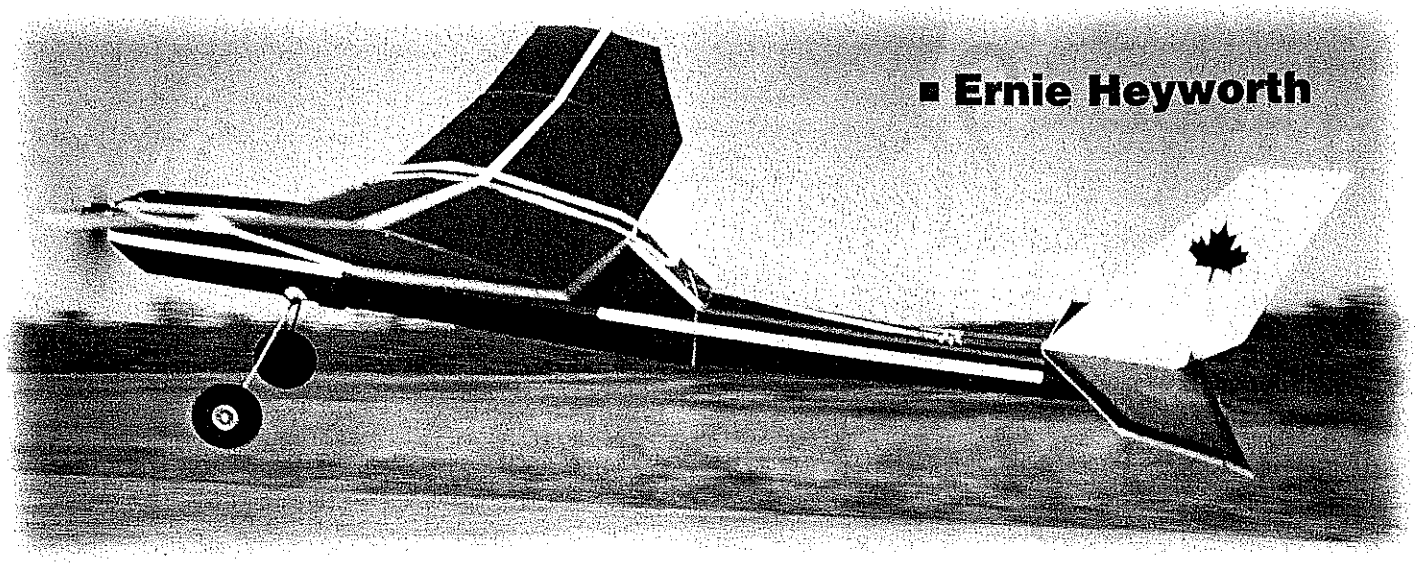
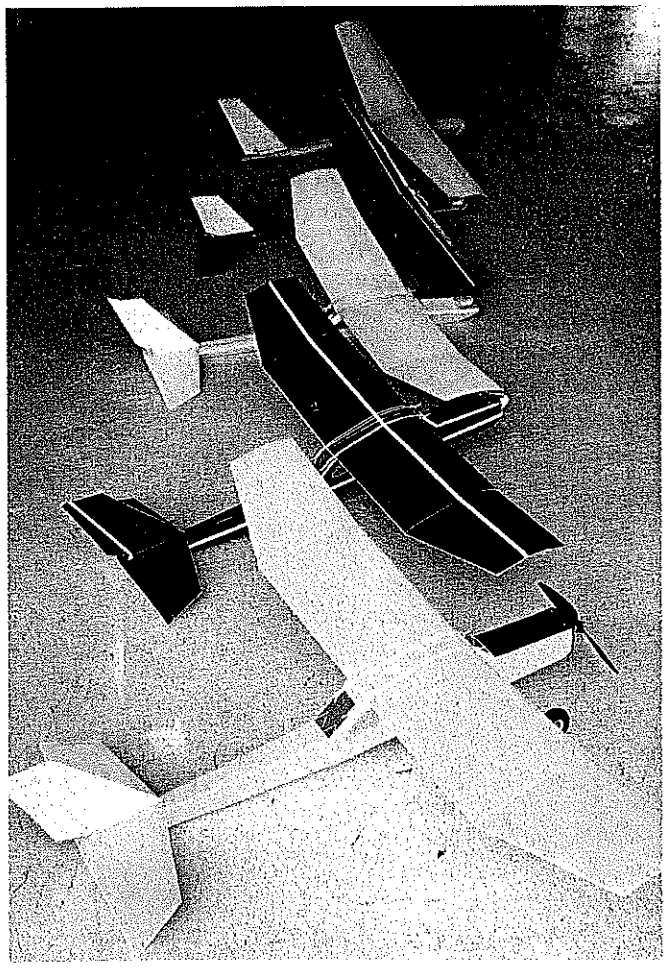
#900



■ Ernie Heyworth

PAP-E



PAP-E underwent several revisions to reach present configuration.

