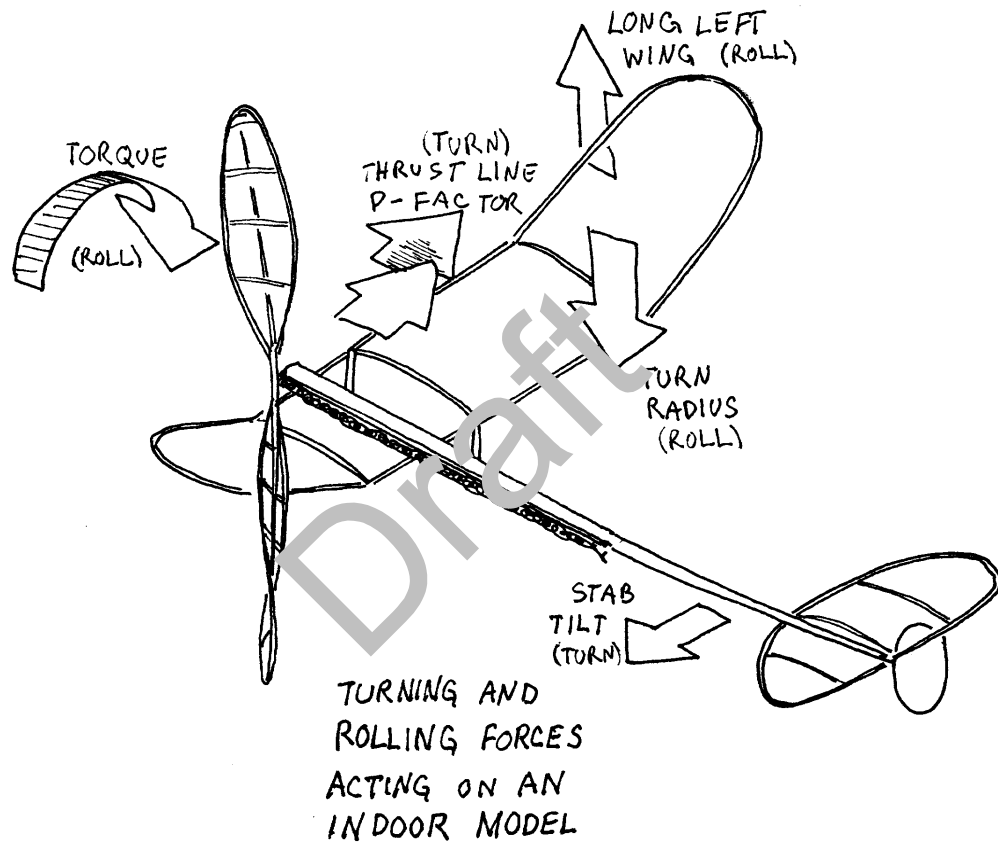


# INDOOR MODEL AIRPLANES

The Best Of Indoor News And Views  
Assembled and Edited by Tim Goldstein



# Indoor Model Airplanes

## The Best of Indoor News and Views

Packing In The Turns .....	5
Making Paper Tubes.....	7
Tissue Tubes.....	7
More-For-Your-Money Test Flying .....	8
Applying boron to motorsticks.....	9
F1d Boom/Fin/Stabilizer Construction.....	10
Boron Update .....	14
Wing Bracing .....	16
Choosing Motor Size For Variable Pitch Penny Plane Props In Low Ceilings.....	17
A neat easy way to cover built-up Propellers with plastic or microfilm .....	19
Covering Indoor Models Using the Thinner Covering Films.....	21
Adjustable Film Frame .....	25
How To "Handle" Ultrafilm Covering Jobs .....	26
Easy EZB Props.....	28
Use All the Air, But Not the Ceiling .....	30
Flying Airlines With Models.....	32
Hobby Shop EZB .....	34
Micro-B EZB Class .....	48
Torsional Twist Jig.....	55
Simple Scale .....	56
Poonker Mini Stick.....	57
Boron Jig For Motorsticks And Tailbooms .....	61
Making Tissue Decals For P-Nuts & No Cal And Any Other Scale Models.....	64
In Search Of The Perfect Sheet Of Balsa .....	65
Fuselage and Boom Assembly Jig.....	69
Dreamduster F1D .....	70
Wing Post Sander .....	72
Balsa Facts.....	73
A New Method of Joining Prop Spars.....	74
On EZB Motor Sticks.....	76
Balsa Facts.....	80
Surface Grinding Indoor Wood.....	81
Balsa Grain.....	83
"My Way" Penny Plane construction.....	87
Making Ribs .....	97
Prop Construction Tip .....	98
Microfilm Techniques .....	99
F1D Motorstick Construction.....	103
Begin with a Moustique! .....	106
Pitch Stability in Indoor Models.....	115
Jim Richmond's Variable Diameter Propeller .....	119
Variable Diameter & Pitch Propellers.....	120
The Variable Diameter Prop.....	122
A Propeller With Constantly Varying Diameter .....	126
Partial Motor Test Flights.....	127
EZB/Penny Plane Adjustable Bearing.....	130
Some Thoughts On Indoor Model Airplane Propellers.....	131
Applying Ultrafilm With Spray Cements.....	134
Ultra-Film Covering Tips .....	136
Construction Of Variable Pitch Props For Indoor Models.....	138

Joshu V/P Prop Hinge .....	145
VP Wire Hinges .....	146
Rubber Stretch Testing.....	147
Rubber Testing.....	149
Clean Motor Stick Repair .....	151
Rubber Measurement By Weight.....	152
Winding.....	154
Balloons, Poles, and Steering.....	155
Straightening Crooked Tail Booms.....	159

Draft

Packing In The Turns  
Chilton's Corner By Stan Chilton

After you've built and tested your model the final moment of truth is when you wind the rubber motor before making your first official flights. If you don't get maximum turns in the motor, the other flyer who does may very well beat you assuming everything else is equal, torque, proper rubber size, rubber lube, etc.

In the last several years I have read that crystallization of the rubber motors maybe caused by excessive stretching (or winding.) However, I have not been convinced enough to change my style of winding, because the bottom line is simply to get as many turns in the rubber motor as it will possibly take. I have experimented with numerous types of lubricant to facilitate not only getting the winds in but unwinding these same turns with the most efficiency. And I do know something is happening to Tan II more so than other batches of rubber and it very well may be crystallization as it may break while winding or on the model 35 minutes later. But, don't lose sight of the goal, and that is to get the maximum turns consistently every flight. Every official flight is always wound to max turns regardless of how many are backed off to get the desired torque level.

It seems that every indoor modeler has their own particular method of trying to get the maximum number of turns into any given rubber motor. And it also seems that whatever method one uses, it is seldom talked about. The situation is really very simple: If you can get 10% more turns into your motor you have a 10% advantage over your competitor.

There are many different ways to wind up a rubber motor. I will tell you how I do it although it may be technically flawed. For instance Jim Clem doesn't stretch out the motor as far as I do. He feels that max stretching causes a crystallization of the atomic links of the rubber. Yet I've seen him crank in over 5000 turns on a Federation ROG!

Following is how I wind a motor that I want to put in absolute maximum turns, under these assumptions:

- 1) The motor has previously been fairly well broken in or stretched to 90% length for 5 minutes and
- 2) the motor has been lubed with a proven rubber lubricant, preferably with silicon in it.
- 3) Calculate from a winds chart how many turns this particular motor should take. (For our illustration here we will assume 2000 turns max.)
- 4) It is helpful to install a brake on your winder so you can hold the winder in your one hand without the danger of free wheeling and losing turns, especially under higher turns and torque.
- 5) Create some sort of winder-torque meter set up where you can establish a model's hook to hook distance between the winder and the torque motor. The set up must allow the winder to be latched or held firmly at the hook to hook distance but at the same time be easily removable for winding and transfer to the model.

Now for the actual winding:

Stretch the rubber loop as far as it can be stretched just short of breaking it. For Tan II this stretched length is close to 10 times the original motor length. Of course the anchored end of the motor is hooked to the torque meter. Do this by holding the winder with motor hooked to it in your right hand and feeling the rubber tension with your left hand.

Now start winding slowly. At about 40 turns (the 2nd winder turn) start coming in as you continue to wind. Keep the rubber slack enough that it doesn't tighten up and break. Put in 500 turns and stop.

A. With your right hand holding the winder again and left hand feeling the rubber, back out (stretch) the motor and again to the max, just short of breaking.

B. Then start winding slowly and coming in at the same time. Put in 300 more turns. Start watching the torque closely now and come in just enough while winding to keep the torque from increasing.

Repeat paragraph A and once again put in 300 turns in the manner described in paragraph B.

At this point while alternating winding, relaxing and stretching drop the turns put in each cycle to 100.

As you approach 1800 to 1900 turns you will notice the torque increasing in spite of coming in. The torque will increase dramatically as you stretch the motor back out as far as it will go.

The last 100 turns may be put on in 2 cycles of 50. If the motor now appears to be able to take more turns than your chart shows to be the estimated max turns put additional turns on as you think you can get away with, but never more than 100 at a time.

When you feel absolute max turns has been reached your rubber motor length should be at the model hook to hook distance. The motor tension at this point should be fairly tight at the hook to hook distance.

Back off the required turns to your desired torque immediately upon reaching max winds.

The winder may now be placed in its stand, or jig with it's unwind brake on and the wound motor in place between the winder and torque meter ready for transference to the model.

As you are winding you will occasionally notice two things:

- 1) Knots grapevining out perpendicular to the motor, (Dick Hardcastle calls it "zinging out the side") and
- 2) Locations along the motor where there will be knots on knots where a heretofore even row of knots bunches up. Both of those situations occur mostly when you are coming in while winding or nearing max turns.

Here again hold the winder in your right hand and knead, separate & massage the rubber motor knots with your left hand so you end up with as evenly wound motor possible. I feel that the rubber gets overstressed and is more likely to break at the knot on knot areas.

Some motors of equal size, length and weight will grapevine and knot on knot much easier than others. Discard these motors when making a serious flight. Causes for the unevenness may be a varying density of the rubber or a varying width or thickness of the strands.

When making an official flight, I always try to have at least 3 identical motors broken in and ready to wind. This allows you to continue to get a flight in spite of a broken first motor.

My technique of winding is similar to that described by R. W. New in the 1989 Free Flight Forum of the Model Engineers Exhibition, London, England. He described his winding technique as the "relaxation method," but he does not stretch the rubber as much as I. He holds the stretch to not more than 5 to 6 times the motor length, similar to Jim Clem's winding. But he did not have Tan II rubber.

There are two more points to point out in order to get maximum turns.

The first point is to make sure your torque meter's shaft and indicator needle is free and does not bind or drag. I have ball bearings in my torque meter but they are not absolutely necessary.

Once I was breaking motors almost every wind up, sometimes not even close to max turns. I noticed my indicator needle was dragging on the plexiglass face and causing it to jerk erratically. When I freed up the torque meter, I stopped breaking motors.

The second point is 100% mental concentration. Before beginning to wind the motor be sure you have no questions lingering in your mind about your model's adjustments.

When commencing winding, the only thing in the world to think about is your winder, the rubber motor and the torque meter. Focus and concentrate on the winding of the rubber motor. It requires extra concentration if you have a talkative timekeeper, especially one who likes to tell jokes to other spectators just a few feet from where you're trying to get max turns on a motor! If someone walks up and asks me questions while I'm winding I invariably will quickly break the motor.

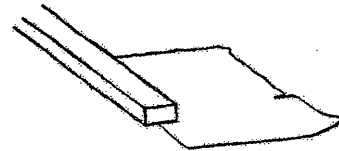
So to get max turns shut out every thought except that of winding the rubber. Do not hurry the rubber motor isn't going anywhere. But it does take effort to coax maximum turns into the rubber motor, not physical effort, but total focusing of one's concentration toward getting the most turns in the motor.

Always remember if you never break a motor going for maximum winds you are probably underwinding. (Or you have some super rubber, in which case call me collect.)

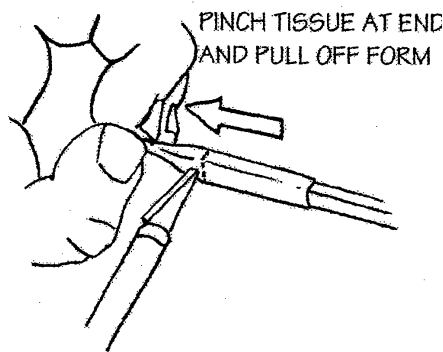
Making Paper Tubes  
By Steve Gardner

Square or rectangular paper tubes are best for holding adjustments. These style tubes are easy and quick to make with this method. A brass form of the exact post dimensions is used as a mandrel. The tissue is glued to the form with Ambroid, style cement to allow easy wrapping. A large amount of cement is applied to the tissue and the tube is wrapped. The surplus glue will ooze out and must be wiped off. A hole must be cut to allow air into the tube so that it can be pulled off of the form. Two or three layers is plenty of tissue for most application.

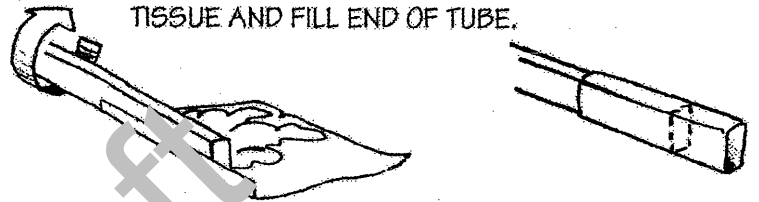
GLUE TISSUE TO FORM, LATER GLUE APPLICATION WILL SOFTEN THIS GLUE TO ALLOW REMOVAL



NOTE TISSUE OVERHANG



APPLY LIBERAL AMOUNT OF GLUE AND WRAP TISSUE TIGHTLY. GLUE WILL SOAK TISSUE AND FILL END OF TUBE.

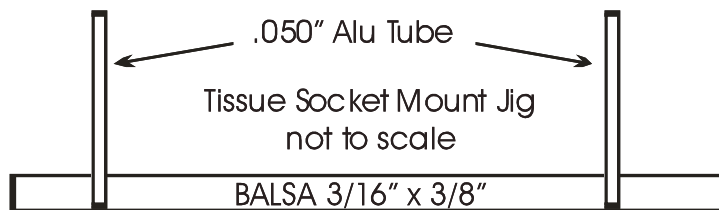


CUT HOLE FOR AIR ENTRY

Issue 68-69-70 1993

Tissue Tubes  
Tom Green as learned from Joe Krush

- (1) I use the shank end of drill bits for a mandrel. They are smooth, straight, and available in diameter increments of 1/64".
- (2) Prior to rolling the tube, coat the mandrel with Chap-Stick. This holds the tissue to the mandrel and also helps release the tube after rolling. Wet the tissue with your tongue before rolling.
- (3) With the tissue stuck to the mandrel, roll the mandrel one revolution so that the bare mandrel does not show and then apply thinned Duco and roll the tube. "As soon as the tissue end sticks down on Its' own push the tube off using a thumbnail". When the tube has dried, coat with CA. This will stiffen the tube and prevent softening when the tube is mounted (or removed) on the motor stick.
- (4) I use a simple jig to mount wing tubes on the motor stick. The jig ensures that tubes are positioned accurately.

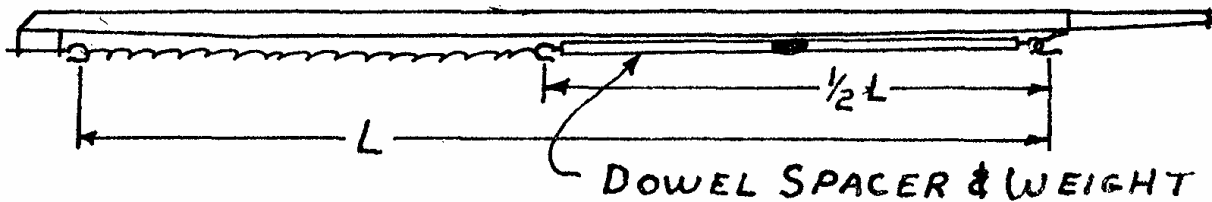


Nov 62

More-For-Your-Money Test Flying  
From Carl Redlin

This hint is for test flying new models or refining the performance of older ones:

To test my FAI models and props the past two years, I have been using a spacer (see sketch below) in combination with half-length motors to reduce flight turns and flight time by roughly one-half (more test flights per day's flying), With the spacer I'm able to see the models perform under full torque without the danger of landing in beams and without long waits between test flights. Works nicely, although the spacer and motor combination must be balanced very carefully. In testing with this system I have found that average prop RPM's for all practical purposes are the same as with full length motors. It's especially good for testing high ceiling props under low ceiling flying conditions."



Draft

Applying boron to motorsticks  
by John Tipper (GBR)

I have tried many different methods to apply boron to motor sticks and have found this one to be the best. The boron stays on straight and has never parted from the motor stick. The weight penalty is only about 2mg for 16 in of boron - a small price to pay for a much stronger motor stick.

