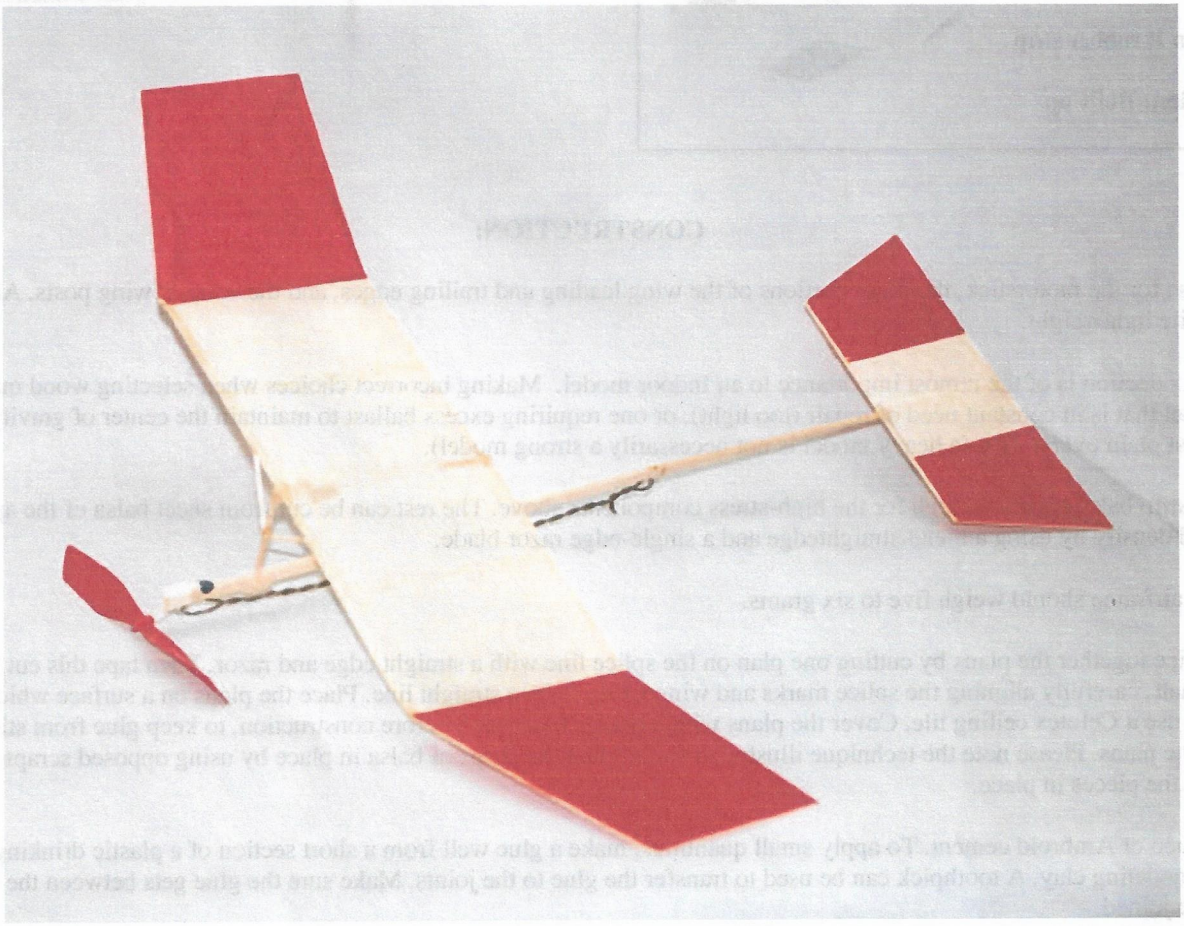
Double Whammy

By Chuck Markos



This article was originally published in the November 1999 issue of Model Aviation magazine; it has been reprinted here (with minor modifications) with permission of Model Aviation and the author Chuck Markos. Photos by the author and Jim Haught.

DOUBLE WHAMMY was designed to be a simple model to introduce Indoor rubber trim, handling, and some building techniques to modelers who had never before tried the fascinating world of Indoor model aircraft.

It has been a most successful airplane in that scores have been built by people of all skill levels and regular contests have been scheduled for this as a "one-design" event using a mass-launch approach. It is quite spectacular to see 25 or more of these brightly colored aircraft simultaneously circling towards the ceiling.

The one criterion was that all materials and equipment for construction and flying must be readily available. Three items not normally found in the workshop are required:

- A box for transport of the model to the Indoor flying site. This container should allow the disassembled components to lay flat on the bottom. Unfortunately the very popular box for copier paper is just a little too small. The importance of a proper box cannot be overstated; most Indoor models are broken by mishandling, and hardly ever by crashes or flight stresses.
- A geared winder. The Sig catalog lists a 16:1 winder for less than $20. Since the rubber motor will require well in excess of 1,000 turns for respectable flights, hand-winding or using a winder with a lesser gear ratio could be quite tiresome.
- A good supply of 1/16 width TAN-II rubber (FAI Model Supply) for motors.

DOUBLE WHAMMY

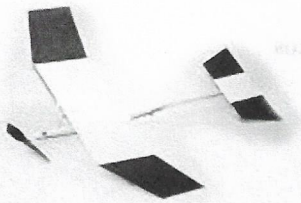
Type: Free Flight Indoor

Wingspan: 17 inches

Flying Weight: 5-6 grams

Motor: Tan II rubber strip

Construction: Built-up



CONSTRUCTION:

Use firm balsa for the motorstick, the inner portions of the wing leading and trailing edges, and the vertical wing posts. All other balsa should be quite lightweight.

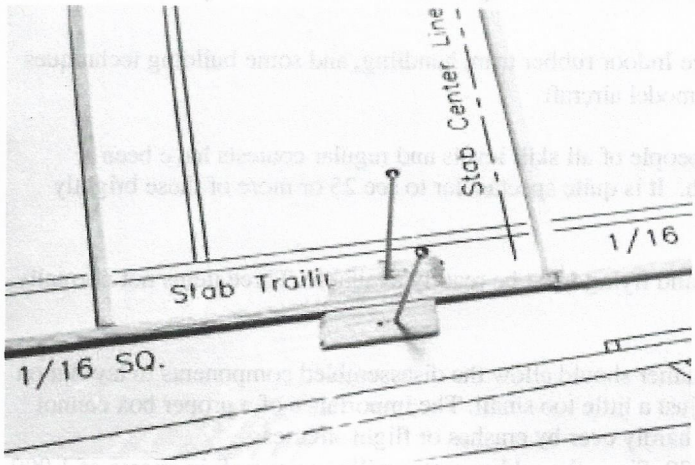
Proper wood selection is of the utmost importance to an Indoor model. Making incorrect choices when selecting wood may result in a finished model that is in constant need of repair (too light), or one requiring excess ballast to maintain the center of gravity (CG), or one that is just plain overweight (a heavy model is not necessarily a strong model).

Most precut strip balsa is firm enough for the high-stress components above. The rest can be cut from sheet balsa of the appropriate thickness and density by using a metal straightedge and a single-edge razor blade.