Gentle flight characteristics in a small foam-board model.

PRONOUNCED "PAPPY," PAP-E's design will introduce you to the fun of building an airplane with an alternative material. It will stimulate your thinking process, and heighten your enthusiasm.

Out-of-the box builders who want to try something different will find it in the PAP-E. It flies so well because it's light, and a Speed 400 provides just the right power to get it above the trees.

The models in the photos are from a fleet of trial-and-error designs, and all of them have been fun.

Besides the motor mounts, servo supports, landing gear, and wing hold-downs, the PAP-E is built entirely of foam board.

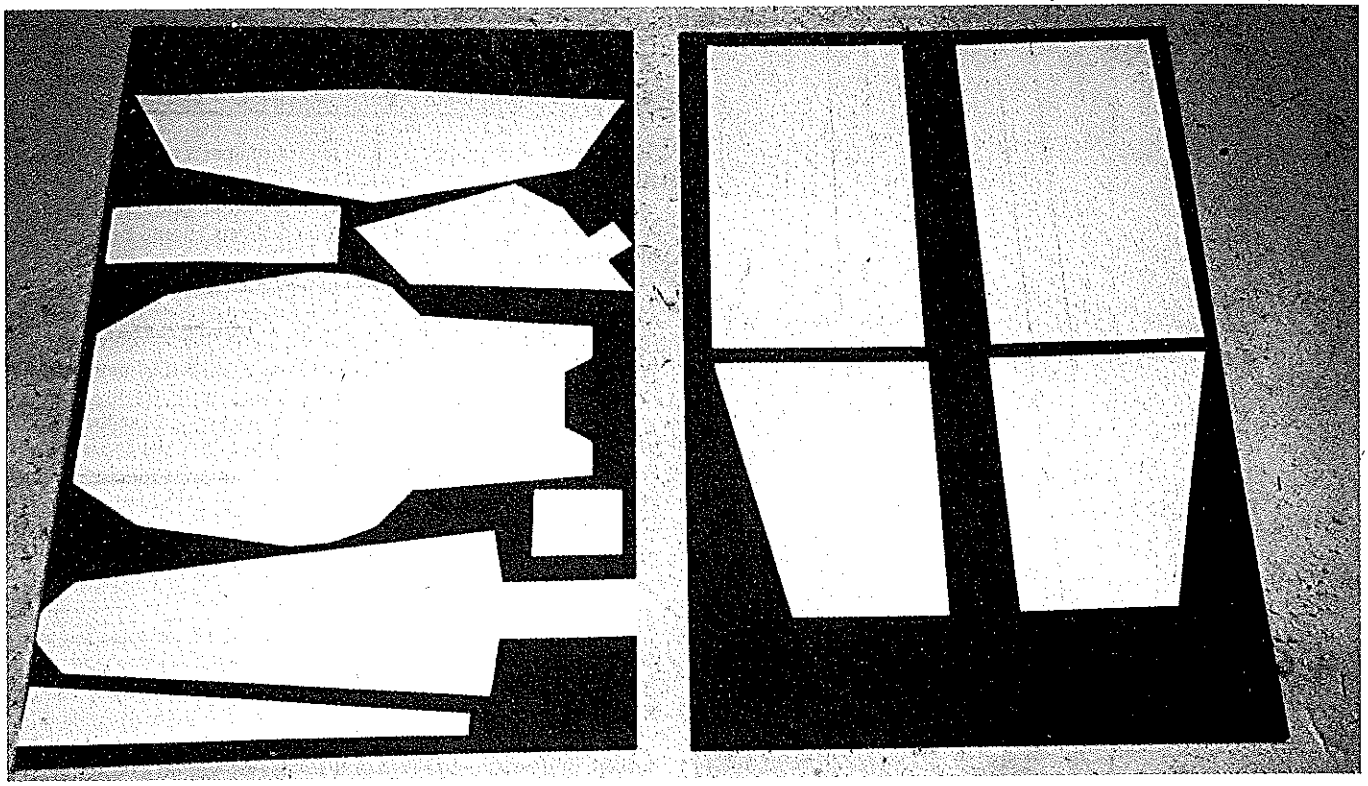
Foam board is different from traditional modeling materials, and it has its own set of techniques for forming it into an airplane. Foam board is light and strong, and it's very easy to repair.