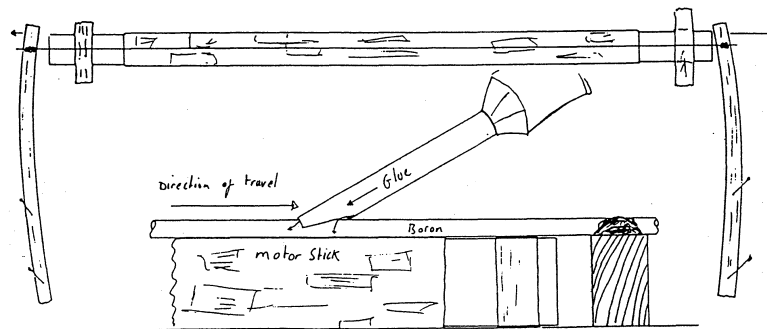
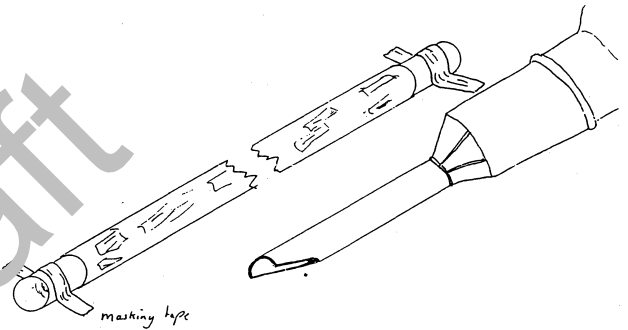
1. Tape motor stick down to work bench by the mandrel.
2. Select two pieces of medium balsa 5mm wide x 120mm long, the depth to be the overall diameter of the motor tube.
3. Glue balsa sticks onto each end of boron and allow to dry. This joint needs to be very secure.

Carefully file off the point on a 24 gauge hypodermic needle (see drawing). This will leave a half round groove in the end of the needle. I use a small high speed drill and fine cut-off blade for this, so as to leave a clean edge on the needle.

4. Pin balsa sticks to work bench so that boron is under tension and in the correct place on the motor stick.
5. Apply about 8-10 dots of glue along boron to secure in a straight line and allow to dry.

6. Mix up a solution of 20% Duco and 80% Acetone and fill glue gun (glue guns available from FID Indoor Supplies).

7. Position the half round section of the needle onto the boron and run a bead of glue along the length of the motorstick. The needle will run along the boron like on rails. The glue will coat the boron and form a very small fillet along its length. Allow the glue to dry before cutting end of boron from balsa sticks, then repeat procedure as above for other boron positions.





F1d Boom/Fin/Stabilizer Construction  
by Steve Brown

Completing the fuselage of an F1d involves the same tradeoffs between weight and strength as does motorstick construction. A well built model will maintain its adjustments under power, accept the stress of ground handling and still meet a weight target. The comments below refer to an F1d with a suspended, unbraced parabolic stabilizer. Many of the techniques also apply to braced stabilizers. I favor unbraced stabilizers because, in my experience, they recover from tailslides better than braced stabilizer models and they are easier to build to weight.

Boom wood selection - The factors previously discussed for motorstick wood selection apply to the wood for tail-booms: uniform thickness, straight, consistent "C" grain, and sheets that lie relatively flat when placed on a flat surface. I say "relatively" because the majority of wood, when cut to .007" or .008", displays some tendency to curl or twist. More latitude in sheet weight exists when selecting boom wood. Booms can be built with or without boron reinforcement. Look for .007" thick wood that weighs .0060-.0070 oz, but good booms can be built of heavier wood, up to .008 oz, without boron.

Rolling the boom - I use a 22" long former tapering from .235" to .125". This gives an i.d. of .160" at the small end of a 13" boom. The idea for using a low-taper former originated with Stan Chilton. It is not only stiffer, but it has less tendency to split at the small end if a model tailslides. You can obtain low taper formers by looking through the fiberglass rod components at a fishing equipment shop.

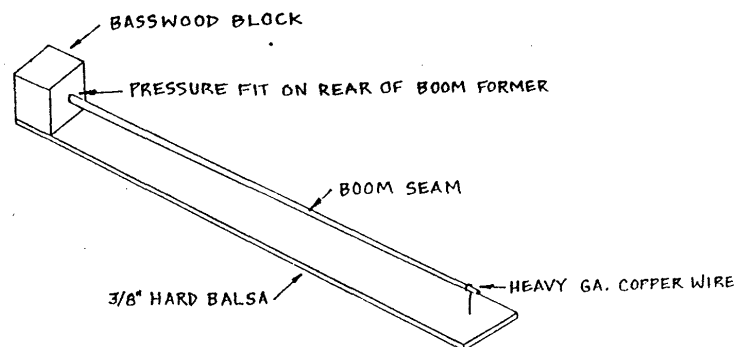
I usually use the traditional method of cutting an exact size tapered blank. Assuming that you are using a .250" i.d. motorstick, locate the .235" o.d. point on the boom form. Wrap a piece of .125" wide masking tape around the .235" diameter. Measure 13" down the form and wrap a second .125" piece of tape around the form at that point. Slice through the overlapping tape and remove both pieces from the former. Mark two points 13" apart on the sheet of wood and trim one edge of the wood straight. Using magnification, place the .125" strips of tape on the wood perpendicular to the straight edge. Position a straightedge adjacent to the ends of the tape. Allow about .015" extra width to compensate for shrinkage. Cut the second side of the blank. I usually make the blank about .250" longer on both ends than my target length, to allow for an exact fit with the motorstick i.d.

Soak the wood for 15 minutes in cool water. Cut a piece of 00 Silkspan to a wedge shape about 2" wide at the wide end, 1.25" wide at the narrow end, and 14" long. Place the Silkspan on a flat work surface and soak it with water applied with a 1" wide brush. Brush out all the wrinkles. Position the boom former along the bottom edge of the Silkspan and attach the Silkspan to the former. Roll the former about 2/3 turn. Place the wood blank adjacent to the former and roll. Bake at 150 degrees F for 20 minutes.

Carefully remove the blank from the former.

00 Silkspan is easier to separate from the wood than is Japanese tissue. The tube will almost always have a slight curve. If the tube is very curved or "doglegged" discard it. It is impossible to straighten a boom that is excessively curved.

Gluing the seam - Spray the former with aerosol Teflon and allow to dry. Place the former in a simple jig like that shown in the sketch. Weigh the rolled balsa tube and then place it on the former. Using the wire loop pull the small end of the former down about .180". Don't overdo it. The bend helps counteract the tendency of the glue seam to warp the boom. Position the wood with its curvature opposed by the bent former.



Recently I have been using Stan Chilton's method of applying glue to seams with a brush. Use Ambroid thinned 50/50 with a mixture of 1/2 acetone, 1/2 lacquer thinner to retard drying, and 4 drops of TOF to

the ounce of thinned mixture. The disadvantage of the brush technique is that so little glue is applied that it tends to dry before the joint can be made. If more is applied it is easy to glue the wood to the former. By slowing the drying time and spraying the former with a non-stick coating these problems can be minimized.

Begin gluing in the middle of the tube, aligning the edges to produce a straight seam. When complete, leave the tube on the former for 6-8 hours to allow the glue to dry completely. Weigh the glued tube, subtract the weight of the bare rolled tube and you should have a seam weight of .0002-.00025 oz.

Applying boron - Remove the tube from the former. Now is the time for a "judgment call." If the tube is straight and seems very stiff, omit boron. Tubes that don't require boron weigh about .0030-.0033 oz. for a 13" length. If the tube is still curved or is very light (.0027-.0030 oz) boron is usually necessary.

Using the same jig as described in my motorstick construction article I apply .003" o.d. boron (from Model Research Labs) to the top and bottom of the tube. Apply the boron to the side away from the curve first, using thinned Ambroid with TOF in a 26 gauge hypodermic needle. Two boron strips will add about .00035 oz.

Building the suspended, unbraced stabilizer - Obtain .028 - .032" thick, 24" long wood from Indoor Model Supply (It is my understanding that 24" wood is no longer available from this vendor. Editor). Grade the wood to find a sheet of about 5.5 lb. density that is stiff and springy. Place the wood on a flat surface, mark the center with an indelible marker and begin sanding from the center to the ends with a 1.125" wide sanding block. Only experience will tell you how much wood can be removed. I usually taper the sheet from .028" thick on the ends to .022" at the center.

Once the sheet has had the taper sanded into it tape it on a cutting board and true the edge. Mark each end to .050" tall by dragging the sharp edge of a razor blade through a felt-tip marker or ink pad and making a tiny cut at the .050" mark. Repeat the process to mark .030" at the center. Position a straightedge against these marks and make two cuts. You will have a double-tapered spar.

Soak the spars for 30 minutes in cool water. I bend the spars, two at a time, around a parabolic form made from 1/8" balsa. Secure the large ends to the form using tiny rubber bands made by cutting 3/32" wide pieces of a toy balloon. These balloons are available in bags and are about 1/4" wide and 5" long. Bake the form for 20 minutes at 150 degrees F.

I build and cover on the same smooth, matte-finished painted particle board surface. Assemble the stabilizer over a pencil outline. The building board has 1/6" thick wood sub-ribs under all three ribs. This assures that the ribs will stay at the proper height during covering. Be sure that the covering board has one or two vent holes to allow air under the microfilm to escape. Positioning the two halves of the stab outline over the pencil outline on the building board. Hold the pieces in place with small weights. Tack glue the large ends of the outlines together at the two points where they overlap. Remove the outline from the form, cut scarf joints and glue.

Reposition the complete outline over pencil outline. If the wood does not lay flat on the building board weight the entire perimeter of the wood down to the board with lead weights and brush on water. Allow to dry overnight and check for flatness. Repeat if needed. Soaking the wood helps relieve any warps or stresses.

Cut three ribs from 5.2 LB "A" grain balsa. Make the two outer ribs of .025" thick wood .030" tall. Make the center rib .025" thick and .045" tall. It is important to make the center rib strong. With experience you may be able to reduce the height of the center rib to about .040". Glue all three ribs using Ambroid with no plasticizer. I always "double glue" rib/spar joints by lightly coating both surfaces with tiny amounts of glue, waiting about 10 seconds, and then applying a second coat of glue to one of the surfaces. Hold in position until dry.

The stabilizer should weigh .0028 - .0032 oz. before covering. If it is less I would suspect it won't be stiff enough to work unbraced. If more, it is too heavy.

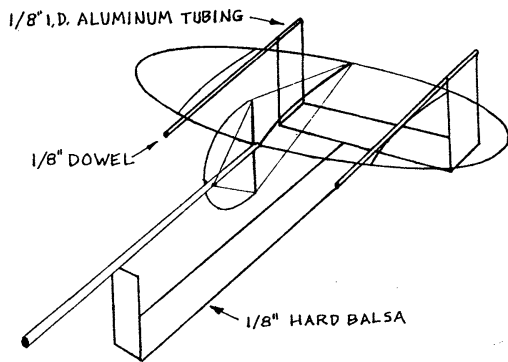
Covering the stabilizer - Select a sheet of straw or gold microfilm that has been aged at least 60 days. Slacken the film by placing 1/4" wide strips of masking tape about 1/8" inside the perimeter of the film frame. Cut the sheet loose so that it is suspended by the corners. Place small pieces of tape at the mid-points of the long sides to reduce the billow of the film. I generally make the sheet quite slack, since stabilizers are easily warped by taut film.

Position the outline on the building board and adhere the balsa to the board with water. Do not get water on the inside of the outline. Using a 3/16 round sable brush adhere the ribs to the balsa sub-ribs with water. This will keep the ribs straight. Make one pass around the outside of the stab leaving a light layer of water on the board outside of the balsa outline.

Lower the film frame over the building board. Blow lightly on the film to be sure that it touches the tops of all the ribs and outline surfaces. Let dry overnight. The outline will shrink as it dries which will add more slack.

Fin construction - Make a circle of .004" boron 4.25" in diameter Glue the overlapping joint and cut off the excess boron. Cut a 3.75" tall vertical balsa upright from a sheet of stiff .028" 6.0 lb. "A" grain balsa. I usually taper this piece from .055" wide in the center to .040" wide at the ends. Position the boron circle so that the overlapping joint is behind the vertical upright and glue the two points where the circle contacts the tips of the wood. Let the glue dry well since considerable stress is transferred through these joints when the boron is broken off. Using smooth-jawed needle-nose pliers or hemostats, gently squeeze the boron/wood joint and break off the unwanted part of the boron circle, leaving a "D" shaped structure.

Cover the fin by outlining a 5" X 5" area of violet or blue slack film with 1/4" tape. Using a #1 sable brush apply water or saliva to both sides of the wood and to one side of the boron. Immediately drop the fin onto the film and allow to dry. After 30 minutes or so blow lightly on the film to check for un-attached areas of the boron. If you find any work a tiny amount of moisture under the outer edge of the boron and allow to dry. Cut both the stab and fin loose with a hot wire or battery powered soldering iron.



Assembly - Use a jig to position the stabilizer with the stab tilted at an angle parallel with the angle of the rear wing spar. The boom should be supported so that the correct incidence angle is formed with the stabilizer. Tack glue the stab to the jig. Butt-joint the boom to the stab and then align the large end of the boom with the centerline marked on the jig. Tack glue the large end of the boom to the jig.

Position the fin at the boom/stab juncture and glue the rear joint. Make sure the upright is vertical both from the side and the front by visually comparing it to a square. Cut a piece of balsa .020" X .020" X .750" long and butt glue it to the side of the boom so that it touches the front edge of

the boron circle of the fin. Glue the boron to the balsa to provide .125" of rudder offset. Clip off the excess balsa with sharp scissors. Glue a .020" square peg of balsa on the opposite side of the boom near the front of the fin. I brace stabilizers with .0003" tungsten wire from Ray Harlan or Indoor Model Supply. I prefer it to thicker wire because it bends around curves more readily.

Weight one end of the wire with a weight of about .002 oz attached with a 1/16" wide piece of masking tape. Measure about 22" of wire and attach a second weight. Cut the wire behind the second weight and position the wire beginning at the front at the .020" square peg, over the top of the upright, around the back of the stab and under to return to the peg. Examine the wire in a cross-light to look for kinks or areas that are not properly tensioned. The wire should be taut. Glue all points, beginning at the rear of the stab and finishing at the peg on the boom. When dry, cut off the weights. Remove the complete assembly from the jig by softening the glue joint at the front and rotating the dowels gently under the stab spars. Weigh the complete assembly. With a boom length of 13" I look for a weight of about .0075 oz.

Stabilizer incidence can be adjusted in the field by softening the glue joint with acetone and lightly repositioning the stabilizer. I find that I only have to do this once or twice with a new fuselage and the adjustment is generally good until the boom/stick joint is altered, usually following damage

Draft

Issue 18 1985

Boron Update

The following article on Boron has appeared in The Hanger Pilot, Dec.'84, The Satellite, Dec.'84, FlightMasters Newsletter, Jan. Feb.'85 and El Torbellino, Jan.'85. We are reprinting it one more time so as many modelers can read it as possible, especially our friends outside the United States. This article was written by Bill Warner, Free Flight Scale columnist for Model Aviation, and a second article by Bill appears as part of the March 1985 "Safety First" column in Model Aviation.

HIGH TECH PROGRESS BORON STEEL WIRE is to be avoided like the plague. Sure, it stiffens up your model and lets you build nice and light but who are you risking? At Sikorsky, they call the Boron Room the "Death Room". Protective clothing, masks and all the good stuff. When someone gets a bit of it in them, they cut it out immediately. Neat stuff. I tried using it, figured that I certainly was smart enough not to have any problems. Well, despite all my precautions which included protective glasses, taping all unused bits to a white paper so as not to lose any, some got away. When it gets away, it just disappears. It has the thickness of a human hair. It is nonmagnetic, so you can't pick it up that way. It gets lost in the carpet. It goes into the flesh easily and accidentally. I found I'd get a bit into a finger despite my best efforts. Finally, I began feeling a pain in my right foot. Somehow I had picked up a piece while barefoot (the bed is only 3 feet from my work space).

I called Kaiser Permanente (editor's notes this is a health maintenance group in Southern California) about it and they did not know a damn thing, except that an X-Ray would be useless with something that size. Los Angeles County and UCLA Medical Center were also ignorant of what could be done. Finally, an end about .005" long worked itself out and my dear wife, Phyllis, performed surgery and got out the offending bit, a piece about 1/16" long. Even then, it broke off several times during the extraction process with tweezers, plus it keeps going deeper in when you try to get it out.

Since then, we have repeated the operation several times for other bits, and it is not fun. Also my foot still is hurting, with the boron steel somewhere inside. The articles sound the alarm that when it gets in the bloodstream, look out. Great. The worry alone and the ignorance of the medical profession regarding it makes for something less than mental tranquility. I'll keep you posted. In the meantime, I suggest you do not get yourself into a similar predicament.

And from Erv Rodemsky, 1980 World Champion, comes his comments "I think this boron thing is the most important issue we have ever faced! My family and I have had at least 6 pieces of the stuff in our feet, one in mine went in and never came out - it's somewhere in my body. Boron should be outlawed in all forms of modeling RIGHT NOW!" The above article is from the December '84 issue of The Hanger Pilot and should be read by all. Do we wait until some kid puts out an eye, or worse, before we do ban the stuff? We have received several letters and phone calls expressing concern about Boron. Stan Chilton got a piece into his hand and when his thumb and forefinger became numb several days later he became very concerned. Materials experts we've spoken with feel it is inert and won't cause problems except they admit they know very little about Boron. We also consulted Dr. Jim Thornberry, a free flighter from Madison, WI, whose major concern is that because Boron has a rough surface and is not sterile it would carry germs, etc. into the body and become an infection site.

