. Allow sufficient room for the thickness of the fiberglass center section reinforcing. When everything fits, and is square with the fuselage, add the fiberglass reinforcing to the wing using epoxy.

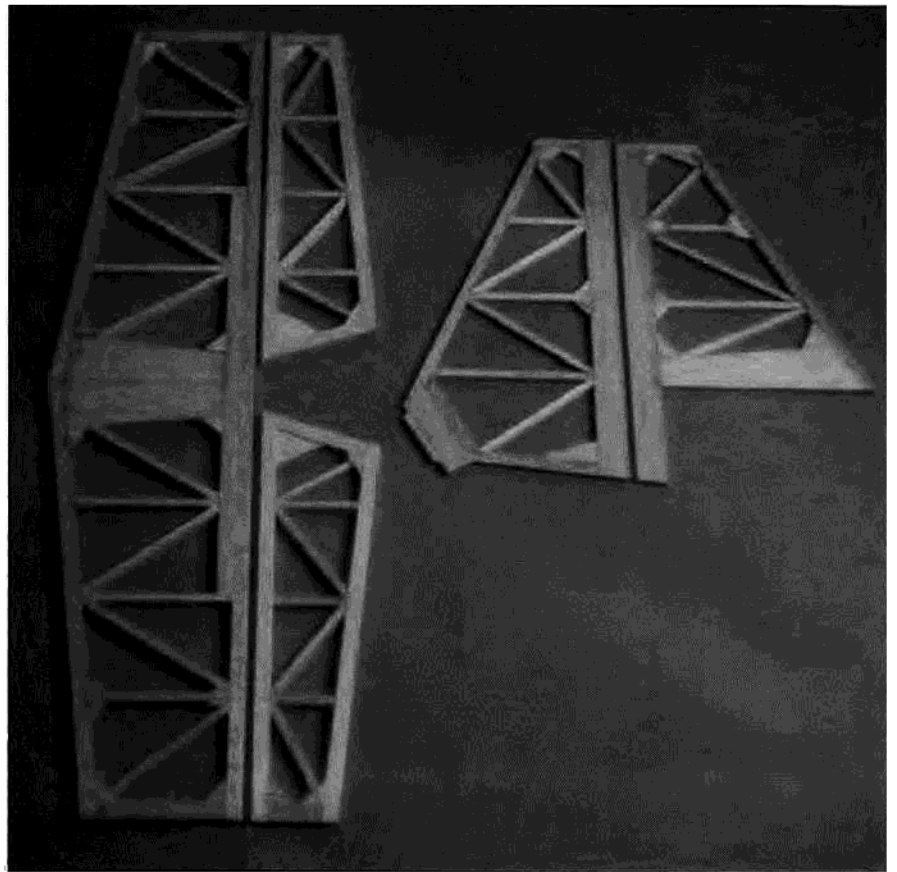
#### Ailerons:

Pin 3/32" x 1-3/4" x 22" aileron sheeting strips at the proper location on the drawings (don't forget the wax paper), then glue the rabbeted and slotted trailing edges in place. Glue the shaped and slotted aileron leading edges on the aileron sheeting strips.

longitudinal reference line at the top of the main fuselage side sheeting. If all is well, glue the horizontal stab in place with 30 minute Z-Poxy. Before it sets up, place a pin at dead center of former F4, and with a string measure from the pin to the back corners of the stab. Adjust the stab, keeping the front centerline centered on the center of former F6, until the measurements are equal. This will ensure that the stab hinge-line is exactly at 90° to the centerline of the airplane.

Remove the temporary tail post and epoxy the vertical fin in place, aligned with the centerline of the plane and at right angles to the horizontal stab.

Install the balsa blocks that form the juncture between the horizontal stabilizer, vertical fin, and the lines of the fuselage. Tail support wires (installed after the tail surfaces are covered) are fabricated from high strength fishing line or weed-eater line, threaded through the brass tubing previous-



*Tail feathers ready for sanding to shape.*

ly installed in the surfaces, and secured to the underside of the fuselage.