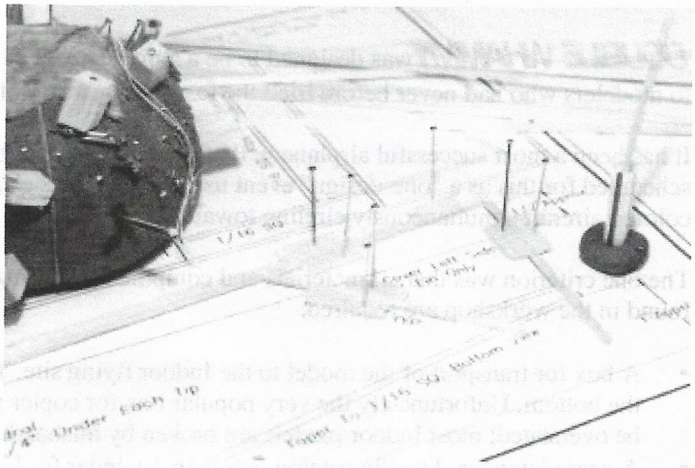
The finished airframe should weigh five to six grams.

Carefully splice together the plans by cutting one plan on the splice line with a straight edge and razor. Then tape this cut half on top of the other half, carefully aligning the splice marks and wing LE to form a straight line. Place the plans on a surface which will accept pins easily; I use a Celotex ceiling tile. Cover the plans with a plastic food wrap before construction, to keep glue from sticking the structure to the plans. Please note the technique illustrated for holding the strips of balsa in place by using opposed scraps and pins to gently clamp the pieces in place.

Use either Duco or Ambroid cement. To apply small quantities, make a glue well from a short section of a plastic drinking straw pushed into modeling clay. A toothpick can be used to transfer the glue to the joints. Make sure the glue gets between the two pieces of wood to be joined.



Scrap balsa is used as wedges on each side of strip to hold in place without having to pin through the wood (which causes splitting)



Rudder construction under way. Wedges used again to hold pieces in place. Drinking straw glue "well" at right.

Tailboom/Fin and Stabilizer: If you cannot form a double-tapered boom as shown on the plans, it's okay to use medium-weight 1/16 balsa sheet and a single taper cut from 1/16 x 1/4 to 1/16 sq. over its length. Make precise bevel cuts in the soft 1/16 square fin LE and TE pieces to match the angle of attachment to the tailboom. These should be slightly overlength when they are glued in place. Did you use the scrap balsa and pins to hold everything in place?

Mark the location of the tip piece on the LE and TE and cut through, using a sharp razor blade so as not to crush the balsa. Hint: Use a scrap of manila folder paper under the two marked fin members so the cut doesn't go through the plastic wrap into the plans. The gap would allow excess glue to seep onto the paper and make removal of the completed fin difficult.

The 1/16 square fin tip is cut slightly longer than its final dimension and glued in place. Trim to length after the glue has dried.

The stabilizer was designed to be minimum area so it could be made from lightweight wood and still be rugged enough to withstand the rigors of handling and flying. The LE and TE are cut slightly overlength and held in place using balsa scraps and pins.

The crosspieces (ribs) must be fit precisely between the LE and TE. The technique to attain this fit is to place one end of the crosspiece against the LE while cutting partially through it at the location of the TE. The crosspiece can then be picked up as it grabs the razor blade and the cut can be completed on a cutting board.

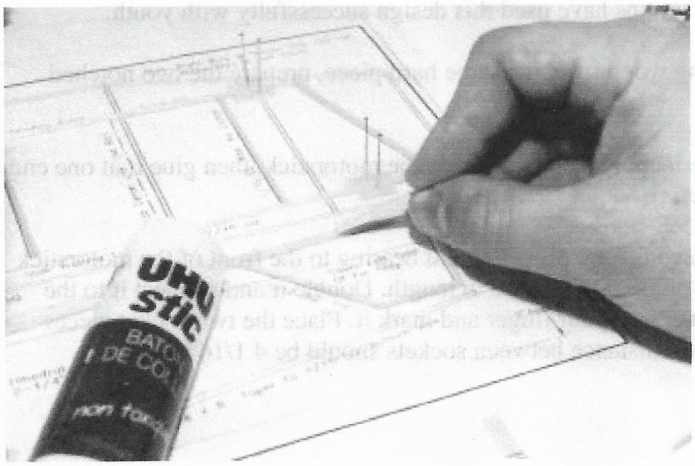
If the crosspiece bows or causes the LE or TE to bow, it is much too long and must be reduced in size. If it won't stay in place without glue, it is too short and it must be discarded (use the too-short piece as a gauge to cut its replacement just a hair longer). Do not depend on glue to fill in the gaps. That practice will result in a heavier and weaker structure than properly fitted pieces.

Once all of the crosspieces are glued in place and the glue has dried, trim the excess length from the LE and TE.

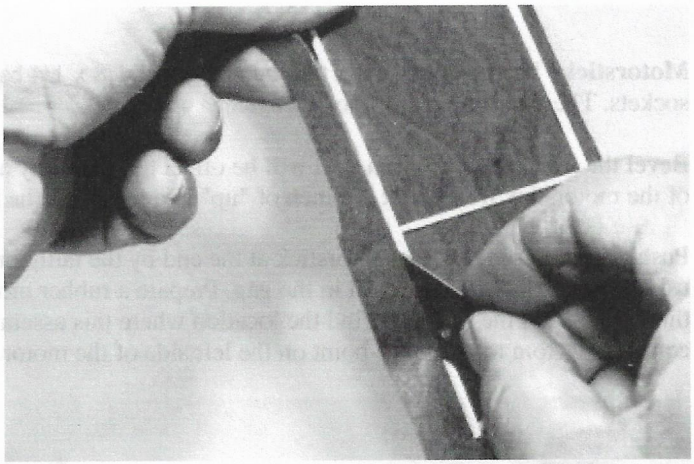
Cover the fin and also the stabilizer with gift-wrapping tissue while they are still in contact with the plastic wrap held by glue that seeped from the joints. Cut the tissue about 1/2 inch longer than the length and width to cover each piece. Make sure the grain of the tissue runs spanwise for the stabilizer.

Use a glue stick (Kidstick or UHU Stic) to coat all wood that will come in contact with the covering. Place the covering over the adhesive-treated structure and rub it gently with your finger to hold it in place. Use a scrap of manila folder cardboard to loosen the structure from the plastic wrap.

Trim the excess paper from the wood, using a very sharp razor blade. Be extra careful not to tear the paper when cutting across the grain. Place the stabilizer upside-down and glue the tailboom and fin to it at the LE and TE locations.



Glue stick can be used to apply adhesive to structure for covering. Soft balsa applicator makes job easier.