Boron, once it pierces the flesh and enters your body, it appears to continue to travel in the same direction through the body. Eight months after some Boron entered my own foot it came out in many pieces each about 1/32 inch long. The Boron had entered at the front of the arch and travelled forward exiting by my little toe some inch and a half away. During this same time span I suffered a respiratory infection which my doctor could not identify and it did not respond to treatment. Whether this illness was connected to the Boron or not is only speculation.

First off Boron Filament is not wire, its structure and the way it behaves is more like glass fiber and should be treated like glass fiber. Use extreme caution.

WEAR SAFETY GLASSES and to contain the small pieces that fracture at the ends when you break off a piece. Ray Harlan suggests you work inside a container. I suggest you store Boron in an unpenetrable container such as a coffee can.

Here in the Great Lakes region drastic changes in humidity are common, often occurring within hours. As a result, unless Boron strands are placed in a symmetrical pattern, when the humidity changes and the balsa swells or shrinks, the part can warp. Also Boron applied to a motorstick of mine in January 1984 is now coming loose and falling off from repeated expansion and contraction of the wood. Another problem occurred when I had a motor come apart at the roof in Akron, causing damage to the wing, when I got the model down the wing was repairable and all the balsa pieces were accounted for, but some of the Boron which had been on the wingposts was missing. What would happen should a model explode close to the floor, near modelers and spectators? Are we endangering these people by exposing them to flying pieces of Boron?

I have found an alternative to Boron in using a .0010 x .0020 strip of balsa every place I had thought to use Boron. The wood gives extra strength while being lighter in weight than the Boron without warpage from humidity changes. Sure, it isn't as stiff, but in most cases it is stiff enough.

Several modelers - Rodemsky and Chilton - are considering a ban on the use of Boron filament and I personally am not adverse to a ban. However, a ban only in the United States would not be effective and would possibly put U.S. teams at a disadvantage in international competitions.

Notes The A.M.A. Indoor Contest Board ruled in 1984 that all high-tech materials, which include Boron, are, banned from Easy B. Only wood, Condenser paper (since changed to allow plastic film. Editor), suitable adhesives, and wire for prop hook and rear motor hook are allowed in Easy B.

We are very interested in the opinions of modelers from countries other than the U.S., especially the British and Swiss flyers who have used Boron in their models.

Issue 86 1996

### Wing Bracing:

Chilton's Corner by Stan Chilton

If a wing is braced on a jig requiring it to be lifted or removed after bracing, modify the jig so it is at least 3 inches longer than the wing, beyond each tip. To then remove a braced wing, turn the jig upside down, support both jig ends outside wing tips at least 24 inches above floor, and let the wing drop out of the jig, releasing any snagged bracing on jig as necessary. This way the bracing is never subjected to any force beyond that of the weight of the wing.

**BRACE WIRE TENSION:** Have you ever had wing spars buckle between bracing points due to high humidity at the flying site? The problem can be corrected in most instances (when building the next wing or stab) by bracing with less tension on the bracing wires. How much less? Too much less tension and the wing gets floppy and weak in dry, hot conditions. Two important points to remember in bracing are proper tension and even tension. Check over the variety of pins you have on hand. In addition to the conventional straight pin, there are different sizes of "T" pins and smaller 1/2 in. long pins known as bankers pins. From this assortment prepare the pins with a hook on the sharp end and cut or file the pins so you end up with about 8 pins of each individual weight of .001, .002, .004, .005, .006, and .008 ounces. I have been using .006 oz. weights for tension on FID wings, .004 oz. on smaller intermediate stick wings and .002 oz. on braced stabs.

If your braced parts are too floppy or loose, re-brace with slightly heavier weights. If the braced parts warp or bend inside the braced areas, go to a lighter brace weight. Some modelers use up to 3 pins together for bracing tension weights, some use no weights, just 3/8" square folded masking tape at the wire ends. Different techniques will require different weights, and may vary if you brace differently.

I have heard of modelers standing at the top of a stairwell and bracing a jig-mounted FID wing in about 30 seconds with just one long piece of bracing wire with a tension weight at the bottom end. This method satisfies my two concerns of proper tension weight and even tension, but I've never tried it.

**MOTOR STICK BRACING:** For bracing motor sticks, I use a large 1 1/2" long concrete piercing nail, weight about .125 ounce. Some modelers have used a quarter taped to the brace wire for motor stick brace wire tension. An average quarter weighs 5.96 gm or .196 ounce. For the strongest motor stick, it should be braced in a jig that bends its ends away from the rubber motor side about .015" on each end. When a fully wound motor is hooked up, the stick will flex to perfectly straight, as we want it be.

Issue 80-81-82 1994

## Choosing Motor Size For Variable Pitch Penny Plane Props In Low Ceilings

By Jim Clem

I was asked to write about choosing rubber size for variable pitch P.P. props. At Oklahoma City, Larry Coslick had chosen a large cross-section, short motor with the prop set with high pitch and a low RPM. Although he had optimum trim and used most of the turns, he ran out of turns at 10+ minutes. I used a cross-section motor smaller and slightly longer that would take more turns. The prop was set at a lower pitch and higher RPM. In proper trim, this combo was good for 11+ min.

For 60 years, indoor modelers have strived for lower and lower RPM. This has been our tunnel vision! The Federation ROG has changed this vision! This 3.1 gm, 30 sq.in. model with a 6" plastic prop can do nearly 10 minutes! It does not matter what the RPM is on an indoor model as long as we have enough turns in the rubber motor to get the desired duration!

Enough philosophy. Specifics:

1. P.P. motors can vary in width from .090 -.115 Tan II
2. We want to determine the optimum motor for existing conditions.
3. Larger motors can be used in sites where you can "ceiling scrub."
4. Use partial motor test flights. See INAV 7/93 Bob Randolph's article, & Model Aviation, 9/91.
5. Use "O" rings.
6. Make a 'WAG' as to the best length and thickness. Use enclosed rubber charts to play "what if" with RPM. Use this RPM and the rubber charts to pick the size and length of the motor to give you the number of turns you think it will take to win the contest at this RPM.
7. From your test flights, you can establish an RPM, and this eliminates one variable in your 'WAG' equation.
8. You want to land with as few turns as possible. (6% to 8%)
9. Remember that small cross section, short motors weigh less, so lower the overall wing loading.
10. Set the hi-pitch stop for a very high pitch (46"), and the lo-pitch stop for low pitch (15").
11. The model does not climb above head high (and may actually descend) in the first 1-1/2 to 2-1/2 min. of flight. Adjust switchover point with tension screw. The model then climbs just to the ceiling and descends to the floor.
12. Think about the greatest secret of all in indoor flying. Any well-built, proven design will be a winner if the prop and rubber combination is optimum. These are steps for trying to achieve that combination.

Examples for a place to start:

I. 4-18-93 Bedford TX Cat I Record 12:46

Motor: .119 x .040 x 21 Weight: 3.28 gm

Turns: 1533

Turns Remaining: 87 (6%)

Torque: 1.16 in.oz.

Lo-Pitch : 15.41"

Hi-Pitch: 46.23"

(Model on ceiling to 11:30)

II. 3-6-94 Oklahoma City, OK Cat II, 1st place P.P. 11:17 (altitude used: 35 ft.)

Motor: .100 x .044 x 15 Weight: 2.14 gm

Turns: 1440

Turns Remaining: 125 (8.7%) Torque: .8 in.oz.



Lo-Pitch: 15.1"  
Hi-Pitch: 46.23"  
RPM: 116

Bob Randolph's absolute world record of 55+ minutes proves that V.P. props are the way to go in any ceiling!! (The best I have been able to do is 14 mins, in Cat IV) I was also asked to write about winding technique.

1. Use Armorall, Dow Corning #33 Silicon Grease, Castor oil, or favorite lube.
2. Stretch motor to four times its made-up length, five times at the most. (More will lead to premature crystallization of the rubber.)
3. Put in half the desired turns rapidly.
4. Pause at this point to allow both rubber and the rubber winder to relax. Move the rubber gently in and out to align the knot ting.
5. Give the rubber a little slack and continue winding slowly.
6. Keep an eye on the torque meter as it climbs, and as you relax the motor, observe the torque. It should go lower. When you pull the motor back, if the torque follows you right on back, it's time for more slack!
7. Continue in this manner until the desired turns and hook length are reached. It will take about five minutes to wind a motor in this manner.

Draft

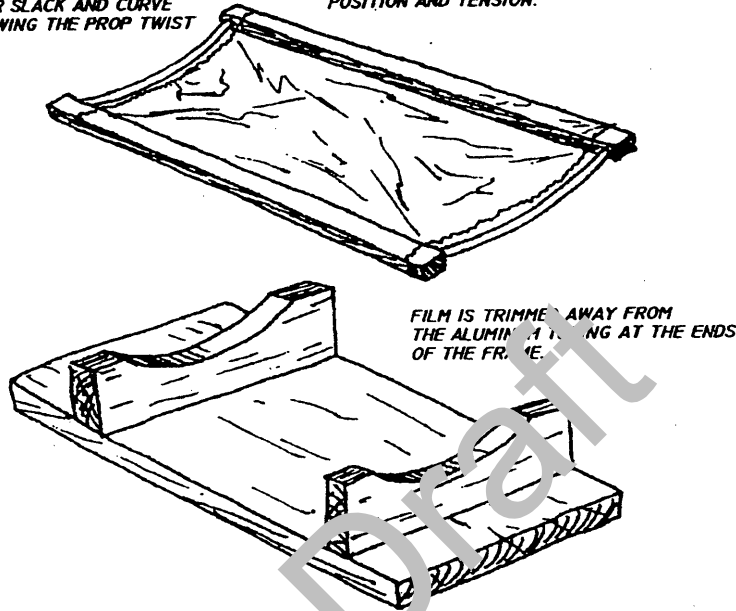
A neat easy way to cover built-up Propellers with plastic or microfilm  
By Larry Coslick and Steve Gardner from Indoor News and Views

The following method is based on the one developed by Larry Coslick and myself for covering props with the new Y2K film It is applicable to any other covering material including microfilm and any sized prop. It has the double advantage of being very easy and working really well.

First build the basic jig base for the size props you are going to cover. Larger jigs may be used for smaller props with a bit of care, but of course smaller Jigs are no good for the larger props, so unless you build a bunch of those little ROGs start with a large jig. See the drawings.

*ALUMINUM TUBING IS BENT ABOUT 1/4" TO FORM THE CYLINDRICAL SHAPE SO THAT THE COVERING HAS THE PROPER SLACK AND CURVE FOR FOLLOWING THE PROP TWIST*

*COVERING IS ATTACHED TO THE FRAME WITH PRANG BRAND GLUE PEN. THIS ALLOWS MINOR ADJUSTMENTS OF THE FILM POSITION AND TENSION.*



*FILM IS TRIMMED AWAY FROM THE ALUMINUM TUBING AT THE ENDS OF THE FRAME.*

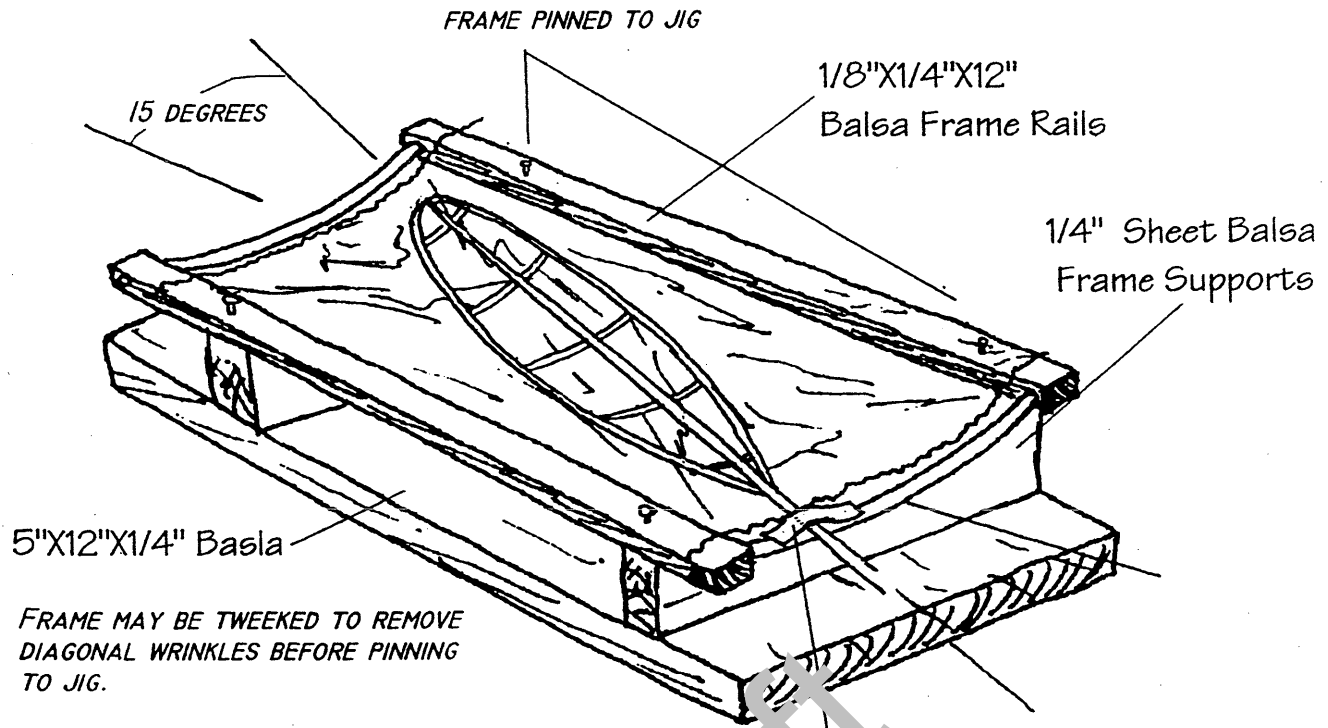
Next, build a pair of covering frames. These are made from 1/8 X 1/4 firm balsa strips of the appropriate length joined by 1/16 dia aluminum tubing at each end. The ends of the aluminum tubes are flattened and glued into holes drilled into the balsa strips. This aluminum tubing allows the frames to be bent to shape after the covering material is applied

Once the two frames are built and are covered with film the tubes are bent into arcs so as to allow the covering material to take the shape of a section of a cylinder. The covering material is then cut free from the tubing with a hot soldering iron. For microfilm a small length of thread is glued to the tip of the propeller and to the aluminum tube nearest the prop tip. This thread prevents the film from tearing when most of the film has been trimmed around the prop outline.

Before you can spray the prop with the 77 Sprayment glue you must take a Length of masking tape 1/8 wide and cover the prop spar so that the covering material will not adhere to it. Drafting tape or other very low tack tape is good here to prevent trouble getting this tape off of the prop without damaging it. Once the prop has the glue sprayed onto it remove the tape and it is ready to place on the film. Have a 1" bit of the same low tack tape ready before you proceed

Position the prop at the classic 15-degree angle so that the twist of the blade matches the curve of the covering on the frame. The prop is placed by putting the hub at the hook onto the tubing and rocking the prop down onto the film. Carefully position the prop so the leading and trailing edges meet the film at the same time. Once the prop is in contact with the film lake the bit of tape mentioned before and tape the hub to the tubing of the frame. Now the prop and film are held at one end by the tape and the other by the length of thread (for microfilm only). Gently push the prop outline down onto the covering, or reach

underneath the frame and lift the covering up to the outline as needed to get the outline attached to the film everywhere.



FRAME MAY BE TWEEKED TO REMOVE DIAGONAL WRINKLES BEFORE PINNING TO JIG.

**HINT:**  
 GENTLY WRAP TISSUE AROUND THE FIRST BLADE COVERED TO PREVENT GETTING SPARY GLUE ON IT WHEN SPRAYING THE SECOND BLADE.  
 TAPE STRIP TO HOLD PROP HUB

Once the outline is attached to the film everywhere you can trim the film around the prop. The thread will prevent the prop moving and tearing the microfilm once most of the outline is cut free, and in the case of plastic film, leave the very tip of the prop until last when trimming. Remember to remove the tape at the hub before trying to lift the prop from the frame.

## Covering Indoor Models Using the Thinner Covering Films

No author listed, but likely Larry Coslick and Steve Gardner

This article will cover using polymicro II or the new Y2K films to cover indoor models. The newer films are more delicate than previous films and so demand new techniques to get good results.

The first step in using the plastic films for covering is to make a covering frame. Basically a covering frame is a pair of rails that the covering is glued to that hold the film while a structure is lowered onto the covering. A method of adjusting the rails in relation to one another is needed to produce the slack that allows the structure to be covered without the film being too tight. Any simple system to allow one rail to be adjusted will work. One method is to use 1/4" x 1 1/2" X 24" hard balsa rails that have two slots cut into each of them 2" from each end and in the middle of the 1 1/2" face. The slots are cut to be a tight fit for 1/4" X 1/2" X 7" spreader pieces that tie the two rails together. Once the rails have the spreader pieces inserted into them the position of the rails can be adjusted by simply pushing the spreaders into or out of the slots until the desired film slack is achieved and any diagonal wrinkles are removed. A better but more elaborate system is to build a pair of rectangular frames from 1/8" X 1/2" X 35" as shown in the diagram. These are joined by 1/8" X 3" X 7" hard balsa crosspieces along the bottom only. This leaves the upper rails of the frames very flexible. A set of five turnbuckles are used to adjust the width and diagonal tension on the upper rails. These upper rails are the ones used to hold the film. Three of the turn buckles go across the frames, one in the center and one at each end. The other two turnbuckles are set up along the diagonals of the frame and are used to adjust the diagonal wrinkles out of the film. This frame is more permanent and more versatile than the frame first described, although both do a good job.