Foam board is made from two layers of paper that sandwich a polystyrene core. It's available in assorted sizes and colors, and generally costs less than $5 for a 3/16- x 20- x 30-inch sheet.

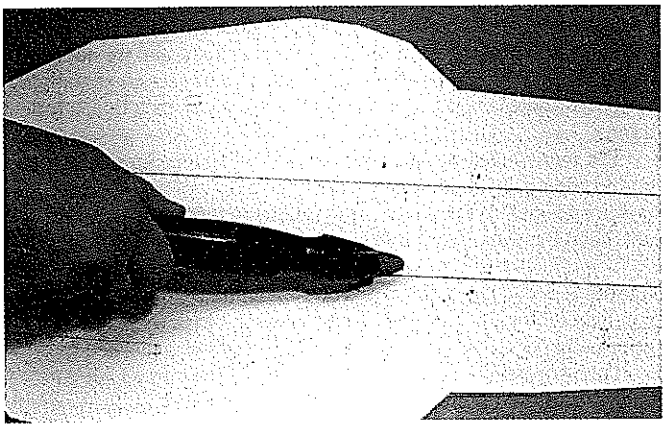
You can get foam board at Staples™, Wal-Mart™, and most art-supply stores. Examine each sheet before you buy it, and don't settle for warped boards. Slightly bowed board may be used for constructing the fuselage, but the wings must be straight. (Make a mental note for later: there is a left and a right wingtip.)

Test all chemicals on scraps of foam board before gluing or painting; waterproofing with Krylon® clear should be

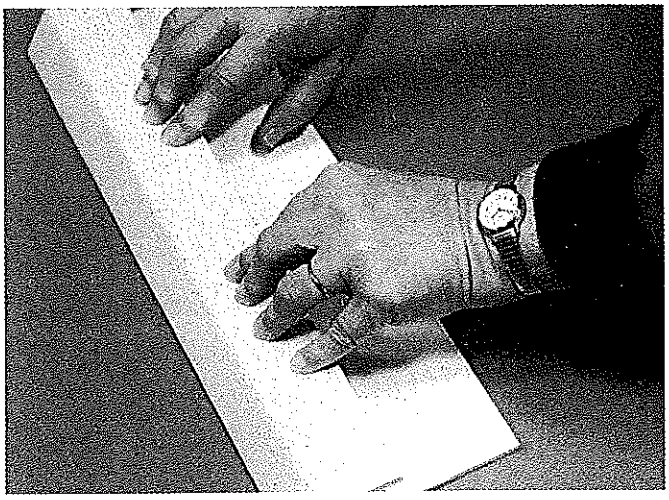
Photos courtesy the author Graphic Design by Carla Kunz



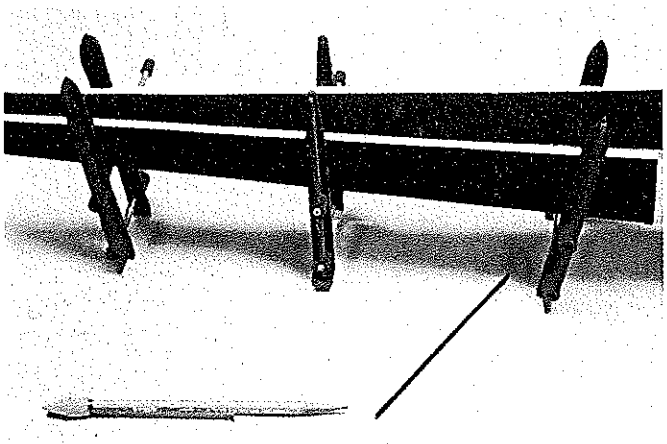
Fuselage and tail parts are cut from a single 20- x 30-inch foam-board sheet. Wing parts are cut from a second sheet.