Trim Excess covering with sharp razor blade

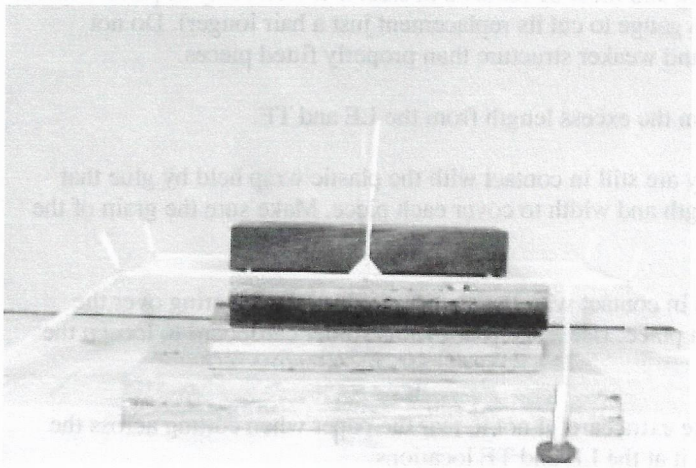
Wing: The wing construction is similar to the stabilizer. A major difference is the dihedral added to each tip section after covering. Prepare for this by placing some glue over the joints where the center section LE and TE meet the tip sections. This glue will act as a hinge later on.

Did you remember to cover the wing with the paper grain spanwise? Do not attempt to tighten the tissue by spraying with water or alcohol (as you might on an outdoor model). The structure of this model is not strong enough to resist warping when the tissue shrinks.

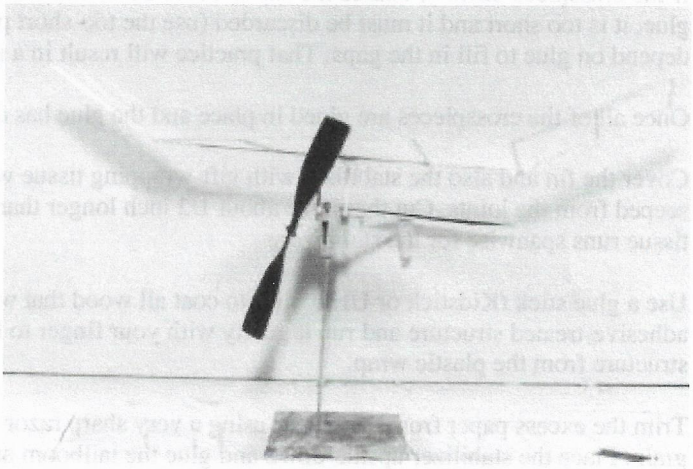
To add dihedral, the covered wing is placed upside-down on a support 2 ¼ inches high (three sheets of plywood) under the center section with the tips bent down and hanging over the edges. Place a weight on the center section to hold it in place while the tips are held down to the building board with scrap balsa and pins.

Sharpen four "stakes" from 1/16 square balsa, put a gob of glue on each, and also some in the gaps formed between the center section and tip LE and TE. Push the pre-glued stakes into the joints and let the glue dry for about one hour. Trim the excess away with a fingernail clipper. Prepare the two wing posts and gussets to be added at the "center" rib location. Be sure these posts will be skewed so the inboard wing will be washed-in (have a higher angle of attack than the outboard wing) when the wing posts are forced into a parallel configuration as they are placed into the sockets on the motorstick.

Be sure that all of the glue joints are dry before the wing is assembled to the motorstick.



Wing is held flat. Note offset/twist built into wing posts, which gives left main panel wash-in for proper climb.

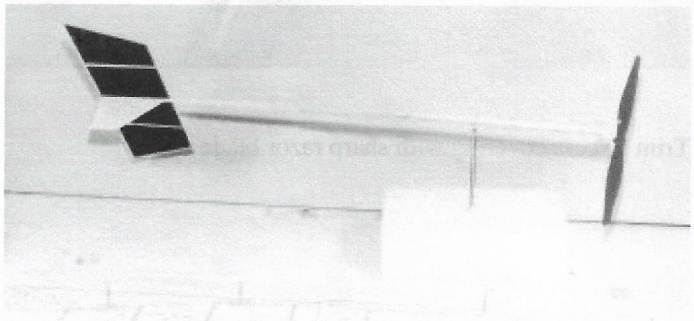


Completed Double Whammy at rest in run-down stand. Note wash-in in left main wing panel. Bong Eagles and other groups have used this design successfully with youth.

Motorstick: The motorstick is a ten-inch length of 1/8 x 1/4 balsa. Using wood from the same hard piece, prepare the two notched sockets. These will be fitted into place later.

Bevel the end of the tailboom so it will be offset to the left by about one inch when it is glued to the motorstick, then glue it at one end of the motorstick with about 1/2 inch of "up" in addition to the left offset.

Push a straight pin into the motorstick at the end by the tailboom and assemble the propeller and bearing to the front of the motorstick using a scrap of 1/8 balsa to fill in the gap. Prepare a rubber motor loop of about 15 inches in length. Double it and connect it to the thrust hook and the rear pin. Find the location where this assembly balances on your finger and mark it. Place the two socket pieces equidistant from this balance point on the left side of the motor stick; total distance between sockets should be 4 1/16 inches.



Completed motorstick and tail assembly is balanced to find proper horizontal Center of Gravity location. Though not shown here in this picture, the rubber motor (doubled to take up slack) should be attached for this procedure.

FLYING:

An Indoor rubber model is different from other models in that it has asymmetric construction to fly in left-hand circles. Note that the left wing is longer than the right. Make sure the assembly of the wing to the motor stick maintains this orientation.

As noted in the construction section, the wing is also twisted to provide more incidence inboard than outboard. If the model doesn't demonstrate this twist when assembled, reposition the wing posts to correct it.

The other built-in "adjustment" is the offset fin. The model may also need some left thrust if the flight circle is too large in diameter to keep the model from hitting the wall of the flying site. This can be accomplished by removing the propeller and bearing, slicing a thin wedge from the right-front of the motorstick, and gluing the same wedge to the left-front side before replacing the propeller and bearing.

The only adjustable part of the model is changing wing incidence by sliding the wing posts up or down in sockets to correct stalls or dives.

Initial flights should have about 200-300 turns in the motor. After the motor is tied to form a single loop, coat it with some commercial rubber lube, or as a substitute, hand cream. This will increase the number of turns that may be put into the motor and also decrease the internal friction as it unwinds to power the propeller.

Have a helper hold the model at the thrust bearing while you stretch the rubber motor rearward, to about four or five times its relaxed length, with the winder. As you wind, move in so the last winds are put in just as you approach the rear pin.

Take the motor off the winder by pinching it (so it doesn't unwind) and attach to the rear pin. Take the propeller from your helper in one hand and hold the model at the motorstick, just under the wing, with the other. Simultaneously release the propeller and give the DW a gentle push forward.

For Indoor rubber models, there should be no nonpowered/deadstick glide phase of flight. For best duration, the model should be under power from launch until touchdown, using every bit of energy stored in the motor, so every turn put into the motor is used up.

If the model lands with too many turns left in the motor, it may be too heavy. One way to use more of the motor is to change the propeller to a lower pitch by twisting both blades to a lower angle. A more-drastic change is to cut the diameter of the propeller.