Getting the film off of the card tube is not a trivial job, especially the new Y2K film. Gene Joshu discovered very recently that if you unroll the film out onto a large piece of the foam rubber used in furniture upholstery a very large part of the static that plagues this material is eliminated. Once the film is unrolled to the desired length a piece of cardboard is placed under the film at the desired cut off point. A hot soldering iron of about 15 watts is recommended for film cutting and trimming. Once the film has been cut you can further eliminate static by gently wrinkling the film by rolling it up into very loose ball about 3" in diameter and massaging it gently with the fingertips for a minute or so. Do not roll the ball too tight, this can ruin the film by bursting small air bubbles. Gently and slowly unravel the film onto a smooth matte surface such as a piece of cardboard or Formica. If you are using the new Y2K film you must go very slowly and be very careful not to pull too hard on any one bit of film since this film will tear very easily. Your fingers must be absolutely clean and glue free or the smallest bit of glue on them will start to tear the film. The same is true of all the other items that may touch the film. To help spread the film out evenly and to get the air out from under it you can blow very gently down onto the film, forcing the trapped air out. This job is finished by smoothing the film out with a very soft watercolor brush, or a mascara brush. If a drafting brush is used you must be careful to always draw the brush with the bristles sweeping back. If this type of brush is used with the bristles being pushed the ends of the hairs will tear many small holes into the film. Work with the film until it is well flattened and looks tight with no wrinkles. It is now ready to have the frame glued to it.

The glue that works best for attaching the film to the covering frame is the Prang Glue Pen from Office Depot. This is a very slow drying liquid glue that will allow a small amount of adjustment to the edges of the film to help you remove wrinkles. Glue stick can also be used if the area of the frame is not too large. Once the film is attached to the frame the whole thing is turned over and inspected for diagonal wrinkles or loose spots. Small placement corrections can be made by sliding the film on the still moist adhesive. The object is to get the film tight and wrinkle free on the frame before you use the adjustability of the frame to get the needed slack in the film. An inch of extra film on the outer side of the rails will make these placement corrections easier.

Now that you are ready to cover the model there are some things you can do to make the covering job better. If you are covering a very light structure like an EZB wing you will want to add a handle device to

hold the wing spars straight and so that you will have something to hold onto as you place the wing into position on the film. This handle is constructed of a piece of 1/32" X 3/4" X 18" medium balsa with 1" balsa fingers spaced to hold the spar between the ribs. The ends of the fingers are glued with a very small dot of ambroid cement to the trailing edge spar. With six or seven fingers the spar will be very straight, The ribs will hold the front spar straight since the back spar is straight. The handle is glued with a slight droop, like the flaps on a conventional plane. This will allow you to easily place the wing onto the film with precision.

Now you place the wing onto the film without any adhesive to see if there is enough slack to allow the leading and trailing edges to meet the surface of the film. If it is too tight the wing will just rest on the top of the ribs. If it is too loose the covering will have a great number of wrinkles, especially at the tips. Adjust the frame rails so that the entire wing rests on the film. It is better to error on the side of having the film too loose. The wing is now turned over so that the glue can be applied to the top surface. Before the spray is sprayed you must cover the handle and fingers with drafting tape so that the spray is not applied to the handle.

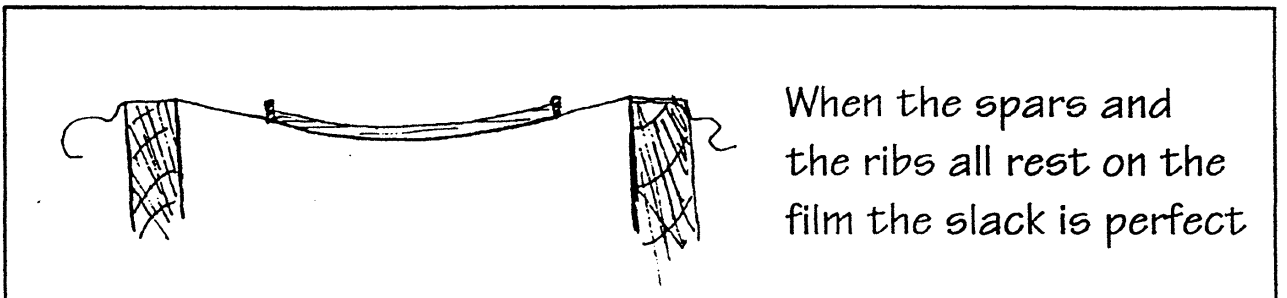
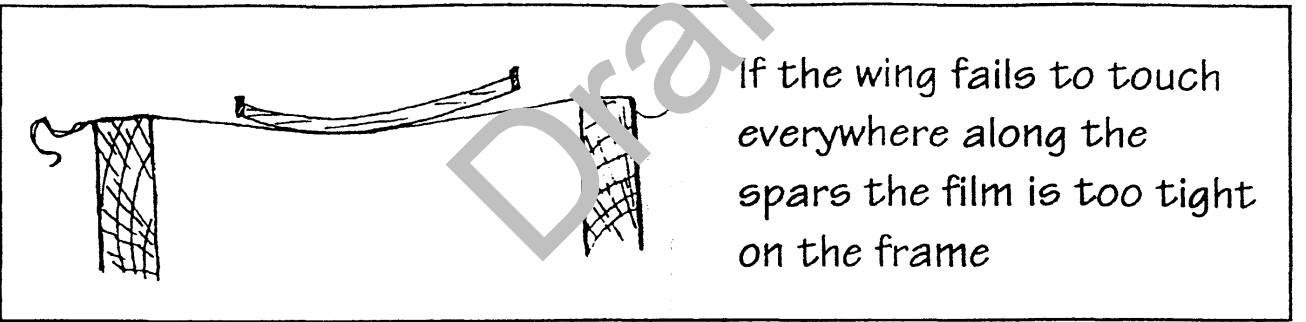
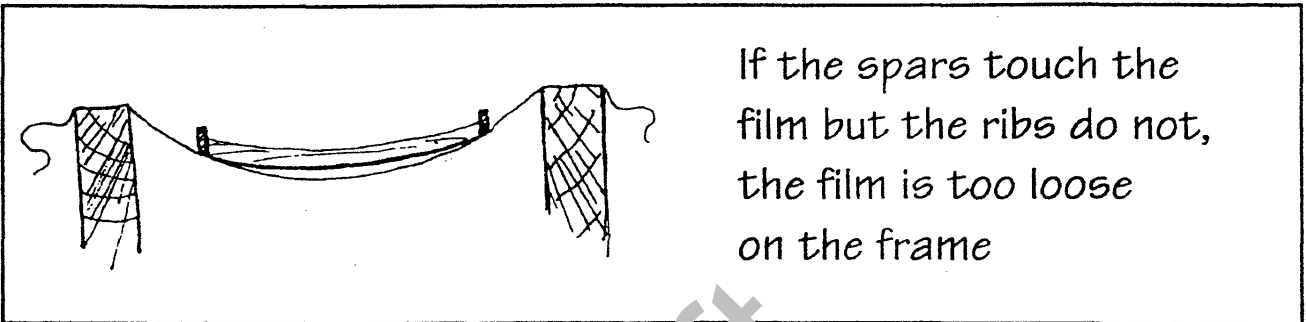
The adhesive of choice is 3M #77 Sprayment, buy the larger can since it is much less expensive this way. This stuff is very sticky, do not use it near anything you do not want to stick things to. To apply the spray to the wing you need an area with a dark background and strong sidelighting. This will allow you to see the spray as it floats on the Holding the wing by its handle in your left hand, spray a small cloud of sprayment into the air and immediately pass the wing through the cloud so that the top of the wing picks up the spray. Repeat this step several times until the entire wing is thoroughly covered. You can test any questionable area with a small ball of scrap film. Just touch the ball of film onto any parts of the spars you think may not have enough spray on it. If the ball show any tackiness that area is OK. Once the wing has been sprayed take the drafting tape off of the model. Do this by holding the wing vertically by the handle and pull the tape down across itself. This will automatically pull off the drafting tape from the fingers as well.

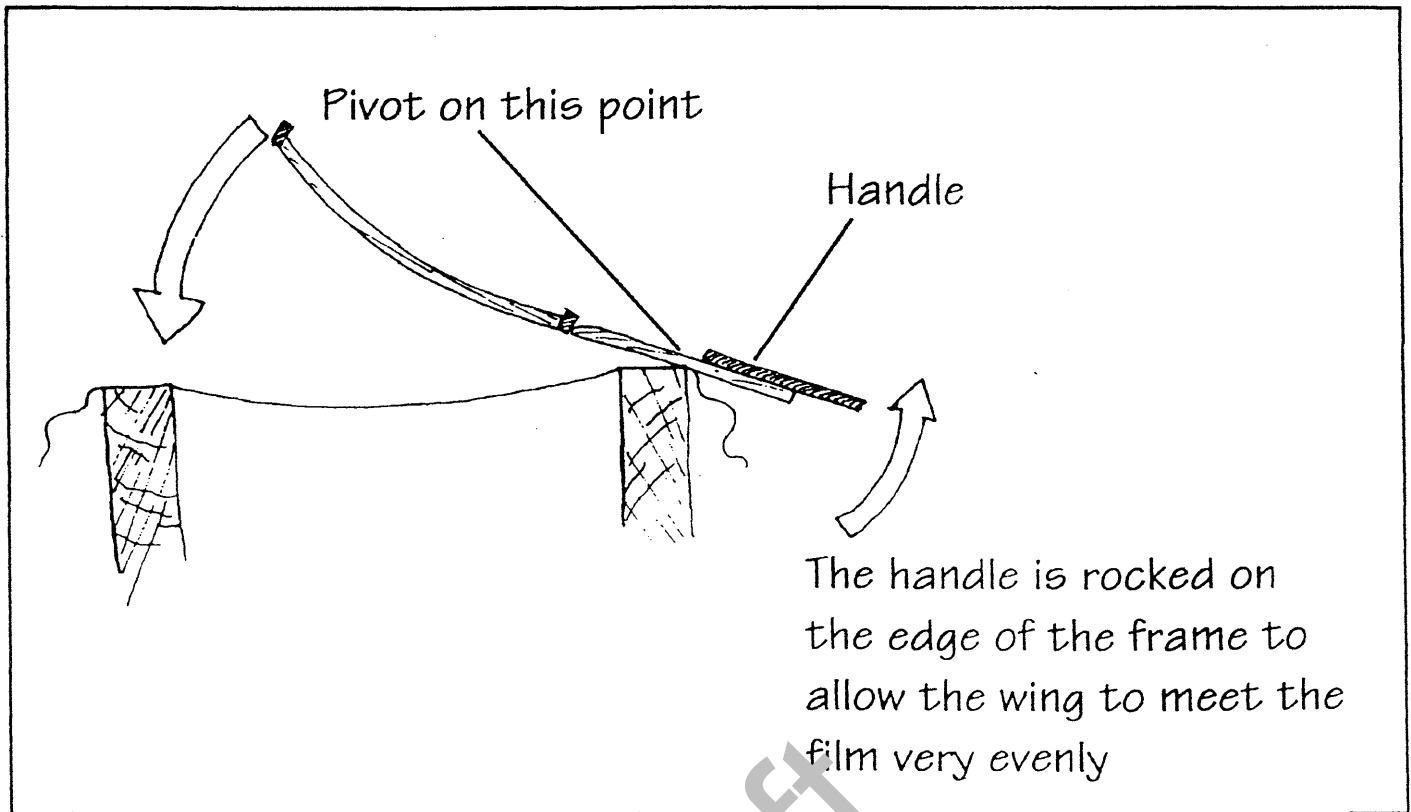
It is best to get the wing onto the film fairly quickly once you have sprayed it with glue. Since you let only the very finest glue particles settle onto the structure this glue can dry out pretty fast. As long as you can get the wing onto the film in four or five minutes you will be fine. The covering should be done in an area with very good light so that you can tell just how to place the wing. Be very careful to put the wing onto the film right where you test fit it before gluing. Use the handle to get it just so before letting it touch the film. One good method is to rest the fingers of the handle on the rail nearest you with the wing tilted up and clear of the film. The handle is then slowly raise which lowers the wing down onto the film. Remember that you will not be able to easily lift it once it is down so position it carefully before you put it down onto the film. A possible error is to let a tip or one end of a spar touch in the wrong place and then try and force the wing back into place. If this happens you can lift the wing back off of the film by using a small clean brush with clean acetone to unglue the offending area. Placing the wing on the film is not that difficult, it just needs to be done carefully to get superior results, with the wing in place on the film you can gently push any parts that are not attached well down onto the film surface. Simply run your finger around the outline to make sure you are down everywhere. Look carefully and gently poke here and there until you are certain that you are attached everywhere. If there are any areas that you simply did not get any glue on you can take a solution of rubber cement thinned with the proper thinner and fix it. By using a very small, soft paintbrush you can apply a very small amount of glue to fix the offending area. The cement should be extremely thin, perhaps 10 to one or thinner. Any area where you had to use this extra glue you must allow to dry for a good while before the next step. If you do not need to add this glue anywhere you are ready to trim the wing.

A very low power soldering pencil is a good tool to use for trimming the new films. Do not use a medium or large iron as this will have too much heat coming off of the element. This can tightly shrink the film in very localized places and really mess things up. I use a 12-watt iron and often have to unplug it for moment or two to keep it from getting too hot. Also, never trim from under the film as the heat will rise and the film may collect hot air underneath until something goes bad. Trim from above and keep the iron moving. When the film is trimmed from around the wing several small tabs of film are left uncut to hold

the wing in place. Once the majority of the film has been trimmed from the wing outline these tabs can be trimmed with the iron while the wing is held by the other hand. This way when the wing comes loose from the film it will not shift and reglue itself to the remaining film on the frame. Clean the tip of the iron frequently during your covering sessions to insure the very best cutting action.

Once you have the wing trimmed all the way around you can give the outline one last very careful inspection. You are looking for anyplace that the film is not attached. If you find any areas that need it you can use the thinned cement to fix them. Use this glue very sparingly. Allow the wing to dry completely so that if the wing touches some other film covered part in your model box it will not stick to it. The above method will work with stabs and other flight surfaces on typical indoor models. Most structures other than the EZB wing do not need the handle to straighten then, but it is a very good way to get any structure down onto the film with good control. I beats the method of "dropping" the structure onto the film and is very much better than trying to use your fingers.





---

The following was not part of the original article:

I personally do not use the technique of rolling the film into a ball as I find it easier to just roll the material out flat onto an anti-static treated piece of cardboard and attach it straight to a frame from there. I was talking with Gene Joshu (the supplier of Y2K film) at a recent contest and on the newer Y2K2 film the crinkling technique is NOT recommended as the film is too likely to get holes from trapped air bubbles popping. Editor

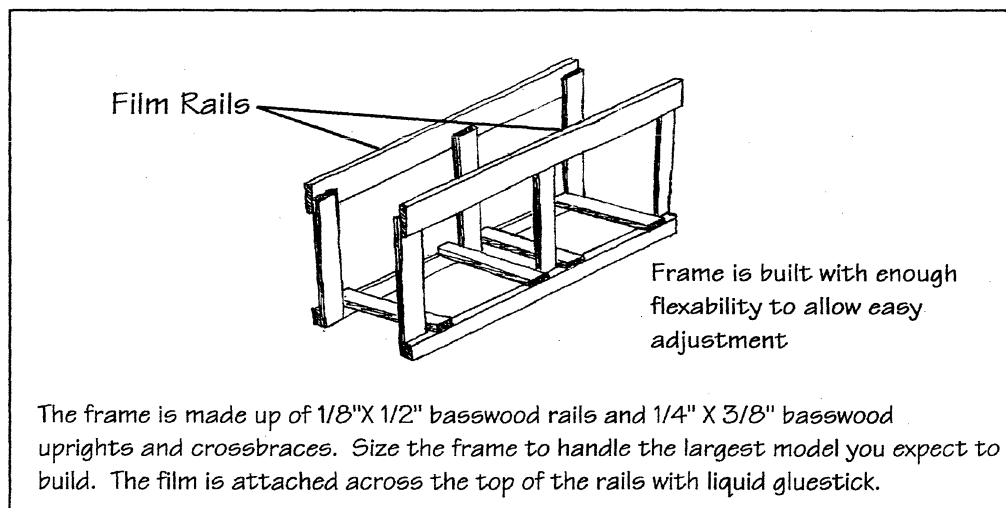
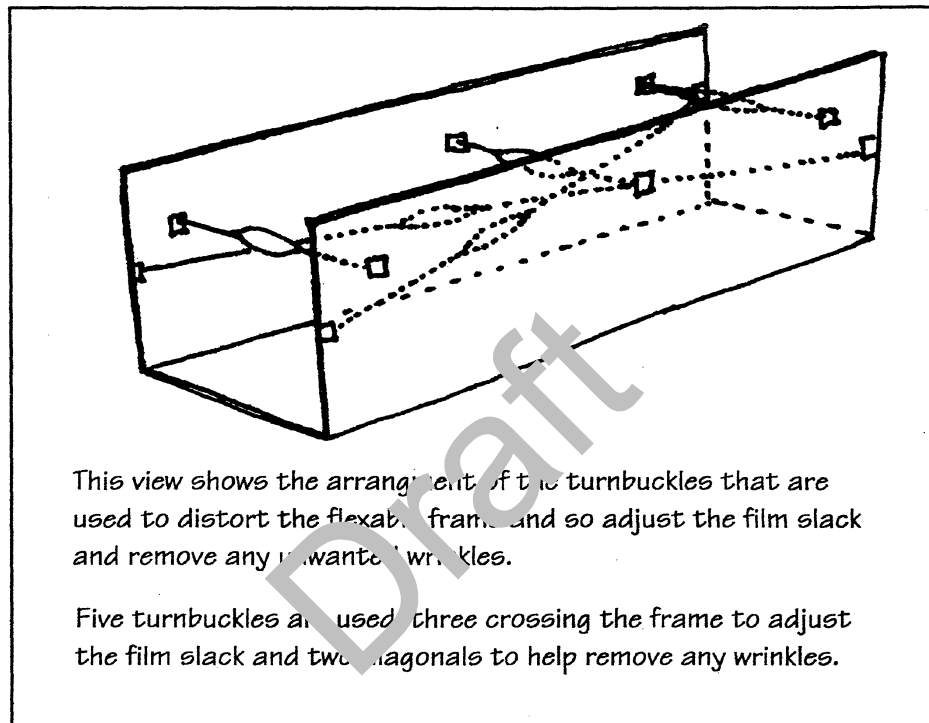
## Adjustable Film Frame

Larry Coslick

This view shows the arrangement of the turnbuckles that are used to distort the flexible frame and so adjust the film slack and remove any unwanted wrinkles. Five turnbuckles are used, three crossing the frame to adjust the film slack and two diagonal to help remove any wrinkles.