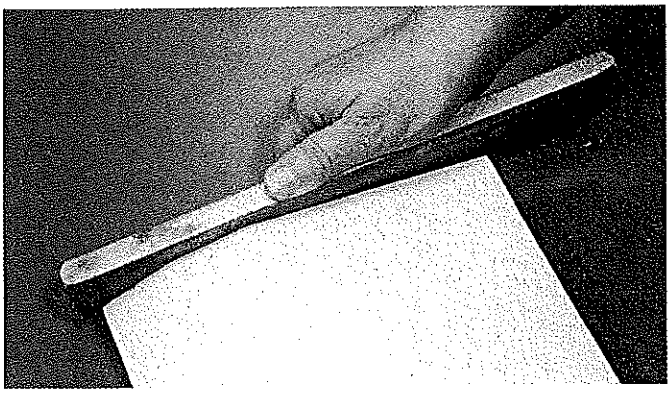
Score bend-lines on parts, and do not break paper liners. Scissors or other object with a rounded end works well.



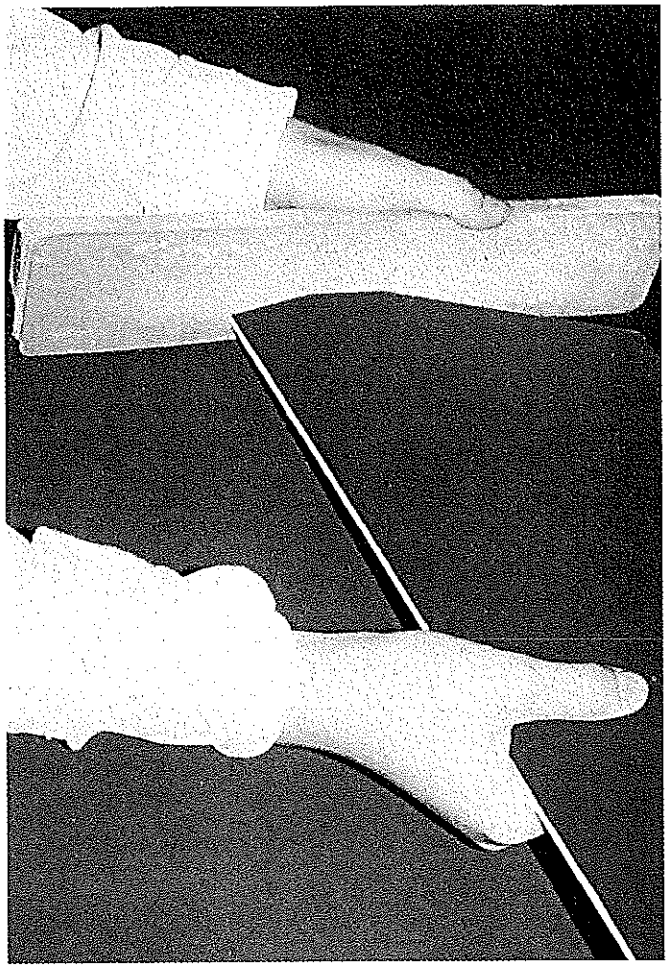
Fold parts on their bend lines to produce structural shapes.



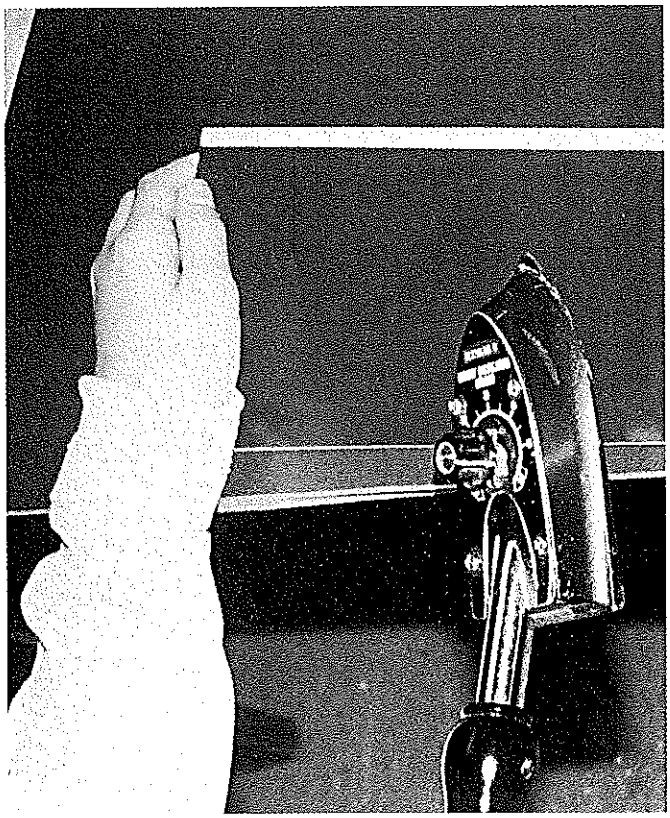
Stabilizer, swept fin are attached to fuselage with five-minute epoxy.