Impressive increases in flight duration can be obtained by optimizing the propeller-motor combination of an already trimmed model.

Double Whammy will outperform a Delta Dart, but the intent of the model is to teach newcomers some of the basics, not to make a performance model.

However, the model can be converted into a Pennyplane by changing to a 12-inch-diameter wood prop, and the wing to a cambered airfoil. Such changes will result in a model capable of five-minute flights. This was the original intent of the design: two for one, thus the name Double Whammy. Editor's note: If there is sufficient reader response, we may run a follow-up article on the Pennyplane conversion.

(Note: indeed a follow on article was written. It was called: "Double Whammy Pennyplane" and will be reprinted here soon)

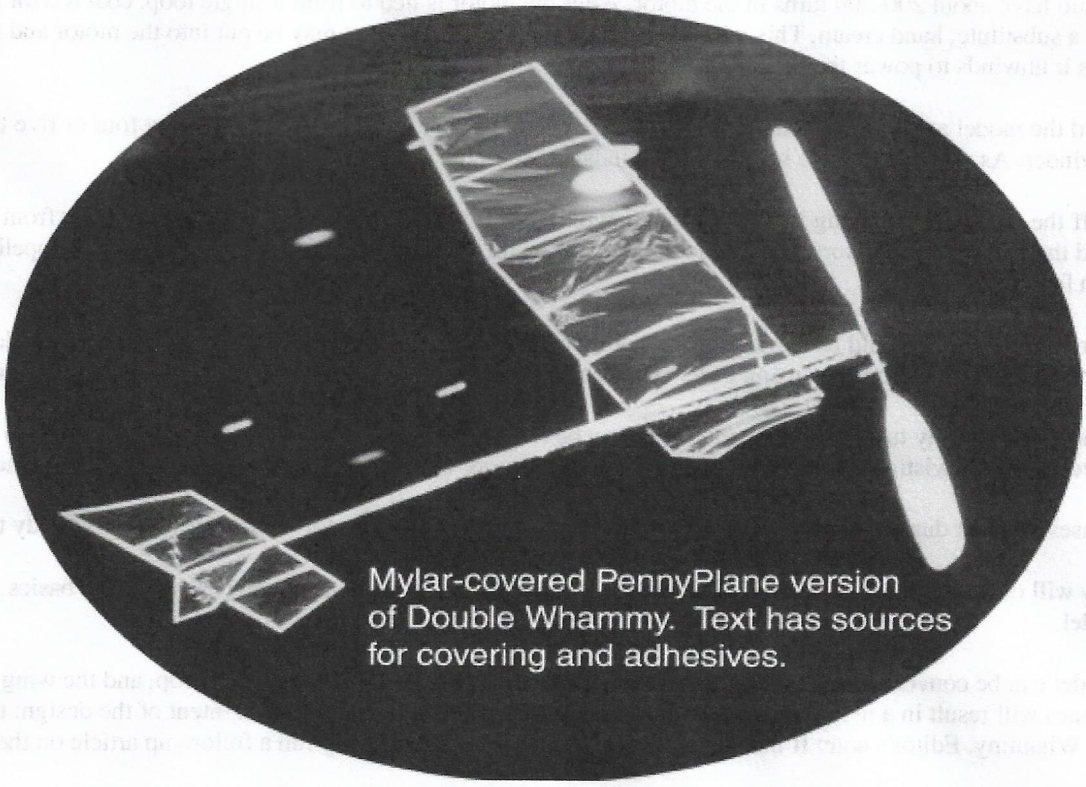
Happy Landings!

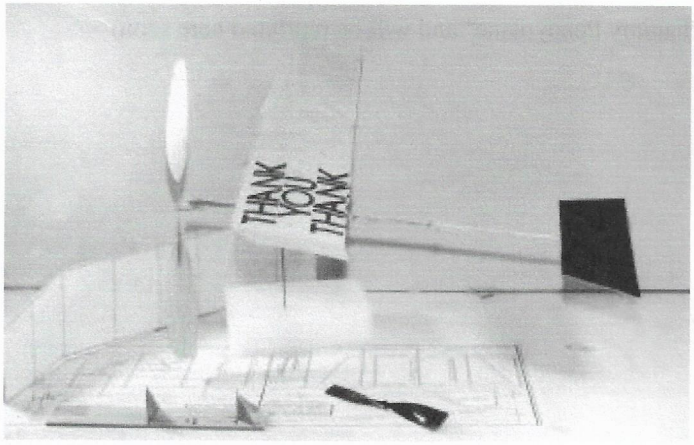
Chuck Markos

Email: cmarkf1@aol.com

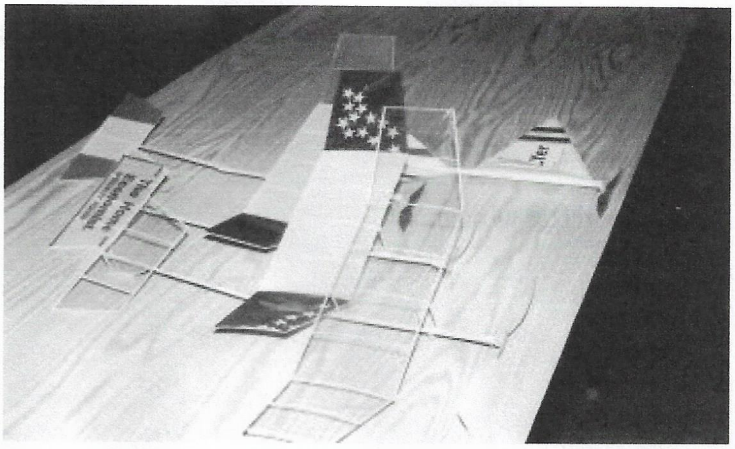
Double Whammy PennyPlane

by Chuck Markos



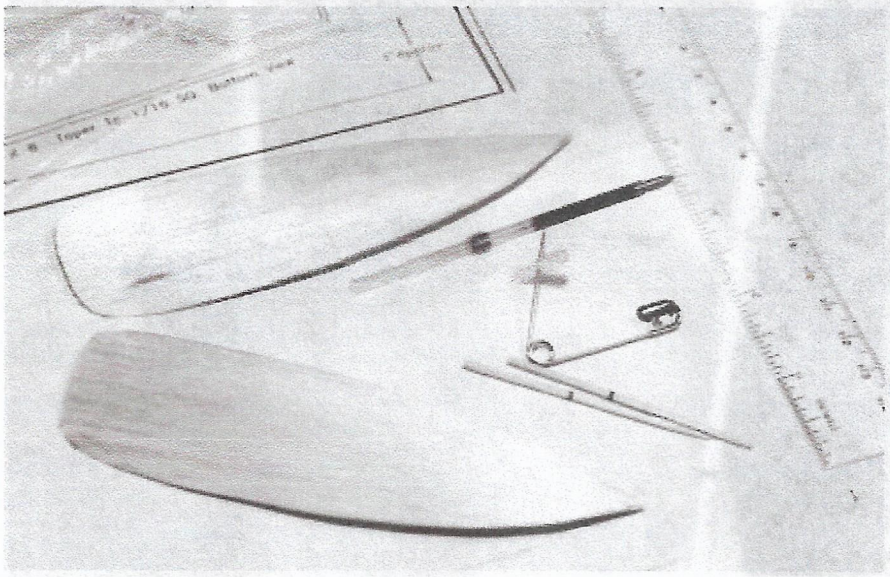


Wing is covered with HDPE plastic from shopping bag. Pitch-setting fixture for prop is in the foreground.