Frame is built with enough flexibility to allow easy adjustment

The frame is made up of 1/8" X 1/2" basswood rails and 1/4" X 3/8" basswood uprights and crossbraces. Size the frame to handle the largest model you expect to build. The film is attached across the top of the rails with liquid gluestick.





## How To "Handle" Ultrafilm Covering Jobs

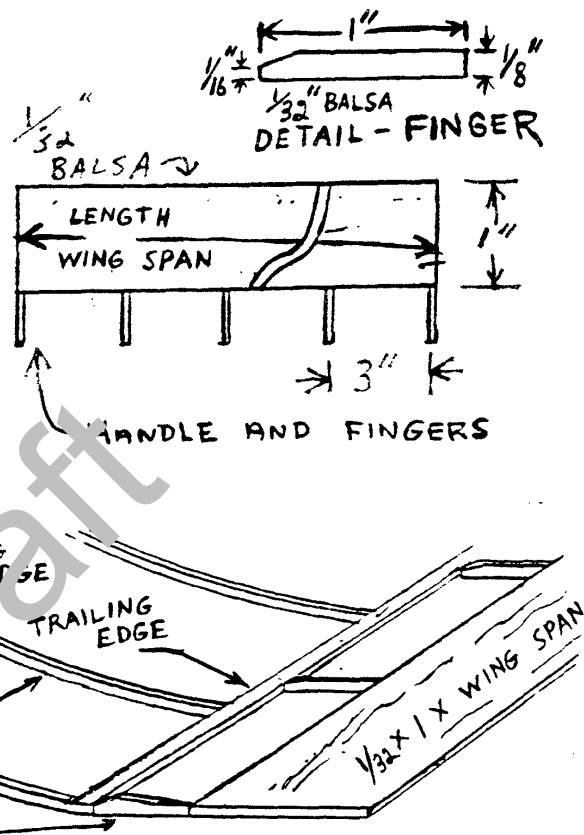
Larry D. Coslick

First published in The Turbulator of St. Louis MO. I attach a handle to wing and stab outlines for all my Ultrafilm covering jobs. It keeps the trailing edge straight and gives me complete control when I place the outlines on the film. It works best on large wings and very light stabs. All outlines are covered flat and any dihedral is added later.

### MAKING THE HANDLE:

Make the handle from a piece of 1/32 medium sheet balsa 1 inch wide and as long as needed. Make the fingers from 1/32 sheet, 1/8 X 1.25 inches long, and attach to one edge of the handle 3 inches apart. Using a straight edge, trim the fingers precisely 1 inch long and taper the finger tips to 1/16 inch. The handle is now ready to use.

Using any flat surface and wax paper, invert the outline, and slide the handle, centered on the span, up to the trailing edge (TE). Using a fine marking pen mark the position of each finger on the TE. Now place a small dot of thinned carpenters' glue at each finger location and also on the end of each finger. Let it set about one minute. Using weights hold the handle in place then connect the fingers to the TE glue points. Again, a few weights on the back side of the TE will hold it in place. Prop up the leading edge (LE) 1.5 inches for an EZ-B, more for larger wings. Try to place the handle on the outline one hour before covering because it is easier to remove the handle after the outline has been covered.



### PREPARING THE FILM

I prefer using crinkled film. Take a piece of film 10 inches longer than the outline and wad it up in your hand several times. Then spread it out on a piece of Formica. You can either tape the film down taut or spread it out until all the wrinkles are gone. Then pick it up with a covering frame. I use an adjustable frame with 3 turnbuckles to slack the film and 2 diagonal turnbuckles to remove the wrinkles.

### SPRAYING WITH THE 3M 77 TYPE ADHESIVE

Protect the top side of the handle and handle fingers with Scotch drafting tape until the outline has been sprayed. The drafting tape is easier to remove than regular masking tape.

With a light behind you and paper on the floor, make a test by spraying the adhesive 5 feet above the floor and watching the mist as it falls to the floor. Now take the outline with the handle attached and spray as before and wave the outline through the falling mist, ONCE. To determine if the correct amount of adhesive is on the outline, take a 1 inch patch of film and wad it up into a ball and very lightly touch the outline with the film every 5 inches. The film should just barely stick. I have found that you can use your finger instead of the film patch on the LE but the stiffness of the TE (because it is attached to the handle) makes it difficult to determine if there is enough spray unless you use the

film patch. If the patch will not let go you have too much adhesive, release with some acetone on a small brush.

### PLACING THE SPRAYED OUTLINE ON THE FRAME

With the tape removed and having predetermined where the outline best lays on the covering frame, lay the handle fingers on one edge of the covering frame and lower the TE onto the film. The LE should be in the air at this point, free of the film. Lightly rub your finger along the TE. Then raise the handle and the LE will contact the film. Trace the entire outline and if there are any unwanted wrinkles, push down on the film beyond the outline and loosen the film with a fine artist's brush and acetone while still depressing the film. Finally, press the outline back on the film.

### FINAL OPERATION

Remove the handle be using an artist's brush and wetting each finger where It attaches to the outline. Wait 5 minutes for the glue to soften.

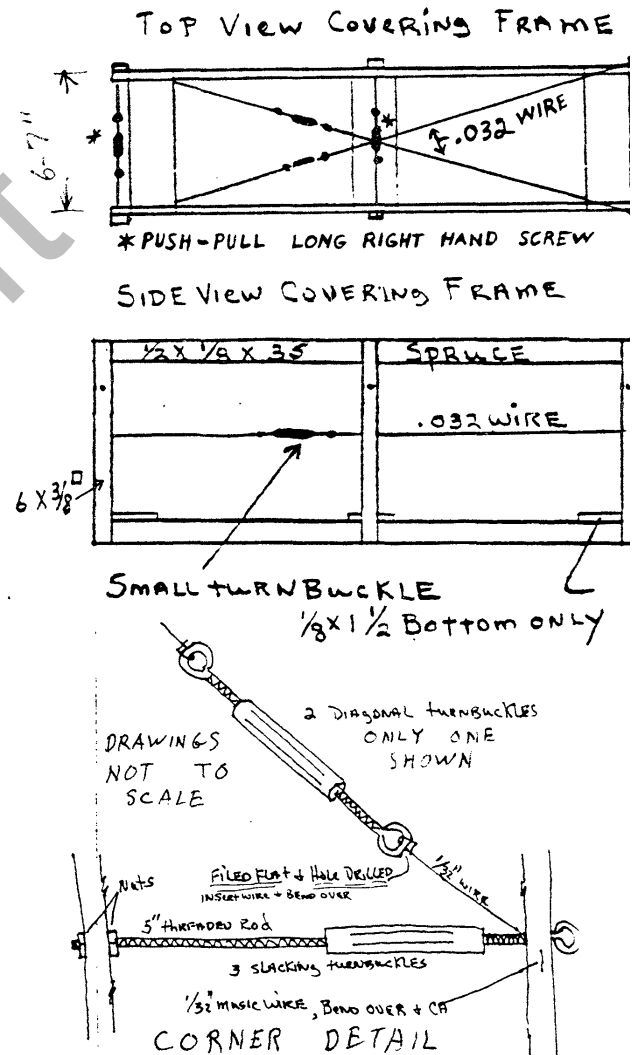
Several applications of water may be necessary. Gently raise and lower the handle until it separates from the outline. Wait an additional 5 minutes for everything to dry. My 25 watt iron will cool and possibly tear the film If the wood is too wet around the glue points. After things have dried, use the iron and make your burn in 4 to 5 inch sections and then sweep the iron away from the outline. Leave a 1/8 inch strip of film at each corner to hold the outline in place until It Is free from the film, then hold your hand under the outline and burn the 4 corner strips free.

### REMOVING SLACK IN THE FILM

After placing the dihedral the slack at the tip dihedral breaks can be removed by making a solution of 1/2 teaspoon (2.5 cc) of water and 3

drops of carpenters' glue, thinned 50/50. Using an artist's brush, load the brush with the solution and starting at the LE and on the tip side of the rib, run the brush from the LE to the TE and it will pull the loose film up against the rib. A brush that is about 1/8 inch diameter at the bristles works best.

Addendum: The three cross frame turnbuckles each have one threaded section removed and replaced with a 5" threaded rod. The end away from the turnbuckle passes through the frame upright and is held with a nut on either side. These slacking turnbuckles are only intended to pull in the sides but if extended will tighten the film. The diagonal turnbuckles are also pulling but must be loosened when new film is placed on the covering frame. It helps when burning off the film if the covering frame is a dark color instead of the natural wood color.



Easy EZB Props  
Author unknown

I used to hate EZB props. I had EZB prop envy. I would follow directions to the letter, using the best wood I could get, and end up with a waffly, wavy prop weighing around 150 mg. My props were the worst part of my EZBs and I did not like any of the first dozen or so I made. My models would kind of bob through the air as the prop shuffled along. There just had to be a great deal of wasted energy in all that wriggling around. After a while I got better at it, but I never actually liked any of my props. I had trouble getting wood I considered adequate, and I always managed to come out with wavy edged blades once the prop was finished. The blades would come off of the form so pretty and nice. Beautiful curves with perfect edges. Glue them to the spar and in a few days they were like all my earlier ones. No fun at all.

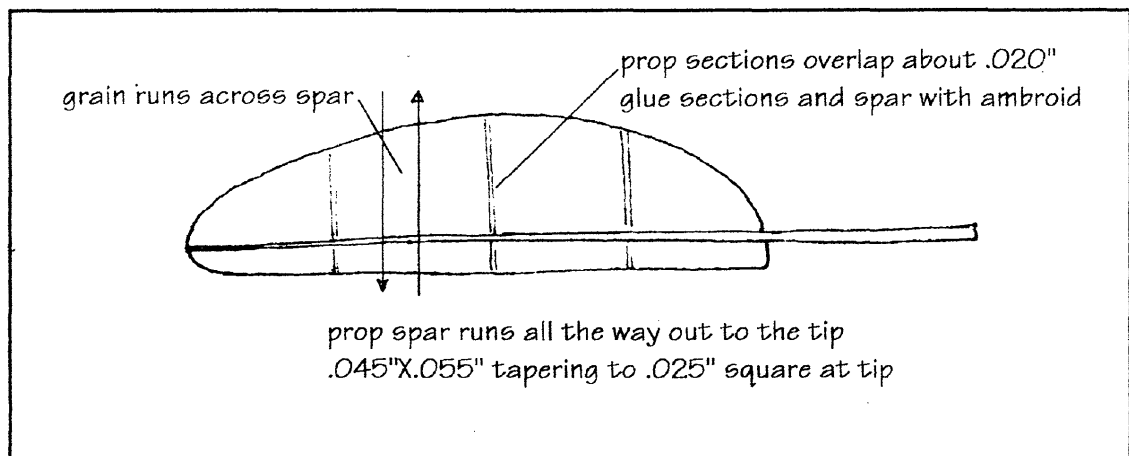
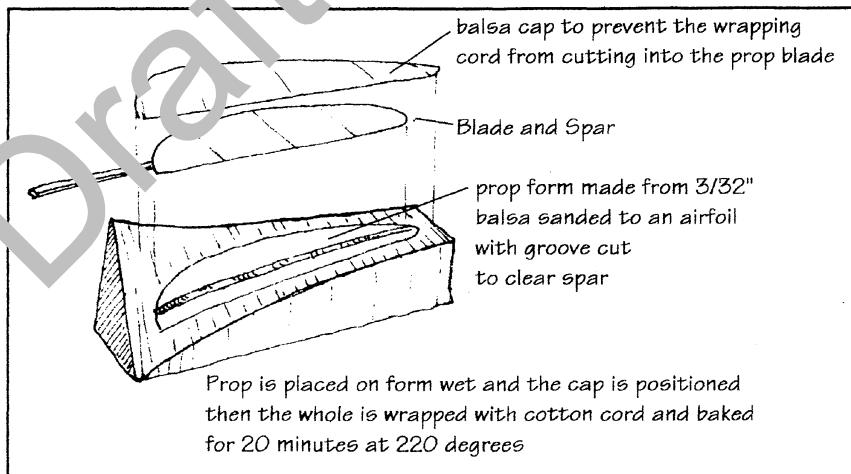
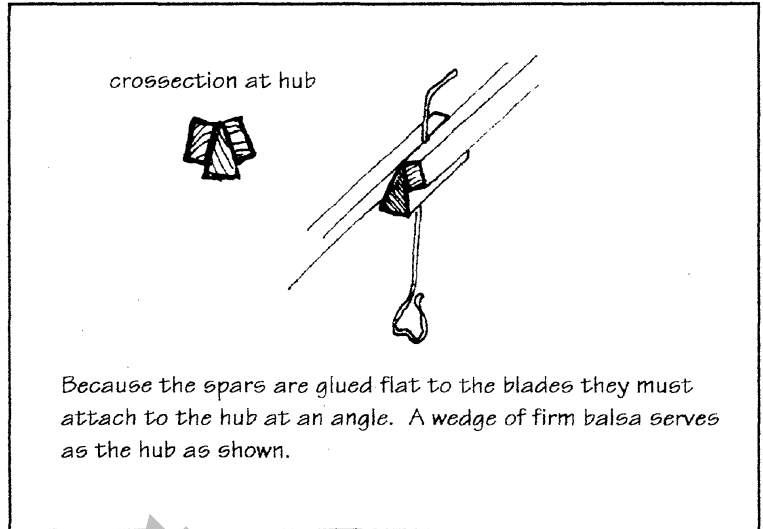
It is kind of funny how things gel all at once. At one of the regular local flying sessions Larry Coslick showed up with an EZB prop dyed red and blue. The color edges were perpendicular to the prop spar, and I gave it a pretty good look to see how he did it. It turns out he dyed the wood before he made up the prop blank so that each piece was a different color. Larry had put the grain straight across the blade from edge to edge instead of the diagonal direction. He had also used very thin A grain balsa. By using a bit more substantial spar he had gotten by with using wood you would never have considered for the prop. I had some of that stuff at home! All I had to do was to sand it to thickness. I made up some blade blanks using my regular ambroid and lacquer thinner. After cutting them out I was worried. Such flimsy things! They just could not make workable blades, no way in the world. Even if they were OK off of the form, my gluing them to the spar was sure to ruin blades this thin. So glue the blades to the spar first! Who said that! Who cares, try it. I quickly slapped the spar onto the blades using Ambroid. Normally the blades are glued to the spar with aliphatic so as to eliminate the warping from shrinkage of the glue. I figured that I was going to flatten the blades after any warping the spar gluing was going to do so I went ahead with the Ambroid. Besides, I had to use waterproof glue so that the prop blades would not end up glued to the form. I cut a quick groove into the form for the spar and made my balsa sandwich. Twenty minutes in the oven at 220 and TaDa! A very nice, pretty, perfectly formed, and obviously strong and stiff enough prop blade. My best ever blade formed from wood sanded down out of 1/32" A grain balsa. Three different ideas all tried together worked out perfectly. I made four props in the next 12 hours, each better than any I had made up until then. Average weight was 125 mg using 5-pound wood and very strong spars. I like these props. Give this method a try and see if you like it too.