Use wing saddle to determine angles of bends for wing parts. Wing must fit.



Sand wing panels to mate. Total dihedral is two inches.



Use an iron for "heat pressing," to form edges.

okay, although the use of clear dope or various adhesives requires your personal testing and approval.

If you're a traditional balsa builder, you'll be in a new environment with foam board.

Tracing the Templates: Templates for the parts can easily be cut from the plans.

Before doing so, note how the parts will be laid out over the foam-board sheets. Two 20- x 30-inch sheets should be enough to build the PAP-E.

If you've purchased colored foam board, work on the white side.

Cut the templates out and arrange them over the foam board, then trace their outlines onto the sheets. Score lines—where the foam board will be folded to form parts—must also be transferred from the templates.

To transfer these and other important markings, I use the old trick of making pinholes though the templates into the foam board, then removing the templates and drawing lines over the tiny pinhole guides.

Transfer the score lines in this manner, then transfer the locations for the motor mounts, where the two parts of the fuselage join, and the cut-lines for the hinges.

Cutting: A very sharp #11 blade in a hobby knife or a single-edge razor blade is the ideal tool. Work over a smooth surface, and make your cuts against a steel rule, to assure straightness. I cut over old pieces of posterboard.

Hold the knife vertical as you cut, and don't try to cut all the way through in the first pass. Two or three passes will do a neater job.

Scoring: Practice this procedure on a scrap before committing to the parts.

Apply light pressure along the score lines with a rounded object, such as the back of a scissors or a screen-door beader.

Press gently along each line on your first pass, and try not to break the paper liner. Press more firmly on your second pass, then break the scores evenly along the entire length of each line, a little at a time.

The two wing scores will hold the airfoil shape. Score pressure on the wing parts should have developed a bow of approximately ¾ inch, or enough to match the wing saddle on the fuselage. If it has not, bend the parts over more sharply.

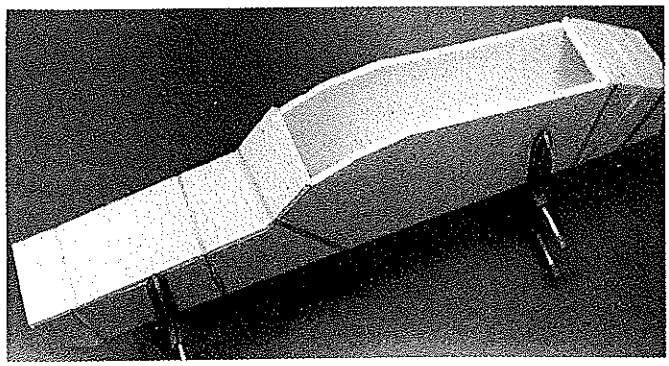
Sanding: Use a large, flat board or aluminum as a plate. Use a commercial tool, or make your own sanding block by gluing 100-grit sandpaper to a board; I use a ½- x 3- x 15-inch piece.

This step is important. Sand both sides of the curved wing panels, until 100% of the wing/saddle joint touches.

Take the time to get it right; keep refitting until you're satisfied.

Adhesive: I used five-minute epoxy on everything (I'm allergic to cyanoacrylate), which made working with foam board easy and fast.

Mix the five-minute glue and hardener on a Post-It®-type notepad or a plastic coffee-can lid. A ⅛ dowel or a few scraps of



Front, rear fuselage sections are built separately then joined.

sticks (from your last crash) make ideal mixing and application sticks. You'll make many small glue batches.

When applying adhesive, lightly coat both sides of all joints. The fuselage needs some method of clamping or holding it against the wing. Masking tape wrapped sticky-side up around the fuselage works.