Progression from AMA Cub (upper right) to Pennyplane increases flight times from 30 seconds to more than 5 minutes.

Three blades and tissue ready to soak/stack/bake on six-inch diameter jar. Blades angled 15^0 to impart pitch



Propeller parts. Spars are toothicks; jub is formed from ballpoint pen ink tube. Note pitch in blades after baking.

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The model presented in this article is a serviceable Pennyplane (minimum weight = 3.1 grams or one 1970s penny) that can be made with materials and tools available to the non-Indoor specialist. It can provide flights of more than five minutes in a typical high-school gym (26-foot ceiling).

Just think what an accomplishment it is to go from an AMA Cub and 30-second flights to an Indoor model capable of five minutes—in two easy steps!

NOW THAT YOU have mastered the basic Double Whammy construction and flying (November 1999 MA), you may be inspired to move to a higher level of performance using the same plans. The changes described in this article will allow you to easily double the flight times achieved with the basic model, even using the same 1/16 rubber motor that powered the plastic-propeller-driven model.

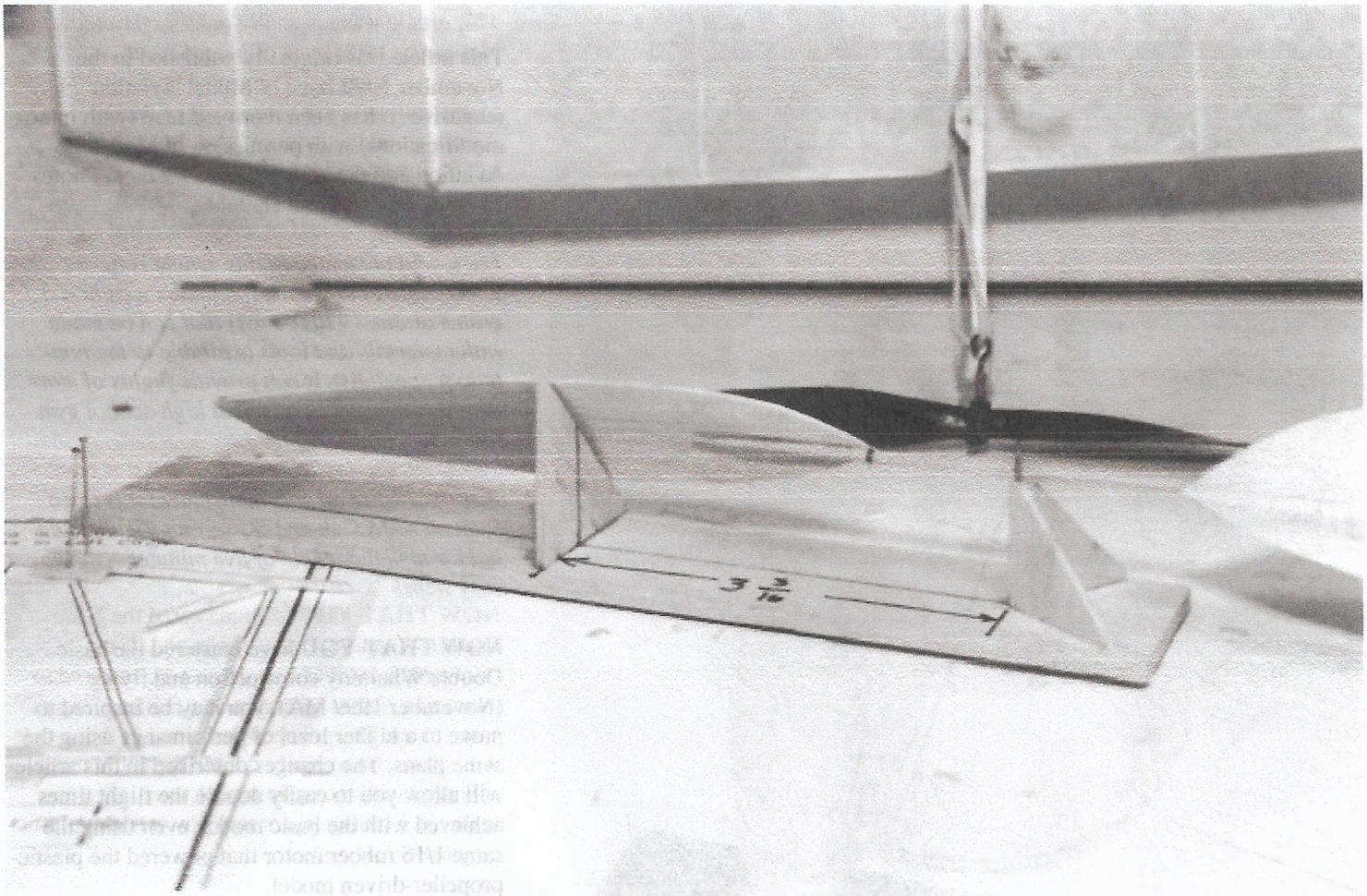
Three changes will be made: Substitution of a balsa propeller for plastic; a cambered airfoil in place of the flat plate; and a lighter-weight and less-porous covering for the wing.

Everything else from the basic model can come along for the ride. The changes are not strictly state-of-the-art Indoor modeling, but are easy to accomplish using readily available materials and tools.

Propeller: To make the propeller blades, use 1/32 balsa cut to the outline shown. Soak them well in water and bind them to a large circular surface (six to seven inches in diameter) at a 15^0 angle, tips offset to the left. The circular surface will impart camber (curvature) to the blades; the offset adds pitch, which will approximate the pitch of a carved blade.

Bake in an oven for approximately one hour at 200 degrees. Remove the blades after they return to room temperature, separate them, and sandpaper lightly to remove any imperfections.