Start with some four pound 1/32" balsa (100-mg props) in any cut of grain you have. If you have some really nice C grain save it for Penny Plane props. One of the secrets to sanding wood down to usable thickness is to use very coarse paper to start with and do not push hard at all. If you start with too fine a paper you will have to press down pretty firmly to get it to cut fast enough. This compresses the wood fibers and drives up the density. What you get is five and a half pound wood that makes a heavy prop. If you use a very coarse paper and very light pressure you will keep the density down and the prop light. You still finish up with very fine paper, but NO pressure. A block with 280 paper using a pair of wraps of masking tape to space the face of the paper above the board makes a nice tool for getting the wood to its final thickness. Once you start sanding the wood you need to be extra careful not to crunch the wood. Sand in one direction, away from the hand holding the sheet against the table. Let the tooth of the paper do all of the cutting do not press down! Balsa this thin is very much like a bundle of drinking straws. If you push down on the bundle you will collapse the straws and so crease the walls of each tube forming a flattened oval. Not only will the density go up, but also the collapsed tubes will have less stiffness and the wood will be very limp. To help "revive" the wood he sands, Larry Coslick has a trick where he washes the wood after sanding. This removes the imbedded balsa dust from the grain and helps expand the tubes the wood is composed of back to their original shape. He sands down to about .006" and after washing the wood returns to about .008" and is quite a bit stiffer.

Once you have some nice wood sanded (it will seem far too limp, but do not worry) you can go ahead and use your prop template to make the prop blanks. I use very thin Ambroid to glue the sections together, overlapping them about .020" or less. Cut the spars to size and glue them into place with the same thinned glue. Be careful not to use too much glue here, and to not get glue where you do not need it. You will find that gluing the blades to the spars before they are formed is much easier to do than the regular way. Note that the spar runs out to the very tip. This is necessary due to the direction of the grain of the prop blank. Let the prop halves dry before putting them onto the form.

You will need to cut a groove for the spar in the camber form you are going to use on the prop form. Be sure it is deep enough along its entire length. Wet a prop half and place it onto the camber form, then place the camber form and the cap used to prevent damaging the blades onto the prop form and wrap with carpet thread. Bake the whole thing in a 220-degree oven for around 20 minutes. Let the form cool a bit before unwrapping the prop half. You should have a very nice looking prop blade with just a bit of curl (like the prop is under a load) and perfect pitch twist. Make the other blade and join using a wedge as shown in the illustrations.

The resulting propellers will hold the blade twist very well and the blades made this way are very close to identical.



Issue 94 1998

## Use All the Air, But Not the Ceiling

By Larry Coslick

In my opinion, flaring props are the way to fly an EZB at Johnston City. When they are right, the model can get very good no touch times. The idea is to make a long, slow climb to the main beam, go into a long cruise, and then a slow decent. The flaring of the prop slows down the initial RPM and climb. Because early, stronger turns take longer to use, the climb is longer. When the model is torqued properly it will take about 13 minutes to reach the main beam or slightly above it. It will cruise for another 4 minutes and hopefully avoids a mid-air and lands with the winning time.

A flaring prop can use more rubber effectively than a symmetrical prop can. You need the wider cross section to give the cruise torque and let the flaring prevent too high a climb. I use a motor approximately 18% heavier than the weight of the model. My model weighs .53 gram and the rubber weighs .62 gram. Motor stick length compared to rubber motor length is also important. For my style of flying, an 8.5" M/S is just right with a 13" loop of rubber. 7 to 7.5" M/S models max out at about 27 minutes, you simply can't get the long cruise and let down with a short stick and long loop of rubber because the cruise torque is not high enough.

Light EZB's really like flaring props but they are a little harder to trim at full power (.12 to .13 in. oz. of torque.) I rarely launch above .12 in. oz., because these light props are easy to overpower. They will usually flutter when launched above .14 in. oz. If your model weights from .5 to .6 grams and you have to launch above this torque, your prop is probable over pitched, its flaring too much, the rubber motor is undersized, or the model is out of trim. Don't think that by using a lighter motor your times will be better. The rubber has to be matched to the prop.

Flaring props are not hard to make, but you might have to make several to get a really good one. The magic is in the prop spar. A 12" spar with a .009" wire shaft should weigh no more than .035 grams. Build a deflection meter such as the one in the INAV issue #90, of the Hobby Shop EZB article. Assign the prop a number and record the deflection of the spar in both planes. Making prop spars is matter of trial and error. Start by making the spar, .040"X.065", tapered to .025" sq. at the tip. The prop blade outlines that I use are shown in INAV issue #85. They are made from .006" C grain 3.8 pound wood. Two blades will weigh about .075 gram. Use thinned aliphatic (yellow) glue when attaching the blades to the spar. Acetate type glues will continue to shrink, distorting the blades or changing the pitch angle. Prop flair is controlled by the position of the blades on the spar. The one that I use at Johnson City and the Kibbie Dome, has the spar mounted 1/4" from trailing edge of the prop blade. Try different spar locations to get the amount of flair needed to control the climb.

If you are not satisfied with the way the prop flares, soak the blades off with water. There will be a small white patch on the spar line of the blades, where the glue was applied. Take a soft toothbrush and carefully brush away any remaining white glue, while the blades are still wet. Make a new spar and adjust the wood sizes according to whether you want more or less flair than before. Reform the blades before you put them back onto the new spar. I don't bake the blades when forming them, but air-dry them for several days.

My Akron Light EZB requires a fairly stiff tail boom. I still consider the boom of a good EZB to be part of its magic. The wing of this model must have about 1/16" to 1/18" wash in on the right wing panel. Stab wash is not needed on this model. Launch attitude and forward motion during the launch play a big part in the release of the model. The model needs to be launched slightly nose high. I usually launch my models with the prop and thrust bearing between the fingers of my right hand. I move my hand forward releasing the prop and model at the same instant. I don't believe in wasting turns when launching my models.

For safe, no touch flying you must know the exact launch torque each time the model is released. First of all, use O rings. They keep you from losing turns when transferring the motor from the torque meter to the model. You can make them from plastic Q-Tip sticks or ABS tubing from a model

railroad hobby shop. Cut them about .020" with a single edge blade. Don't worry about the sharp edges, they don't cut the rubber motor. If your winder does not have a breaking system put one on it. After the motor is wound, there needs to be a device that holds the winder so that the motor is about 1/2" shorter than the distance between the prop and the rear hook. By being shorter, this helps eliminate grape vining when loading the rubber motor on the model. This device should be adjusted for each different length motorstick.

Work your way up to the ceiling. It's amazing how much a 2/100 in. oz. increase in launch torque will effect a light EZB when its 25 feet from the ceiling. It will put my model into the steel every time. During the practice session at Johnson City, put a balloon up to 50 feet. This will simulate a flight just under the main beam using a 1/2 motor Get your model to climb to the top of the balloon. If there are no other models in the area of your EZB, move the balloon close to the model and have someone looking from the side determine the models height.

Indoor flying is not and probably never will be an exact science, but the closer we pay attention to small details the better are times will be.

Draft

Issue 43-44-45-46 1989

Flying Airlines With Models  
Likely by Richard Doig

Carrying indoor models when flying airlines can be your worst nightmare, but it doesn't have to be. I have flown airlines, three times with FID models, with no significant damage. Here are several approaches to getting to the contest with intact models.

**BY CAR:** The first is obvious. Find out if another modeler is driving, and have him take your models. Even if you have to drive five hours to deliver them, it might be worth it. But this is a rare situation so let us concentrate on packaging.

**AIRLINES:** The standard airline rule for carry-on items is length + width + height must equal 45 inches or less. Some airlines break it down to: Maximum length 23"

Maximum width 13" Maximum height 9"

In fact, this size box will fit in most overhead compartments and will be allowed with no problems. The problem occurs when you need to take something larger.

American Airlines Customer Service people in Detroit have been very cooperative with me over the years, allowing me to go on board several aircraft during cleaning to measure the overhead compartments. Other airlines may not have the identical compartments, even in the same model of airliner, but you have to start somewhere.

The main thing you notice is that the compartments are considerably longer than the 23" maximum length. This is important since a 9" high x 13" wide box can accommodate (2) Intermediate Stick or (1) FID if the length is increased to about 28" to 30". Most of the FID flyers arrange to hand carry one model this way, along with their best props, and send the rest through baggage, arranging for special handling.

**CARRY ON MODEL BOX:** An overhead compartment box must be light weight. I built mine from a material called foam-core, available at art stores. It is a 3/16" thick layer of dense plastic foam, with a layer of clay coated paper on either side, making a 1/4" thick sandwich. The material can be scored, notched, and folded into shape. You just glue with white glue or hot glue gun, using 1/4" balsa reinforcing strips, and tape the joints using 2" wide white duct tape. I also use duct tape for the hinge, and duct tape as the latches. I cut the box open at the site, and re-tape it for travel. This produces a package with nothing sticking out, and a maximum of room inside. I also made a 4" x 6" cutout in the lid, and taped a piece of flat transparent canopy stock over the hole to make a window that is only 1/16" thick. This box carries one Garfield FID model, with a 10 1/2" chord wing, in a package only 8 1/2" x 12" x 28", and fits nicely into the overhead on American Airlines DC 10's and two versions of 727's. It will fit under the seat as well if necessary, but it's really cramped. (No room for my feet!) It weighs just over 2 pounds, so there is no concern about having it overhead.

Most airlines are now very strict about a maximum of two carry-on items per person (other than purses and cameras). Don Godfrey has made a novel carry-on box for two FID models, where each model is in it's own box, and the two boxes hook together with velcro into one piece, but split apart to fit through the opening into the compartment. The handle is also removable. This arrangement may allow you to get additional models through carry-on since many overhead compartments will hold a larger box than will fit through the door into the compartment.

Since the airlines will not allow boxes to be packed in the containers used for garment bags, you build a foam-core box inside a garment bag. This method works well with models like Easy B or Scale, and works with braced models if you use folding wing posts. With folding wing posts, even the largest microfilm model will fit in a 4 1/2" thick box, and into a six inch thick garment bag. You attach the hanger to the end of the box and put it into the bag and maybe even put your suit in the bag too. Make sure that you build some vertical support posts inside the box near the center, so if someone jams another garment bag into yours, they don't crush the sides of the box into the models.

**TOOLBOXES:** Finally, carry your tool box with you, and disguise it. My toolbox is a small 8" x 8" x 16" plastic tackle box. I put the toolbox inside a locker bag, stuff my skeins of rubber around it, and hand carry this bag. I put it under the seat. If it looks like a toolbox, it will get searched. If it looks like a locker bag, and nothing suspicious shows on the x-ray, it will zip right thru. Security people are very concerned about flammable liquids and will not allow them as carry on. If they search the box, glues, solvents, film solution, and CyA glues will have to come out. I wrap these in elastic wrap, aluminum foil, and paper towels inside a sealed box in my luggage. This is the only way to insure that you won't end up having to throw them out at the security checkpoints, and find yourself with no glue or solvents. But this seems to vary widely from airport to airport.

Also, carry a small pair of scissors, and small X-acto knife, so these cannot be argued to be weapons. If you are unsure, take you toolbox down to the airport, stop at security, and tell them that you will be flying in a couple of months, and ask them to search your box for anything that might be a problem. You'll probably find them to be very cooperative since you are taking the trouble to contact them in advance. Any item that makes them nervous, replace or pack in your luggage.

**BAGGAGE SERVICE:** If you must send a box through baggage, American Airlines offers Escort Service, where the box is hand carried from the gate, and delivered to the gate at the destination. Manny Radoff & Sal Cannizzo have successfully used a similar service from United Airlines. Don Godfrey has had bad luck with Northwest baggage, where they destroyed one of his boxes.

American charged \$25.00 per plane change the last time I used the service, and requires advance arrangements through the American Customer Service office at your departure airport. Tell them you have an escort bag with very fragile contents. Ask them to notify the agent on duty for your flight, as well as the agent on duty at the destination airport. Be sure to get the phone number of the Customer Service office at the destination as well. Always ask for names. Contact them about three weeks before your flight, and then again one or two days before. Arrive early, and have your credit card ready as they write the bill at the gate, not at the normal baggage check counter. If you have to change planes, you must go through this routine at the changeover airport as well, collecting the box at the exit of the first flight, and going through the routine again at the next flight. When you get the box back at the gate, do not let them tear the escort tag off of the box. If you do, and then go to collect your other luggage, you may not be able to get the escort bag out of the airport. Save the check tags. The box must be small and light enough to easily carry up and down a flight of stairs. It also helps if it looks like a professional carrying case with something expensive in it. A plexiglass panel is a must, so the box can be inspected without opening it, and on my box you can see the panel if you slide the box out of it's Naugahyde (vinyl coated fabric) cover. The sides are marked with the phrase "DELICATE INSTRUMENTS", with the phrase "DO NOT DROP" on the top, next to the handle. I also have "up" arrows on all four sides. The box rides inside a 3/4" thick layer of spongy styrofoam, inside the fabric cover. It's 21 1/2" x 12" x 28 1/2" with the cover, and weighs 11 1/2 pounds. The box bolts shut with 8 nylon screws, so no-one can open it without a lot of effort. It carries three F1D models using plug on tails and one wing with folding posts.

**MODEL MOUNTINGS:** No matter what kind of box, the mountings for the model parts are very important as well. Wings will stay put better if they are mounted in wing sockets, rather than just plugged into holes in blocks of wood. With microfilm models, arrange the parts so if the film flexes wildly, the outlines bump into the bracing wires on the adjacent parts, rather than the film covering hitting anything. Allow for the covering to flex as much as 1 1/2". This is how far one wing flexed when I flew airline in 1988, and the microfilm hit a wing socket and punched a hole in the film.

Following these tips should increase the odds that your models will arrive intact at the contest.

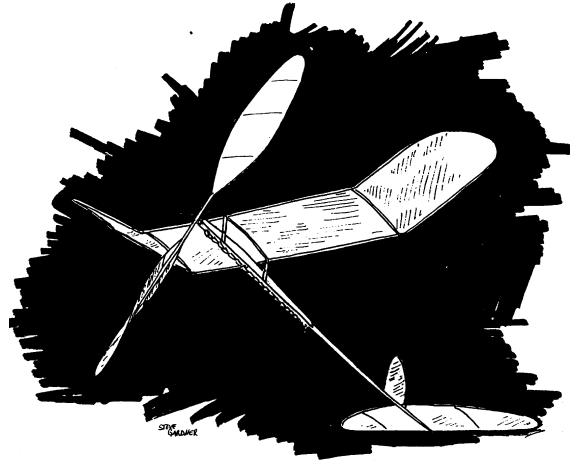


## Hobby Shop EZB

by Larry Coslick

Illustrated by Steve Gardner

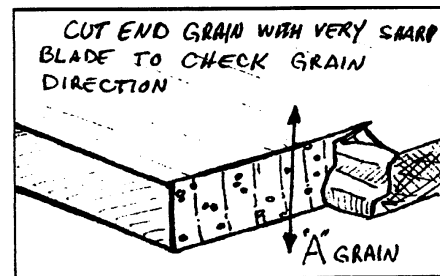
This building and trim article is intended to help the new modeler eliminate some of the frustrations when starting out in this fascinating hobby. It is a detailed description of my methods for constructing an EZB. The prototype was built entirely from hobby shop wood, and was quite strong at .61 gram. Following these directions this EZB should come out weighing less than .75 grams using only wood available at your local hobby shop. At this weight the model could fly from 22 to 25 minutes in a high ceiling Site. For a new EZB flyer this is a very good performance.



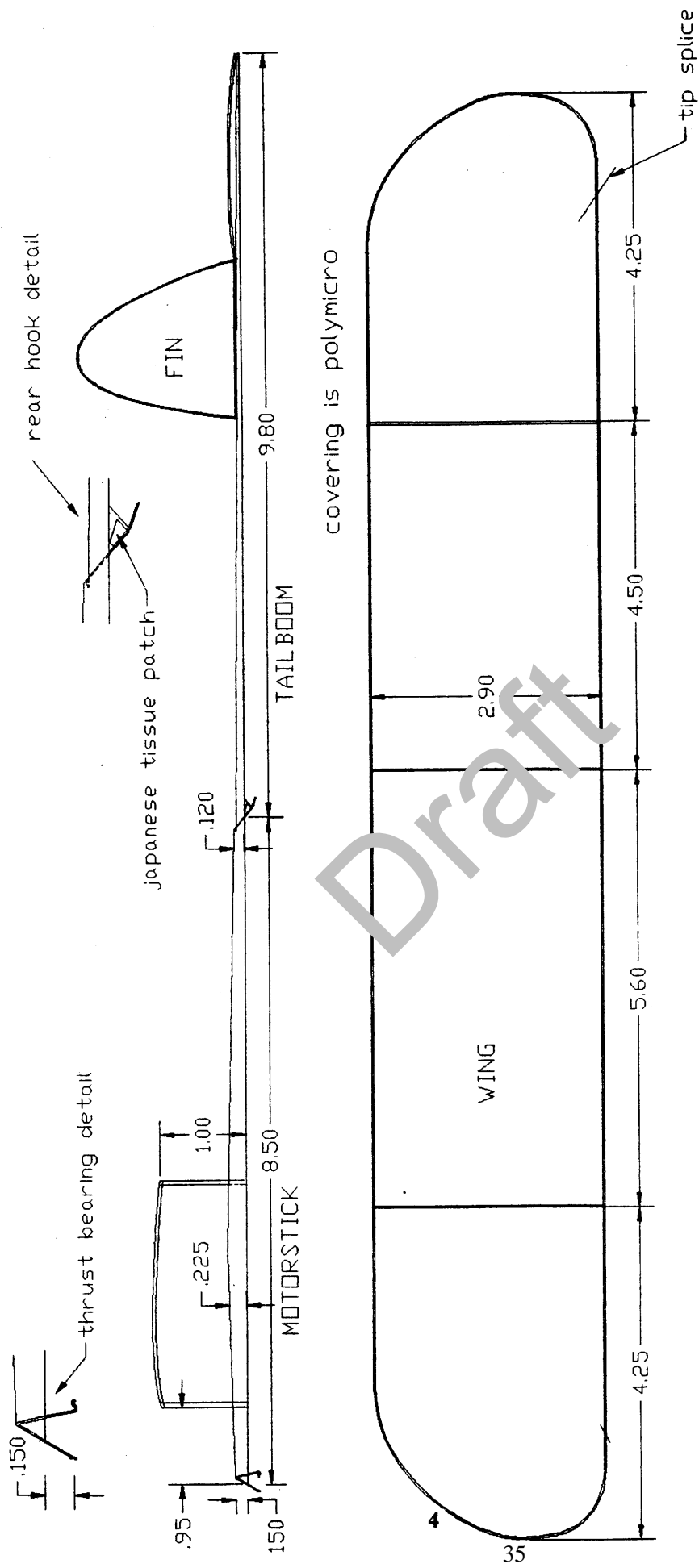
### Balsa Selection

The most important part of building a competitive EZB is the selection of the proper wood for each part. The wood is available at any hobby shop with a fair selection of balsa sheet. Special indoor wood is not needed. The wood used for the prop blades may be a possible exception.