#### Wing Installation:

Block the fuselage in place, upside down, on your bench. Set the horizontal reference line on the fire wall and the horizontal stabilizer exactly level. Draw a centerline on the bottom of the wing, and centerlines on formers F2 and F4. Place the wing in the wing saddle aligned with the centerlines, and verify that the top surface of the wing lines up exactly with the horizontal stabilizer and reference line on the fire wall. If not, shim under the lower wing at the saddle until it does line up. Check the opposite side to see how it matches the wing contour. Remove the wing and sand the high side of the saddle to match the wing contour, then check the alignment again to see if the shim dimension is still the same. Add a balsa strip of the necessary size to align the wing. This method will be less likely to disturb the wing incidence than sanding off the high

#### Installing The Tail Surfaces:

Draw a centerline on the top surface of the horizontal stab, at former F6 and the temporary tail post. Block the fuselage in place on your bench then check the horizontal reference line on the fire wall, the wing cut-outs in the fuselage sides, and the stab bed at the rear of the fuselage to ensure they all line up exactly. If they don't, sand and trim until they are exactly in line, parallel to the bench. Make sure that you haven't disturbed the incidence of the horizontal stab, it should align exactly with the

side to match the low side. When the wing is exactly level with the reference points and with the centerlines lined up, measure from a pin at the center of the tail post to the outboard forward corner of the aileron on each side. With the leading edge centered, make any necessary adjustments to the trailing edge to get the wing exactly at right angles to the fuselage centerline.

When the alignment is proper, block the wing in place, using the holes in former F2, drill through the leading edge of the wing and into the holes in the 3/16" spar joiner for the wing mounting dowels. Remove the wing and glue the dowels in place. Replace the wing, line everything up again, and drill the #7 drill size holes for the wing mount bolts. Remove the wing and tap the wing mount block for 1/4"-20 nylon bolts. Carefully enlarge the matching holes in the wing to clear the 1/4" bolts. Because the wing must move forward and down to clear the front and rear of the saddle, it may be

necessary to slightly "oval" the dowels' holes in former F2. **Note:** The holes should be enlarged upwards only; the dowels keep the wing from moving down, and the fuselage sides prevent the wing from moving up. The fuselage section under the wing may be built-up from foam blocks and covered with balsa; or built with balsa sides, lite ply front and rear formers, and several transverse formers to stiffen the bottom sheeting. Be sure to include the cardboard tube wing bolt recesses. Because the wing must be "rocked" to install it, the front and rear clearances between the fuselage formers and the wing formers must be sufficiently wide to allow for this movement.

#### **Engine Installation:**

Determine the engine you will be using, while you can still access the rear side of the fire wall. My installation of the ASP 1.08 required that I build a 1/4" plywood box to attach to the fire wall to bring the prop washer out to the proper location. Your engine choice will determine how the construction forward of the fire wall is configured. Soft mounting is desirable.

#### **Landing Gear:**

The aluminum (or carbon fiber) landing gear can now be installed. My choice was to use four 1/4" nylon bolts, on the assumption that I would rather break the bolts than rip out the landing gear mounting plate. I drilled and tapped the plywood plate for the nylon bolts. If you would rather use metal attachments, blind nuts can be installed in the landing gear mounting plate.

After completing the engine and landing gear installation, you can finally epoxy the slanted 1/8" plywood lower closure in place. For added strength, epoxy 6 oz. fiberglass cloth strips inside around the landing gear mounting plate and outside at the joint between the gear plate and the slanted closure piece.

The fiberglass cowling, available from Cutting Edge Aero, is a close fit, requiring only minor adjustment of the forward fuselage to slide it smoothly into place. The hardwood attachment blocks should be drilled as shown with a 3/32" drill. This will allow 1/2" lengths of inner NyRod to be pressed into the holes, then glued in place with thin CA, and tapped for 2-56 metal



*Designer Matt Mrdeza with his ONE-DESIGN PROTOTYPE*

screws. This provides what amounts to a lock nut for holding the mounting screws.

#### **Covering:**

Because there are so many color schemes for some of the aerobatic planes (Citabria, Pitts, Skybolt, etc.), IMAC's insistence on verifiable scale appearance does not extend to color schemes or patterns. For the benefit of both pilot and judges, IMAC planes often have greatly contrasting top and bottom surface colors.