Hints: Prepare a "sandwich" of the two wet blades and tissue paper between them before binding them to the cylinder for baking; this will make separation of the blades easier after baking. Use a stack of three wet blades and two pieces of



Prop pitch setup. Use two triangles to set pin perpendicular to base. Set blade 3-3/16 inches from pin

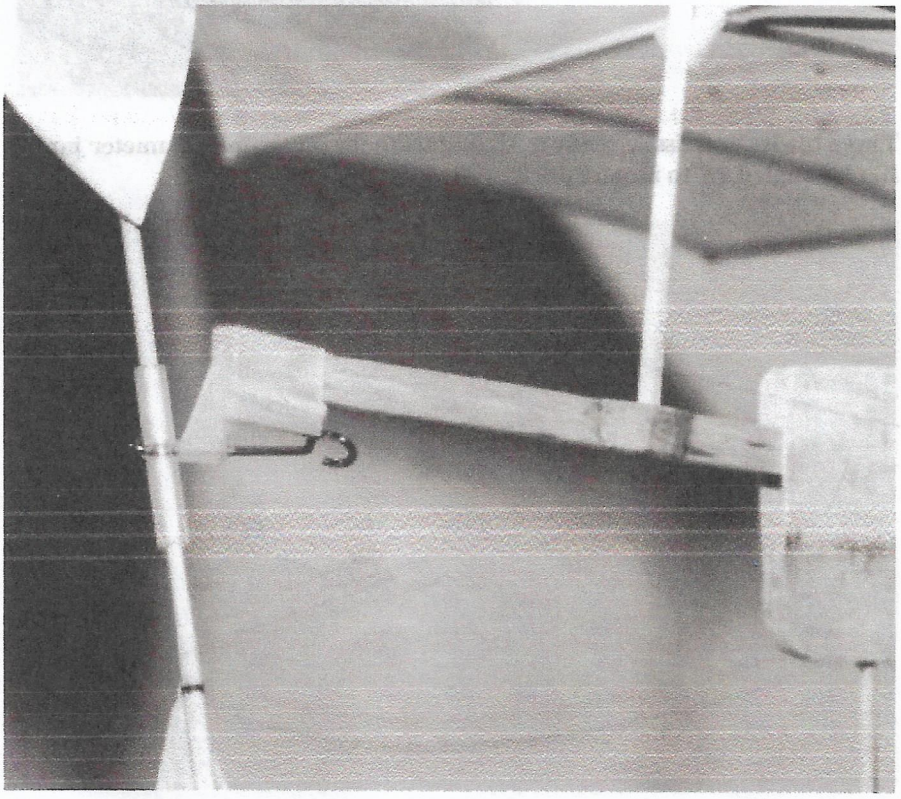
tissue so the outermost blade protects the inner ones from indentations caused by the rough surface of the elastic bandage used to bind them during baking.

The propeller hub is a 3/4 inch section of plastic tubing. I used the inside of a ballpoint pen (use only the part that has no ink in it, unless you want your hands and clothes stained).

The "spars" are two lengths of hardwood dowel that fit snugly into the plastic tube; I used round toothpicks

The front hook is made from a two-inch safety pin. Cut away the hook from the plastic propeller to remove it from the bearing. (I have not been able to reuse the hook that comes with the basic assembly; it breaks easily when bent open and then closed) check the fit of the safety pin wire in the plastic bearing from the AMA Cub so that it rotates easily, with minimal wobble.

Make a hole through the plastic tube hub using the sharp point of the safety pin. Make sure the hole is orthogonal (centered) when the hub is spun on the shaft, so the completed prop will



Front end. Note location of front hook, to provide clearance during rotation.

"track" properly (no "wobble" in the blades).

Glue the two hardwood dowels to the blades, leaving exactly one inch sticking out. The propeller is assembled on a pitchsetting fixture, as described below.

Prepare the fixture from a section of safety pin wire set perpendicular to the base and a 45^0 triangle located 3/16 inches from the pin. This will provide a propeller with a pitch of approximately 20 inches.

Slip the hub onto the wire and insert one spar/blade combination into the hub. Twist the spar until the blade angle matches the 45^0 triangle. Do the same for the other blade. if the fit of the spars is snug, no glue will be needed to assure that the pitch stays in as set.

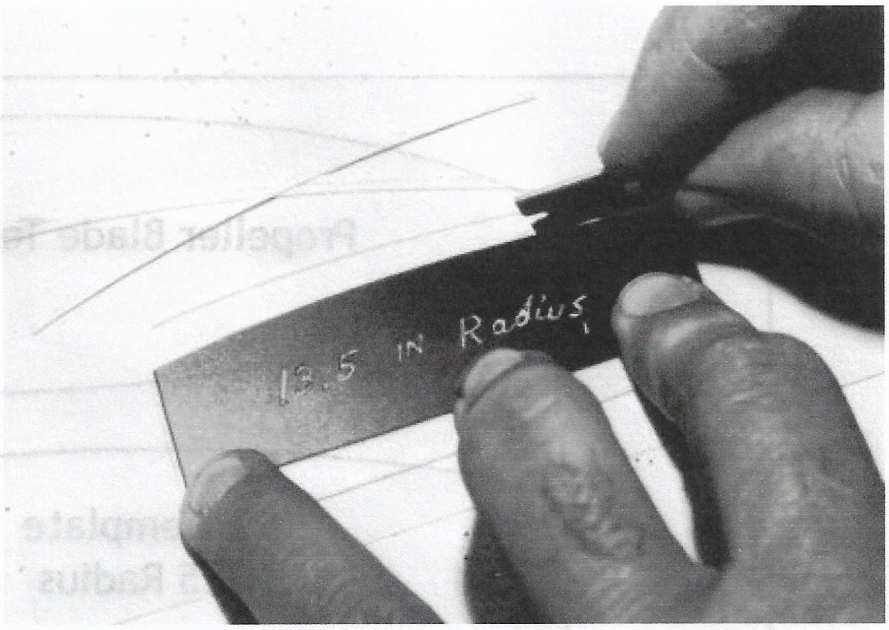
Prepare the thrust hook from the safety pin wire. The spring loop at the bottom of the pin will become the hook. Cut away the unneeded portion of the pin and loop, file the cut end to relieve the sharpness left by the cutter (better to use a Dremel® cutoff wheel, if you have one), and push the sharp end through the bearing and then through the hub. You will need to adjust the size of the hook loop to provide clearance as it rotates under the plastic bearing.

Bend the sharp end over the hub, leaving enough length for the hook behind the plastic bearing to rotate freely. Note that the sharp end of the pin may be tempered to a different hardness than the rest of the wire. If so, it will probably break when you attempt to bend it. It is not necessary to keep the sharp end; you only need enough wire so that the hook clears the bearing.

The hook will probably not clear the bottom of the motorstick; however, adequate clearance can be achieved by moving the balsa scrap fill from the top of the motorstick to the bottom before replacing the bearing at the front.

Wing: Construct a new wing using 1/16 square balsa for the LE and TE as in the original Double Whammy, but substitute sliced ribs for the 1/16 square cross-pieces.

The sliced ribs are cut from medium-weight 1/32 balsa using a template made from stiff cardboard, such as poster board. It's easy; start with a four-inch length of 1/32 balsa, place the template at the top of the sheet, and draw a razor blade next to the template to cut through the wood. Slide the template down about 1/16 inch and make a new slice to produce the first rib. From here on, each slice will produce a new rib. It's so easy, you won't want to stop!



Sliced ribs are made with a template (below) and a sharp razor blade. Cut over manila folder so blade will not "follow" wood grain in building board.

Hint: Place some poster board or a manila folder under the balsa while cutting. The surface has no grain to direct your cut away from the desired template.

Fit and glue the ribs to the LE and Th as described in the DW article.