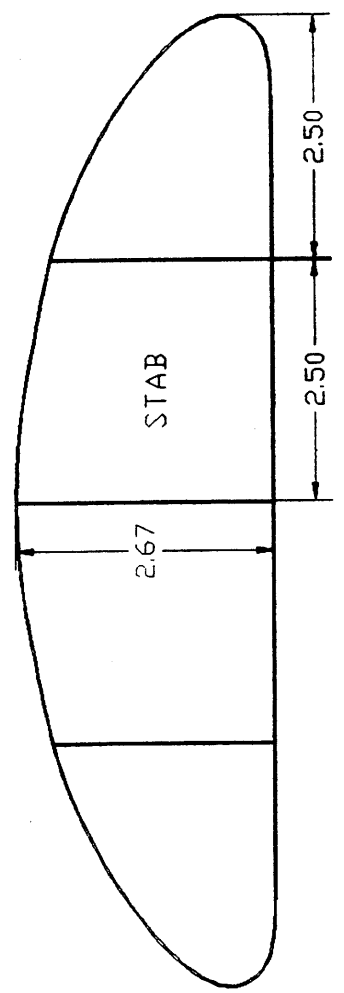
The first consideration when choosing wood is weight. The density, or weight, of balsa is measured in pounds per cubic foot. We say a certain piece of wood is "six-pound wood", and on some plans it may be marked "6# wood". Each component of an EZB is made from a certain weight wood. The very lightest wood is about 3.5 to 4 pounds per cubic foot. Wood with a weight of about 5 to 6 pounds per cubic foot is much easier to find at an average hobby shop, so this EZB is made mostly from this wood. Take a postage scale to the hobby shop and check each piece before you buy it. To check the density of a piece of wood first weight the piece to find its weight in grams. Then find its volume by multiplying its thickness by its width, and then multiplying that number by its length, in inches. We are mixing units here, but grams (metric) are easier to use for weight, while inches (English) are still what everyone used for small measurements. To use these together we take the weight in grams and divide by the volume in inches, then take that number and multiply by 3.81 to get pounds per cubic foot. A piece of 1/16 X 3 X 36 wood in the 5 pound range will weigh about 8.9 grams and a six pound piece about 10.6 grams. By figuring out what the wood will weight in a certain size sheet you can use a postal scale right at the balsa wood rack in the hobby shop to choose wood. You should buy "A" grain wood for EZBs. (see drawing)



Because the density of balsa wood can vary a great deal in any given sheet of wood the next step is to hold the sheet in front of a swing arm lamp with at least a 40 watt bulb. Turn off all the other room lights so that you can see the light coming through the balsa better. The wood will have a brown color that is lighter where the wood is the lightest in weight. The wood that you want is the lighter streaks or sections of wood that the most light is coming through. Mark these areas with small dots from a felt tipped pen while holding the wood up to the light. When you look at the wood when you turn the room lights back on you will probably notice that the wood you have marked is very light in color, almost white, and that it shows almost no grain at all. The areas marked are not usually very wide, yet you will not need much for several sets of wing spars, or ribs etc. When you cut these very small areas out leave a half an inch or so of darker, heavier wood to serve as a handle for the good wood. This will make cutting spars and other

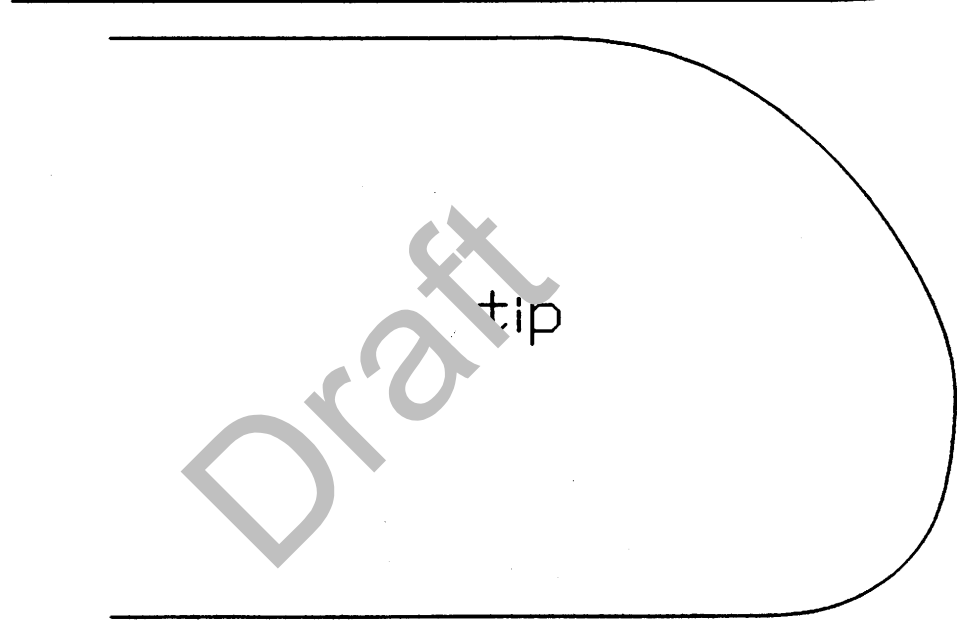
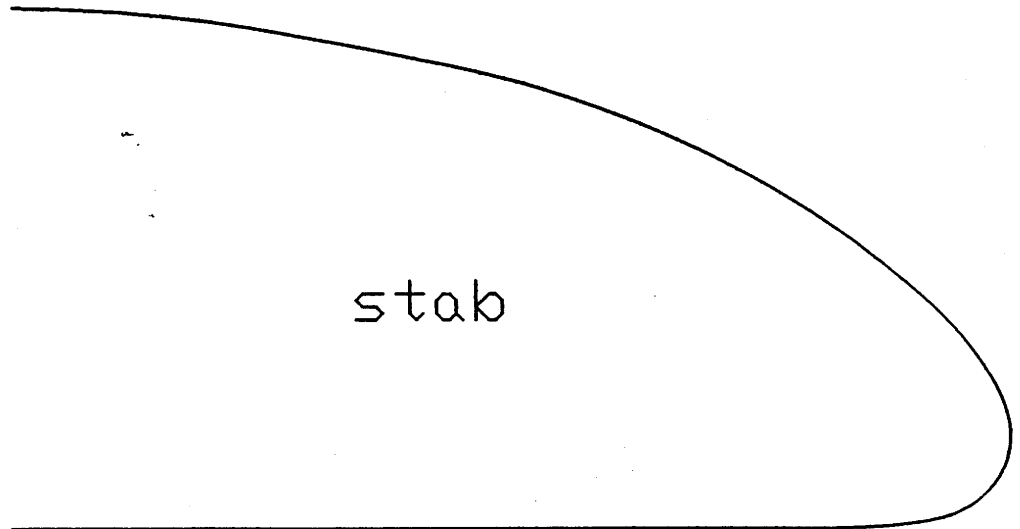
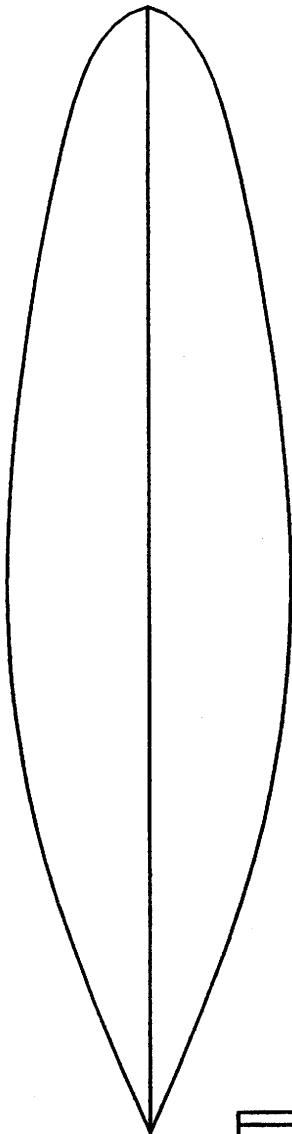


Hobbyshopper  
 Designed by:  
 Larry Coslick  
 Drawn by:  
 Steve Gardner  
 I-18-97

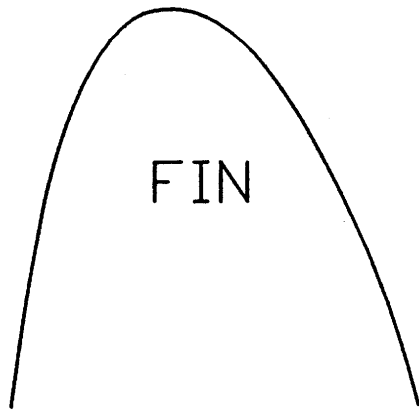
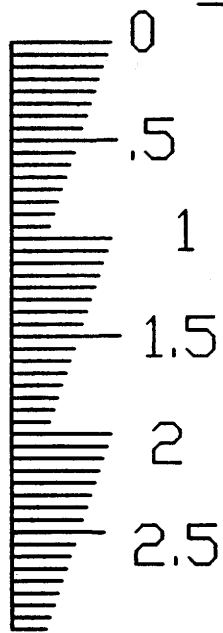


Draft

HOBBY SHOP EZB



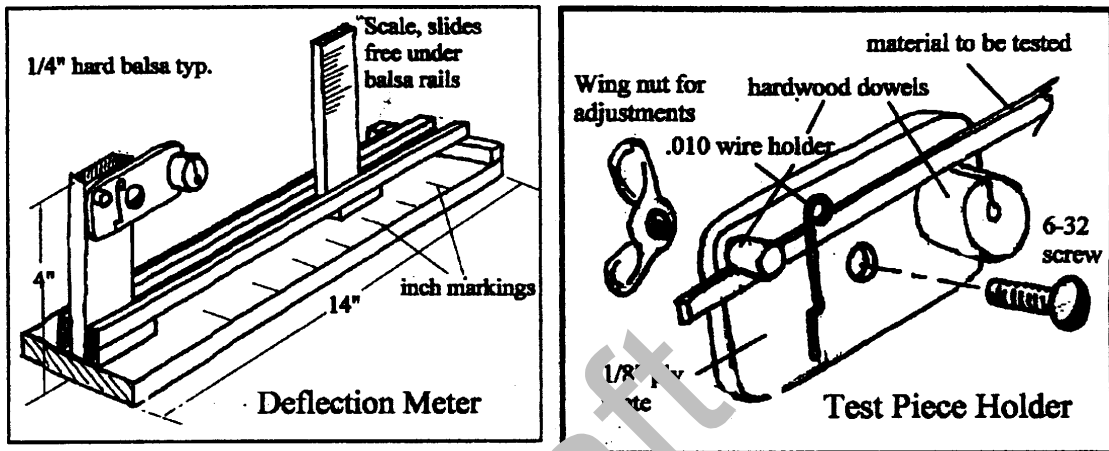
deflection  
scale



5 Full Size Outlines

parts from this wood much easier. This method of picking out the wood will work even with 1/4 inch wood which you might use for motor stick wood. Cut the good wood out of the sheet and recalculate the density of the good piece. It might be as light and stiff as the special indoor wood and it has straight, smooth grain.

The next most important thing to check about balsa wood is its stiffness. Cut a test spar from each of the good pieces of wood and test them on the deflection meter. (see drawing) Use colored marker pens to grade the wood for stiffness so that you can tell which piece made the stiffest spars. If you do not mark them you will get them mixed up and have to test them again. You may be surprised at the difference in stiffness between one spar and the next, cut right beside the first. Simply selecting the stiffest wood from a given section will really improve the model.



#### SANDING

The sanding blocks are cut from pine, .75" X 1.5" X 5". Slightly round the long edges with sandpaper. Cut the sandpaper so it wraps up around both sides. Use 220 wet or dry paper for the fast cut and finish with 360 grit. To sand the wood for the prop blades, or any other wood that you need to be a certain thickness, the ends of the sanding block are spaced up to the height of the wood thickness. To do this shim stock is glued to the ends of the block. It can be made from metal, plastic or masking tape. It takes some experimenting to find the correct amount of shim for each application.

Glass makes a good surface on which to sand. I use a piece of double strength glass 10" X 24" which is mounted on several layers of foam board, painted flat black, (no lacquer). The glass was then taped to the foam board with duct tape to safety and protect the edges.

Sanding prop wood - It can be sanded to around .020" by carefully sanding with a back and forth motion. Once the wood is this thin you must start to sand in one direction only, away from the end that you are holding down on the glass. Make sure to stroke the sanding block past the end of the sheet and to lift the sanding block completely off the glass before making another stroke. Start with 1/32" C grain balsa and take it down to .008". This will take about 45 minutes, so be patient.

#### MOTOR STICK

MOTOR STICK.            8.5"    4.5# AB GRAIN            .185 GR.

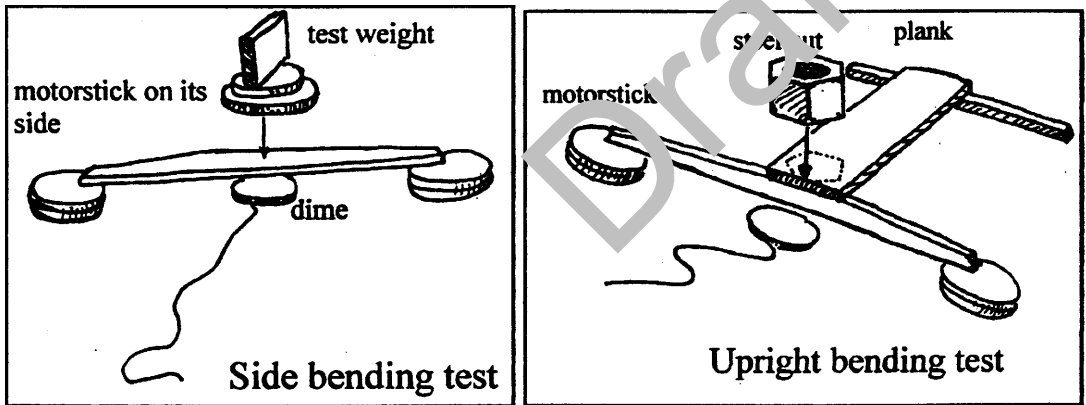
Selecting good Motor stick wood is perhaps the hardest part of building an EZB. The wood must be light and springy. Punky wood will take a set, and the model's flight characteristics will change making the model's flight unpredictable. Do not accept a motor stick that won't spring back after bending it noticeably to the right and in a downward plane viewed from the front. When selecting motor stick wood cut them from 3/32" or 1/8" stock, preferably 3/32". For this project I found a piece of 3/32" AB grain. The sheet had several 1/2" wide sections of white wood sandwiched in-between wide bands of dark wood. I drew the outline of the motor stick right on the sheet and cut it out with a new razor blade and straight edge. The sides were left straight. With no sanding this motor stick

weighed .185 grams, and was just right for this model, I cut 10 sticks and found lighter ones, but felt that this weight stick was one that most modelers could find. If you are able to find a stick that is lighter and stiffer, use it.

Stiffness test for the motor stick- Coins are used to make the weights and spacers for this project because they are fairly consistent and available to everyone. Using new pennies, CA 2 pennies together. Make up several sets. Find a spot on the face of 2 sets that is .12" thick, and mark that spot with a magic marker. Take a dime and quarter and CA them together to make one of the test weights. Cut a piece of balsa 1/8" X 1/2" X 1" long and CA that to the dime as a handle. This is one of the weights used to measure motor stick bend. It weighed 7.9 gram Find a dime that is .051" high and CA a piece of thread to one edge. This will be used as a test spacer so don't get any glue or thread on the faces of the coin. The last weight to be used is a 5/8" coarse thread nut (hardware, auto parts store) that weighs 31.89 gram. The support for the nut is called the plank. Make it out of a piece of 1/8" X 1/2" X 4" balsa. On one end of the plank glue a 1/8" square x 3" long foot.