Don't allow the adhesive side of the tape to come into contact with the colored surface of the foam board; it will tear the liner when removed.

Heat-Pressed Edges: My first few design prototypes had 3/16-inch blunt edges, which must have reduced the performance of my "high-tech" airfoil.

I used my covering iron to experiment with foam-board scraps, and I learned that I could form an edge by pressing down on it or slightly melting it. Play with this technique until you are comfortable. (Try scrap pieces first!)

Adjust the iron to approximately 3/4-7/8 of its heat range. Use many slow, long strokes with medium-to-firm pressure, and the foam board will slowly form a finished edge.

If the paper blisters, the iron is too hot. Listen for a soft snapping sound, which indicates that you're getting the job done right.

Some edges, such as the wing trailing edge, take a very gradual taper. Use an approximately 1/2-inch steeper angle—one inch back on the leading edge. On the vertical fin, I heat-press roughly 1/2 inch on both sides to form a pointed edge.

Use patience with this step.

Hinges: Make two parallel 3/4-inch cuts through the foam board, approximately 1/8-inch apart. Cut at an angle, but don't go through the last layer of paper, because it forms the hinge.

CONSTRUCTION

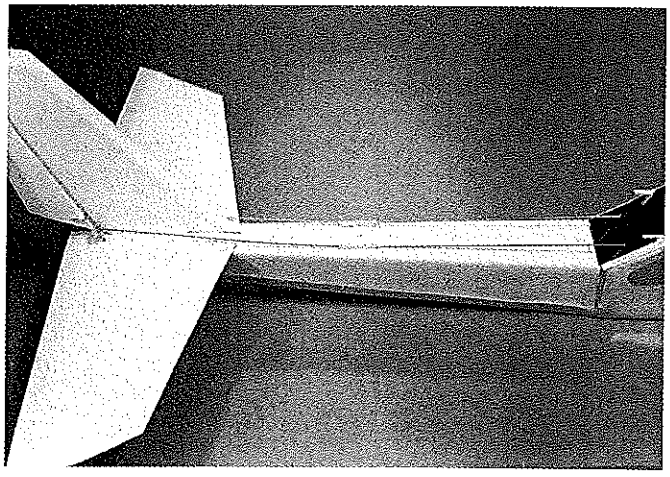
Wing: The goal is 2½ inches of dihedral per side.

Position two 1¼-inch blocks under the wing center to attain it, then mate the wing panels. Sand until the fit is precise, then apply adhesive and push the joint together. There must be 100% contact.

I used spray 3M™ Super 77 contact cement to add chip liners at the center-section of the wing, for extra strength. My chip paper was .015-inch-thick posterboard, available from Wal-Mart™. Posterboard is good material for long-lasting paper templates.

Fuselage: Cut the parts out for the back, top, bottom, and front, then cut the front and rear window parts.

Use the pinhole method to transfer all lines and locations for the motor mounts, the rear servo-tray extension, landing-gear dowel, and wing hold-down dowels. Score the parts,



Author uses simple fixture to hold rear fuselage parts while glue dries.