Covering: A major portion of an Indoor model's weight can come from the covering material; adhesives used to attach the covering can also contribute significantly to the model's total weight. The model's performance will suffer if its weight is much in excess of the minimum.

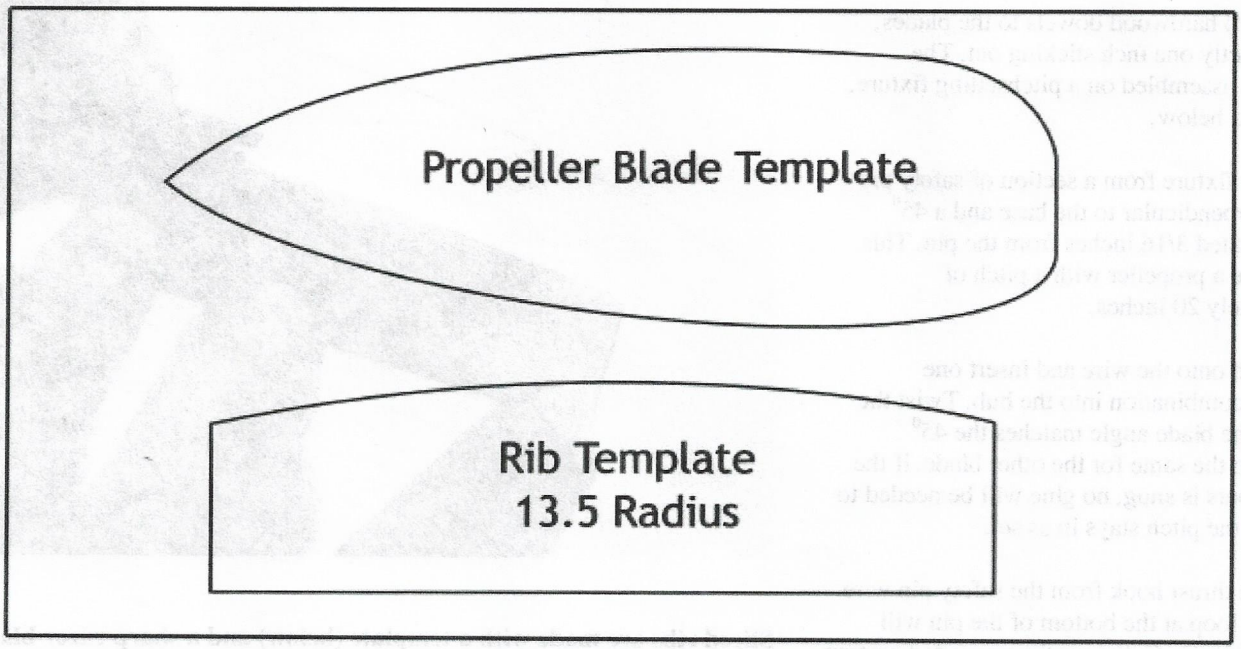
Experienced Indoor modelers will use very light Mylar®, attached with a light dusting of 3M-77® spray adhesive on the framework. For a first-time project such as this model, adhesive from a UHUstic™ glue stick works well.

Give a coat of adhesive to the entire structure that will come into contact with the covering. Use a soft scrap of balsa to transfer the adhesive to the wing. Support the ribs from underneath to keep them from breaking while transferring the adhesive. You will need a light touch. Each transfer application should be to no more than about 1/2 inch of balsa surface.

To aid in covering the wing, build a 6 x 20-inch frame from 1/8 x 1/4 balsa. Cover the frame with the Mylar® and adhesive, then lay the adhesive-coated wing on the covering. Trim the excess material with a sharp razor blade.

An alternate covering is HDPE (High Density PolyEthylene) plastic; it's what many shopping bags are made from, and has a dull luster. You may see the HDPE abbreviation in small letters printed on the bag. This plastic is lighter than most tissue, and is nonporous.

The only drawback is finding an adhesive to hold it to the framework; common adhesives do not stick to HDPE.



One adhesive I've found that does work well is Elmer's Neoprene Based Contact Cement, diluted with two parts of water. Product number is E-753 for three-ounce bottles, and E-751 for quart cans. Borden customer service ([888] 435-6377) can tell you the name of a retail outlet in your area that carries this product. (In my area, Ace or True Value hardware stores will order it, if asked.)

Use a bit of foam from a "Beauty Wedge" (from a drug store cosmetics counter) as a disposable applicator.

Place the HDPE covering over the adhesive-treated wing and lightly press into place on the LE and TE. Wait about one hour before trimming the excess with a sharp razor blade.

The dihedral joints are glued and the wing posts are added as in the DW, with about 1/8-inch skew, to force the wing into a twist when the posts are snugly fit into their sockets.

Setup and Flying: Recheck the balance point of the fuselage-propeller/bearing-rubber motor combination. If it is not near the center of the wing, the sockets for the wing posts should be repositioned.

If the model doesn't gain sufficient altitude with the same rubber motor used for the plastic-propeller version, it may be too heavy; the quick fix is to reduce the propeller's diameter by cutting away blade area at the tips.
If you have access to a rubber stripper, or know someone who does, a larger-size motor can also be prepared. My tests showed that the Mylar®-covered model made six-minute flights easily with a loop of .070 Tan II rubber. The HDPE-covered model, which is about 1/2 gram heavier, flew for about four minutes with the same motor (and did about 3-1/2 minutes with an .060 motor).

A weight of roughly 3.5 grams should be easily achievable with this design. The biggest weight reductions can be made by using lighter wood for the propeller and motorstick. Substitution of plastic covering on the tail surfaces will also help. Use of a lighter-weight wire for the thrust hook will require some sort of fill for the hole in the bearing. I've used the teflon tube CyA glue applicator as fill to reduce the wire size to .015 from the .036 safety-pin wire.