Prototype #1 was covered with Coverite 21st Century Film, and #2 was covered with 21st Century Fabric. Both were easy to work with, and produced an excellent finish. A Coverite hi-tech covering iron provided precise temperature control, and made the job much easier. 21st Century paint and trim sheet was used on the cowling of #2. These products are highly recommended. As usual, with whatever finishing

materials you choose, **read and follow the instructions.**

#### **Cockpit:**

IMAC rules require that a realistic pilot and instrument panel be appropriately installed in all Scale Aerobatic aircraft. This does not mean a "Snoopy" or Bart Simpson. The CD will assess a one (1) percent flight score penalty for noncompliance with this requirement. In both prototypes we have installed a DGA pilot bust, appropriately painted, and a simplified instrument panel.

#### **Canopy:**

The canopy on both prototypes was adapted from a Goldberg Extra 300 canopy. By the time you read this, Cutting Edge Aero will be able to supply a better replica of the IAC One-Design canopy.

Trim the canopy to fit, as shown on the drawings. When you are satisfied with the fit, place the canopy in position and draw

around it with a marking pen. Remove the canopy and cut a 1/16" gap in the covering all around the canopy — with the drawn line being the outside limit of the gap. Tape the canopy in place and carefully apply slow CA glue around the edges. Stop well short of any tape, to prevent the CA from creeping under the tape and spreading up on the canopy. Remove the tape as soon as the glue has set up and then apply glue to the remaining areas.

#### **Flying the One-Design:**

The C.G. is shown on the drawings. For test flying, set up the plane a tad nose-heavy. With the 1.08 up front, a 4" C.B. Associates plastic spinner, a 1200 mAh battery just ahead of the wing, and servos near the front of the cockpit area, prototype #2 balanced about 1/8" in front of the indicated C.G.

For the first flight, set the control surfaces for moderate throws: Ailerons 7/8" up and 1/2" down, elevator 3/4" up and 3/4" down, and rudder 7/8" each way. As you get used to the airplane, you will adjust these to suit your personal preference.

Ground handling is smooth and positive. Line up into the wind and increase the power slowly. The model should track straight with only minor rudder corrections. The tail will come up by itself — when flying speed is reached, gently apply up elevator as needed to lift off.

Climb out at a shallow angle. Trim the model to fly straight and level at about 3/4 throttle; increasing or decreasing the throttle setting slightly should not appreciably affect the pitch. Get up to a safe altitude, throttle back to try slow flight and establish what happens when the model stalls. If one wing drops sharply at the stall, adjust the rudder trim to minimize the wing drop — then readjust the ailerons for level flight. If the plane stalls too quickly and snaps, you may have it set up tail heavy.

Again at safe altitude, try some loops. Start with moderate up elevator, to see how it tracks through the loop, adjust with rudder, if it will not track straight through. When it appears to be tracking satisfactorily, get adequate altitude and try a full elevator loop, to see if it will snap out. If it does, use moderate elevator pressures until you can get it down to decrease the throw at the servo or the elevator horns.

Check out the roll rate, again at safe altitude. The plane should do consecutive axial rolls with ease, unless it is badly out of trim or excessively nose heavy.

Make several landing approaches at altitude, to get a feel for the attitude of the model. Keep a small amount of power on during the landing approach. Keep the wings level, reduce the power and let the plane settle until it is about a foot above the runway. Let it touchdown on the mains, and reduce the power further to lower the tail to the runway. Steer with the rudder until the model has slowed to taxi speed.

Whether or not you wish to compete in IMAC events, this is an airplane that you will enjoy building and flying. Check your AMA magazine for more information on IMAC sequences and review the AMA Competition Regulations for events 411 through 414 to find out what IMAC is all about.

Canopy and cowling are available from Cutting Edge Aero, 10929 Firestone Blvd., Suite 147, Norwalk, California 90650, (310) 929-0529 after 6:00 p.m. California time. Send check or money order. California residents add 8.25% sales tax. Canopy: \$14.00, Cowl: \$35.00 plus \$8.00 S&H. Wheel pants available from Fiber-glass Specialties, 38624 Mt. Kisco Dr., Sterling Heights, Michigan 48310, (810) 978-2512. (Ask for Stock #71, \$25.50 plus S&H.)

## **From RCModeler Jan. 1995**