PAP-E

Type: RC Electric

Wingspan: 48 inches

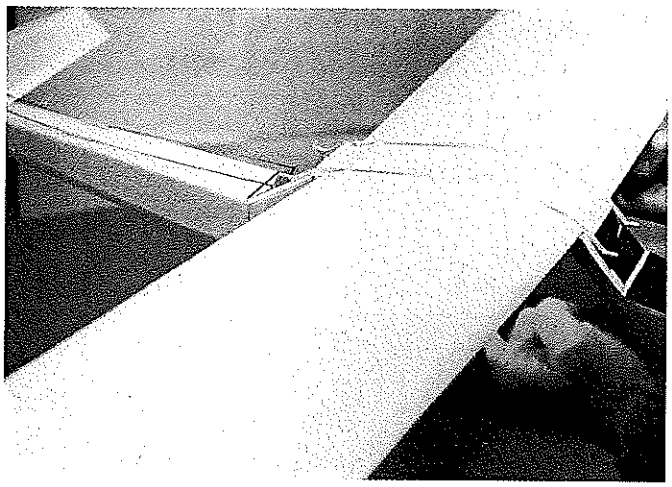
Motor: Speed 400

Functions: Rudder, elevator, and motor

Flying weight: 25 ounces

Construction: Foam board and plywood

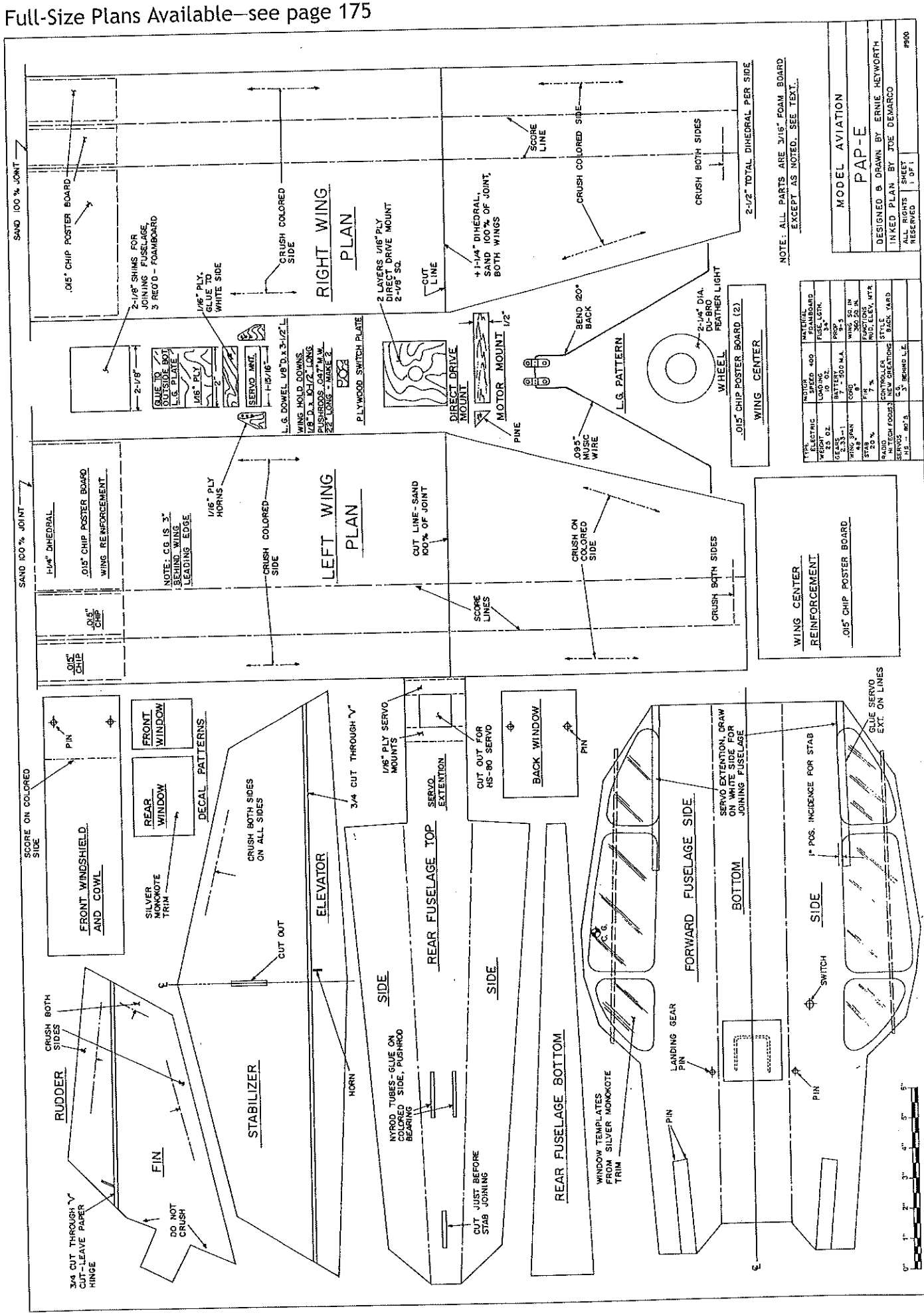
Covering/finish: None



The model's balance point is on the wing's rear score line, three inches behind the leading edge.

With fuselage level, use meter to set stabilizer incidence at 10° positive and wing incidence at 2½° positive.

Full-Size Plans Available—see page 175



folding until the correct angles are attained.