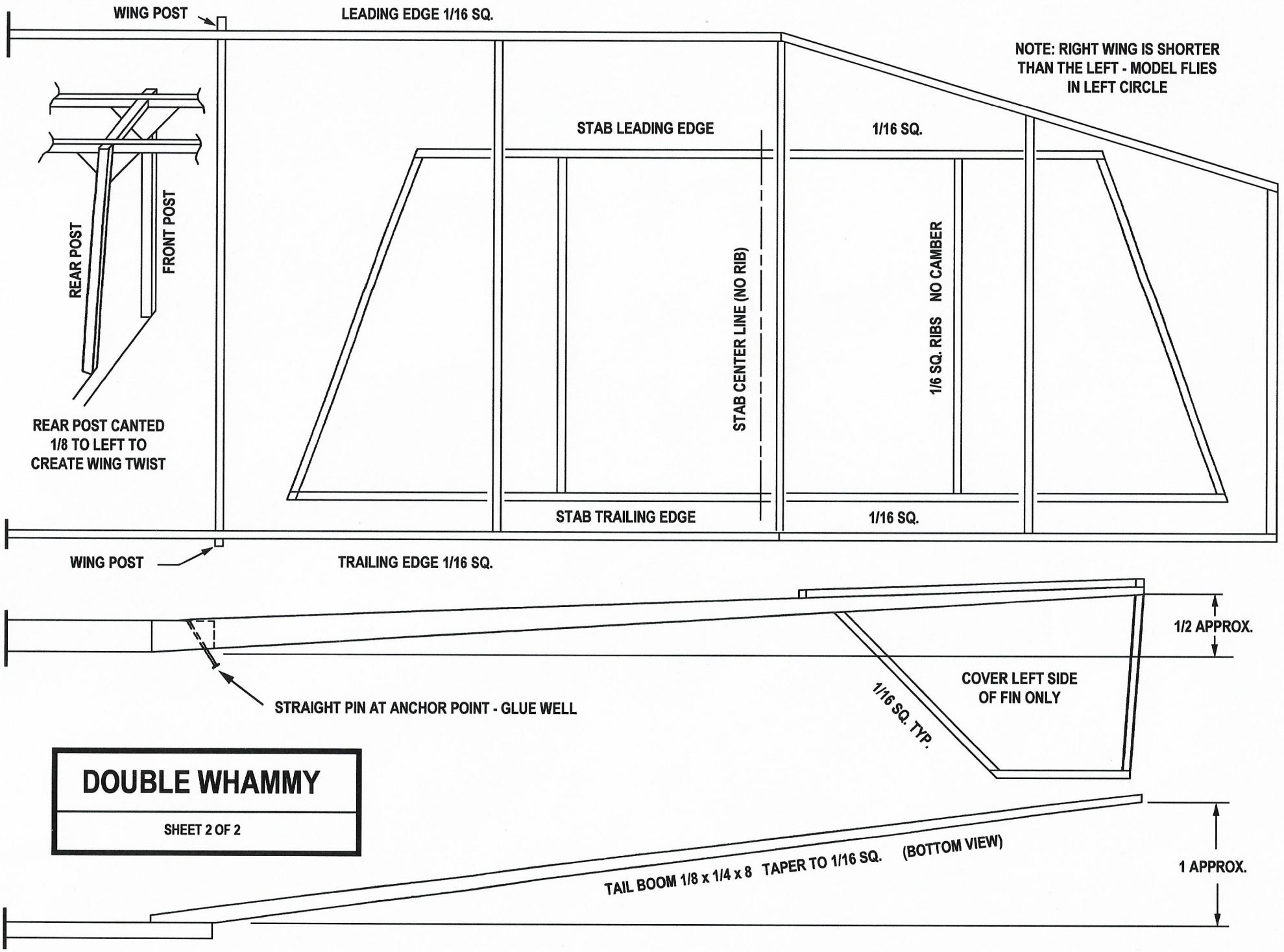
If you are fortunate enough to fly with experienced Indoor modelers, inspect their models and you will find all sorts of weight-reducing construction techniques and materials.

Chuck Markos

Email: cmarkf1@aol.com

Source:

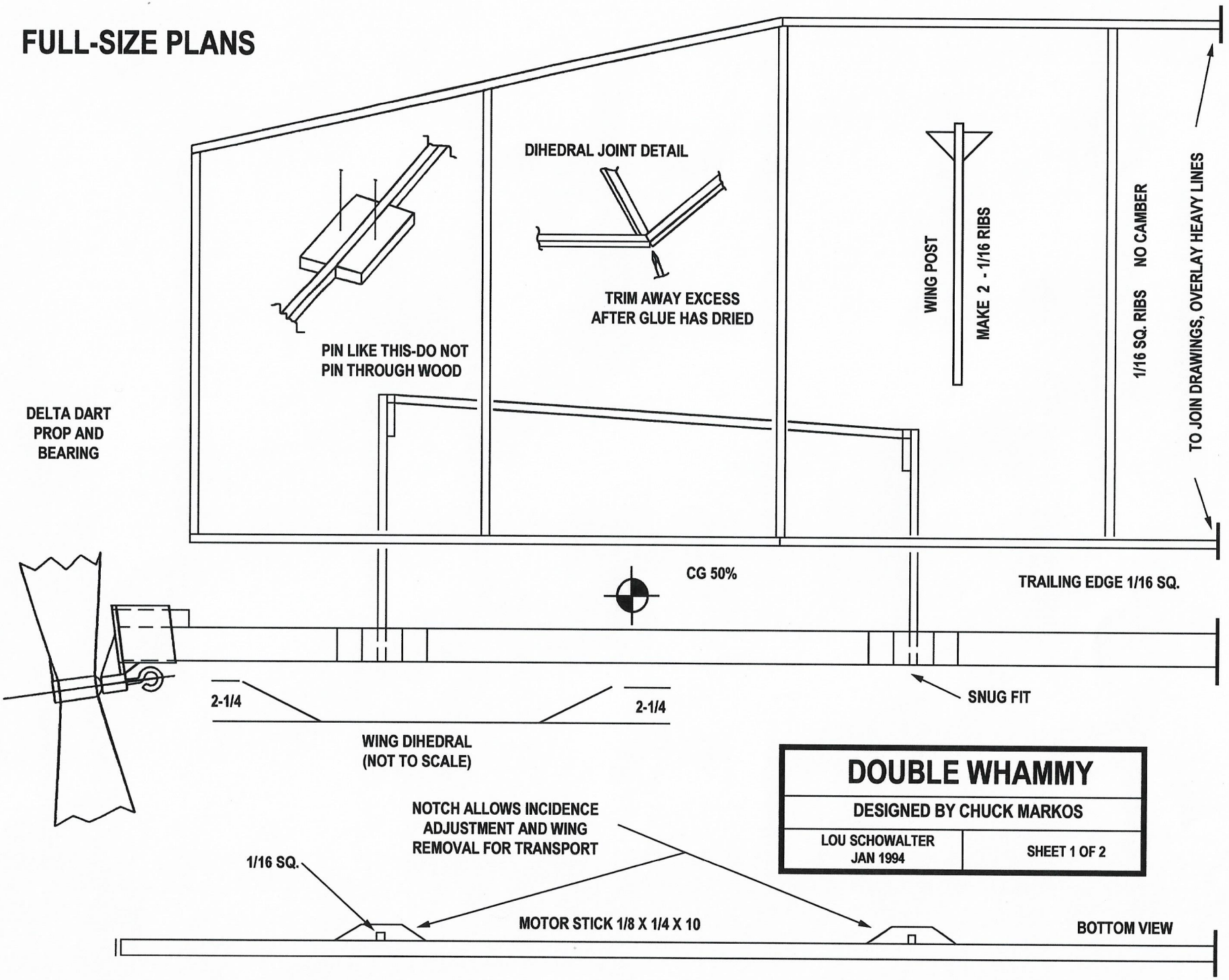
Lightweight Mylar®:
Model Research Labs
25108 Marguerite #160
Mission Viejo CA 92692
www.modefresearchlabs.com
Catalog $2+SASE (55 cents postage)



DOUBLE WHAMMY

SHEET 2 OF 2

FULL-SIZE PLANS



DOUBLE WHAMMY	
DESIGNED BY CHUCK MARKOS	
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