Glue the plywood servo mount onto the back side of the board. (That's the white side if you're using colored foam board.) Install the motor mounts with epoxy.

Glue the rear fuselage parts together, holding with low-pressure clamps or drafting tape until the epoxy cures. Glue the front and back windows onto the forward-fuselage section. Use 2⅛-inch shims as inside spacers.

This step is important! Fit the front and rear fuselage sections together by inserting the rear's servo-extension sections into the back of the front part. Before applying adhesive, be certain that all the parts interlock correctly and that the servo-tray extension is on your alignment lines. This step doesn't just mate the fuselage sections; it also determines the incidence between the stabilizer and the wing.

Add the window decals before installing the wing hold-down dowels, then install the motor mount, if using the direct-drive system, and all dowels.

The plywood landing-gear mount is installed on the outside, near the landing gear hold-down dowel. The PAP-E's landing gear wire is bent from .080-diameter wire. Bend it, and check the fit to the fuselage.

Add the preassembled tail section and install the radio.

Empennage: Glue the vertical fin into the horizontal stabilizer.

Use epoxy to glue the assembled tail section into the rear of the fuselage. Keep it aligned while the epoxy cures.

With the rear of the fuselage level, use an incidence meter to verify that the stabilizer is 10° positive and the wing is 2½° positive.

Control System: Fabricate small control horns from 1/16 plywood. They must be long enough to sink into a knife slit in the foam board. Drill the

Continued on page 43

PAP-E

Continued from page 38

horns to accommodate .047 music wire before installing them in the control surfaces.

I laminated the foam board with 1/16 plywood beneath the servo-mounting areas, to add depth for the servo screws to bite. Install the rudder and elevator servos.

I use .047 wire for pushrods, with an adjustable pedestal on the servo arm.

The pushrods travel through the rear window, along the outside top of the fuselage, through a piece of Nyrod, and back to the plywood control horn, where they connect with a Z-bend. The small piece of Nyrod serves as a midway support bearing.

Motor System: My favorite electric motor system is a Speed 400 with a GR 170323 2.33:1 gearbox, a New Creations M-30 speed controller, a seven-cell 500 mA battery, and a 9 x 5 fixed-pitch slim propeller.

This gearbox has mounting flanges like a wet motor, and is an ideal fit to the PAP-E's motor mounts.

Use Velcro™ to mount the receiver beneath the servos. The battery should be located as far forward as possible, almost touching the back of the motor.

Center of Gravity and Control Throw: Use #62 rubber bands to hold the wing to the fuselage. The hinge-style landing gear is also secured by a #62 rubber band, which prevents damage in the event of a less-than-perfect landing. Mount the wing and the gear.

The PAP-E should hang slightly nose-down when balanced with your fingers on the wing's rear score line, three inches behind the leading edge.

Rudder throw is 1/2-inch left and 1/2-inch right of center.

Elevator travel is 3/8-inch up and 3/8-inch down from center.

Flight: I don't use a wire tail skid on my PAP-E, so takeoffs usually result in a torque-predictable slight left turn. Right motor thrust and a skid would probably tame this, but the model gets airborne quickly, and it doesn't take long for the right rudder to take control.

The airplane is a joy to fly, and is easily kept within the boundaries of any typical flying field. The high-undercamber wing does not lend itself to inverted flight, but the PAP-E will relax you with its gentle habits, slow flying, and easily controlled turns.

The PAP-E is an ideal first airplane, and a perfect fit for people who like to relax and enjoy the fun of quiet flight.

This design has been a fun-filled project for me, and the trial-and-error engineering has maintained my enthusiasm for the ever-changing design.

The first of six airplanes was much smaller, with a conventional stabilizer, straight wings, and direct drive. Then I went through a V-tail period; if I had that to do again, I would add a dorsal fin. With the last few models, I concentrated on lengthening the fuselage and changing the wing in incidence, to make it a better-flying machine.

I hope the model inspires you to investigate and to apply your own changes and improvements. There is room for better techniques when working with this material. Shape, size, color, flying characteristics, and power can be refined.

The PAP-E is a designer's delight. MA

Ernie Heyworth
109 Hidden Ln.
Horseheads NY 14845

Sources:

ESC (Electronic Speed Control):
New Creations R/C
Box 496
Willis TX 77378
(409) 856 4630

Foam board:
(800) TRY-HUNT
www.hunt-corp.com