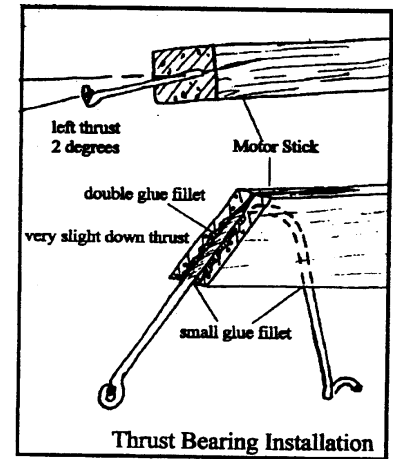
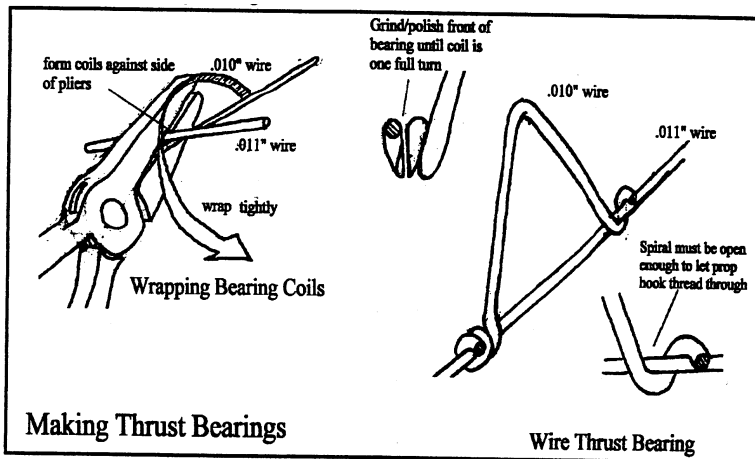
**TESTING**

Use any flat, hard surface to make this test. Place the motor stick flat on its right side across two sets of pennies with each end of the motor stick resting exactly on the center of one of the penny sets. Turn the penny sets to where the .12" thick area is under the end of the motor stick Use a ruler to find the center of the stick and place the spacer dime under the center of the stick. Place the test weight made from the nickel and quarter above the dime on top of the motor stick. The motor stick is a good one if it doesn't bend far enough to touch the spacer dime. If it is too close to see clearly, then gently tug on the thread to see if the spacer dime rubs the stick. Place the motor stick upright and place the plank end on top of the motor stick. Place the nut on top of the plank with the outside edge of the weight lining up with the outside of the motor stick. Again, the motor stick should not touch the dime. See drawing:



**WIRE BEARING AND REAR HOOK**

The wire bearing, called a "thrust bearing", is made from .010 music wire. To make the bearing the wire is tightly wrapped around a piece of forming wire that is .001" larger than the bearing wire, or about .011". All the "music wire" mentioned in these instructions can be purchased very inexpensively at the local music store in the form of guitar strings. A very good pair of needle nose pliers are a very nice thing to have when making thrust bearings, if you are going to fly indoor, get some! See the illustration on bending the bearing. Note that the bearing supports the prop shaft at two points. There is the front of the bearing, and there is the "pig tail", so called because that is its shape. After the bearing is formed, it will usually require some adjustment. The pig tail might be out of align with the front of the bearing, or vice-versa. Insert the forming wire in either the pig tail or front of the bearing and bend to realign. The bearing must swing free on the prop shaft. This will not happen until the front of the bearing and the pig tail are in near perfect alignment.



Before mounting the thrust bearing to the motor stick, make sure that the prop can be threaded through the bearing. If the bearing front end is not ground down far enough, or if the pig tail is not properly formed, the prop shaft will not thread onto the bearing. Make sure that the front of the bearing is ground down to match the drawing. If the problem is with the pig tail, you might be better off by just making a new bearing. Once the bearing is made and you have it aligned you can use it to help get the prop shaft square with the prop spars. Temporarily mount the bearing to a 1/8" sq. piece of balsa, like a false motor stick. Do not mount the bearing on the real motor stick for this step, the pressure of getting the prop shaft straight might weaken the glue joint. At this time I have the prop shaft mounted to the prop spar. No blades. Put the shaft through the bearing and hook up a thin loop of rubber. Put in some hand winds and check to see if the spar is running true. If there is any wobble in the prop spars as they turn, make note of which spar is most forward, and then, grasping the prop spar where the wire shaft is bent and glued to the spar, bend the shaft until the prop spars turns straight. Go easy and make very small corrections.

Remove the thrust bearing from its temporary mount and clean off any glue. Cut a 1/4" deep slot in the front of the motor stick. Angle the slot to provide 2 degree left thrust. Place a piece of .010" wire 3" long through the bearing to check the thrust line. Slide the bearing into the slot. The reference wire should be .150" below the bottom of the motor stick. Do not place glue in the slot. The front of the bearing should intersect the lower right angle of the motor stick. (see drawing) Take a new razor blade and cut the front of the motor stick to match the front angle of the bearing. Recheck for 1 degree down and 2 degree left thrust. The front of the bearing must be flush with the motor stick. Apply two thin coats of glue, to the wire and wood. Build up a small glue gusset where the pig tail and the front of the bearing meets the wood. No extra glue is needed.

Cut a 1/64" slot at the rear of the motor stick. The motor stick and boom are joined by a scarf joint. Cut a piece of .009" wire 5/8" long and bend over one end 1/16" long. The 1/16" hook will be imbedded in the wood but the wire will be flush with the rear of the motor stick. Tack glue the wire in place. Cut an angle on the tail boom to match the motor stick pre-glue both surfaces using Ambroid glue. Attach the boom and make sure the bottom of the boom is even with the bottom of the motor stick. Cut a gusset so that the end of the gusset is .125" below the motor stick. The gusset is glued to the boom. Place a strip of Japanese tissue over the gusset and wire. You can angle the wire again where it breaks away from the gusset. Cut the wire to a usable length (see plans)

Boom  
 Boom 9.80" 6# .04 gram

I cannot stress enough the importance of a good EZB tail boom. It needs to be fairly stiff and light. When they are not stiff enough the model will usually flounder under high launch torque.

To get a tapered boom start with a sheet of good clear grained 6# wood 11" x 1" x .062" (1/16" sheet), and sand it down to a taper from .062" at one end to .028" at the other, using a 220 grit

sanding block. Once the sheet is tapered in one direction the boom can be cut to a taper in the other direction using a Harlan stripper or a good eye and a straight edge. This taper is from .075" to .028".

The boom is used on the model with the .075" side vertical so that the boom is stiffest in the vertical plane. If you build and use the deflection meter the boom is tested in the same position. Insert the large end of the boom into the hold down and adjust the pivot and the scale until the end of the boom is at the 0 mark. With a .270 gram weight trimmed from a paper clip hung on the very end of the boom, there should be less than 1-1/8" deflection. A deflection of around 3/4" is a good boom.

Stab

STAB CONSTRUCTION

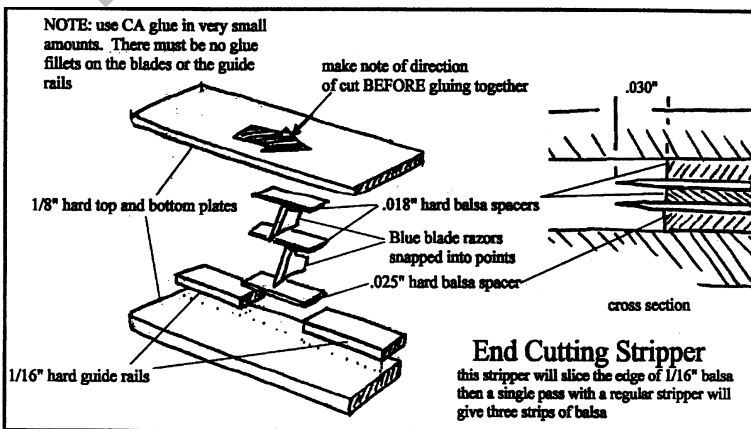
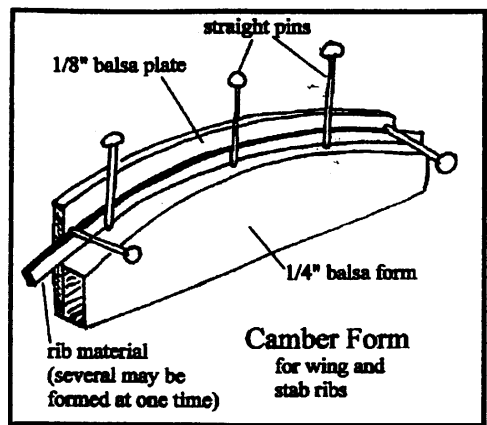
PROJECTED WEIGHT		.05 GR.
OUTLINE	.025" X 0.27" X 24"	5.0 #
RIBS	.017" X .027"	5.0#

Make the template from .032 sheet balsa and coat edge with CA. Cut vee notches at the rib locations so that the ribs will clear the template.

FIN	.025" X .025"	5.0 #
-----	---------------	-------

Select from either 1/32" or 1/16" stock for stab wood. Use A grain with a density of 4.0# to 5.0#, and cut the sheets 24" long A 24" outline will wrap all the way around the stab template, but if you have trouble finding a good piece of wood this long you can cut the spars and splice to get the correct length. When wrapping the thin outline around the template it's easy to put a twist in the wood. To keep this from happening mark thin black lines every 4" or 5" along the edge of the sheet you will cut the spar from. These lines act as a reference when pulling the wood around the template. To get the wood strip to wrap around the template without kinking you must hold a bit of tension while pulling the spar around the curve of the template. You can either sand the wood to .025" thickness or use Steve Gardner's stripper (see drawing). His stripper cuts the stab and fin outline at the same time from 1/16" sheet. If you sand 1/32" down to .025" it is best to use a Harlan stripper (see tools list) if you have one. The dry outline should not weigh more than .025 gram. A light one will weigh .015 gram. Do not cut the outline dimension any thicker, because it is over-built with the wood sizes shown.

The ribs are stripped .027" high out of A grain and then stacked on a form. See illustration for stab wood stripper and rib form.



WING

Projected Weight.		.15 to .16 gr.
LE	.030" X .067" X 10.5"	5.5# .028 gr.
LE	.Deflection	5/16" with .340 gr., paper clip at 5"

trailing edge .027" X .067" X 16.5" 5.5# .031 gr.  
 trailing edge Deflection I 1/16" with .20 gr. clip at 8"  
 Tips .025" X .058" .025" X .035" 4# (2) .022 gr.  
 Ribs .020 X .055 X 3" 4.5# (3) .010 gr.  
 Posts----- .035 X .062 X 1.25" 6# (2) .009 gr.  
 Paper tubes--3 wraps of Condenser Paper, or light Japanese tissue (2) .003 gr.

The leading and trailing edge spars are cut from selected sheets of A grain stock as described in the wood selection article. Use a Jim Jones or Harlan stripper to cut the spars to shape. Test each spar for weight and stiffness using the deflection gauge. Select the L/E and trailing edge spar that comes closest to the spec sheet. The front spar is the most important component of the wing. It must be stiffer than the rear spar for the wing to resist unwanted flexing. To save weight the wing tips can be cut from very light wood. If you can find 3.5# use it.

Leading edge spar - This spar is 10.5" long and is not tapered except for the last 3/4" on each end. Hand sand or cut this taper from .067" to .058".

Trailing edge spar - This spar is 16.5" long and the last 4" of the top of each end tapers from .067" to .035". Scribe a line to show the taper and sand or cut along the line. Mark the top of this spar with a felt marker to prevent turning the spar up side down.

Tips - The tip wood needs to be sanded from 1/32" stock to around .025", not less than .022". Use 4# wood or less. Use a Harlan stripper, if you have one, or a straight edge to taper the 8" tips from .058" to .035".

Template - Mat board of the kind used to mount pictures or photos makes very good template material. It is available at all art stores and most picture framers. Balsa sheet 1/16" thick is also good. Make sure that allow for the width of the spars and another .050" when you make the template to stay under the 3" chord limit for EZBs. Apply CA glue around the entire template edge and sand smooth when dry. This will prevent the template from swelling when you use water to make the bend in the tips. Pin the template to your building board with poster pins. These are 3/8" long pins with plastic heads. Push the pin all the way down to the heads so that they are not in the way of construction.

Construction - The first step is to soak the tip wood in water to allow them to be bent around the template. Gene Joshu suggested a good way to soak the tip and stab outlines. Lay the wood on a Formica counter, top or table and use a watercolor paintbrush to run a bead of water along both sides of the wood. Let the water soak for about a minute, then place the tip with the .035" end at the rear splice marked on the plans. Trap this end of the tip in place with a balsa block and a pin and wrap the wood around the template while holding a very light tension. The other end of the tip will extend past the front splice. This will be trimmed off later when it will be matched to the leading edge spar. Once the tips are dry (about an hour) lay the rear spar in place with the top side marking up, and cut the scarf joints in the spar and the tip. Pre-glue and attach each tip to the rear spar. Place the leading edge on the template. The wood will extend beyond the rib. Make a scarf joint 1/8" beyond the rib and attach both tips to the leading edge spar. Be careful when making the last joint, its easy to cut either the tip or the spar too short.

Ribs - Sand a small sheet of 4.5# A grain balsa to .020". Strip 5 straight ribs .020" X .055" X 3.25", two of these are spares. Soak the ribs and then stack them on the rib form to dry. (See illustration) The ribs are placed with the front end against the leading edge spar, then they are carefully trimmed to length at the trailing edge spar. Check to be certain that the rib is not too long, forcing the spar apart or adding bend to the rib. Pre-glue the ends of the rib and the spot on the spars where the rib will be glued. Wait about ten seconds and place glue on one end of the rib and attach it to the spar in the proper place, then glue the other end of the rib to the spar. Make sure that the rib is vertical before this glue dries. After the ribs are placed its best to leave the wing on the template for one day. Make sure that the center rib is installed perpendicular to the wing spars to properly locate the wing posts. The wing post jig centers each post on the rib location. This jig is illustrated in the final assembly section.



Covering - This subject is not covered in this issue. I did a covering article which appeared in INAV issue 65, 66, 67 Jan 93.

Placing Dihedral - After the wing is covered turn the wing over on a clean flat surface. Take a sharp double edged blade and cut scarf joints on the tip side next to each rib. Don't cut all the way through the spars. Lift the center section of the wing 2" above the table and break each joint where the cut was made. The tips will touch the table. Now support the center section with balsa blocks. Place a small amount of thinned carpenters glue in each joint. After 2 minutes re-glue the joint. Carefully turn the wing over and block up each tip 1.7". Make sure the wing is not over 18" long from tip to tip. Place a small weight on top of the spar at each tip rib. After about one hour lift the wing and inspect each dihedral break. If there is a gap, close it with a sliver of balsa.

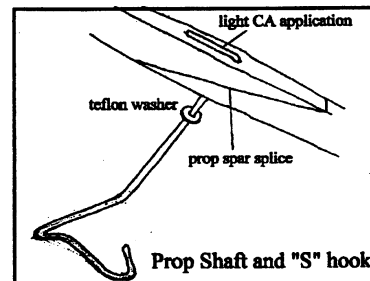
Wing Posts - Strip the posts 1/32" X 1/16" X 1" , 6# wood. Wing post installation is described in the final assembly section.

Paper tubes - Cut another piece of 1/32" X 1/16" balsa to use as a form for the tubes. Cut the tissue or condenser paper .into 3/8"X1" pieces. Apply a bit of ambroid glue to one end of the form and place the tissue so that it is ready to wrap. The tissue should extend off the end of the form by about a 1/16" so that you will have an end to grab when you pull the tube off of the form. The glue will help you start the wrapping by holding the end of the tissue. After the first turn, when the tissue is starting its second layer, put a fairly large blob of glue on the tissue right at the form. Now as you continue to wrap the tissue around the form this glue will spread out and coat each wrap in the whole length of the tube. Once you have three or four turns wrapped around the form immediately grasp the end of the tube extruding past the end of the form with your finger and pull the tube off the form. Set aside to dry an hour, then place back on the form and recoat the outside of the tube. Once the glue is on the tube pull the tube off again and let dry completely. Do not put the tubes on the wing posts too soon, or they will stick. A good idea from Steve Gardner.

Prop

Projected Weight .170 gr.  
Prop Spar-----12.5" X .047" X .075"---.025" X .025"---5.5# .035 gr.  
Prop Spar-----B grain----Deflection 3/8" each side with a .20 gr. paper clip  
Prop Spar Wire---.010 music wire + spar .044 gr.  
Prop Blades-----5.0 sq. in each blade-----4.0# .008" (2) ----- .120 gr.  
Prop 14" X 25" Pitch

Prop Spar - The spar is double tapered from 1/16" B grain, 5.5#. Look for clear uniform grain and cut several 1" X 7". Sand a taper from .050" to .025" using a 220 grit sanding block. The spars are double tapered by cutting the second taper into them when they are cut from the sheet. Use a Harlan stripper or a straight edge to make this cut. Make several spar sets from each sheet. Test each spar for deflection as you did the boom. Both prop spars should match each other closely in deflection. Record the deflection of each set of spars. Pick the lightest stiffest set of spars to use for the prop. When your final selection is made, cut a long scarf joint on the big end of each spar. (see drawing) Pre-glue the ends of the spars and join the two with ambroid. Pick up the spar after several minutes of drying time and realign if necessary.

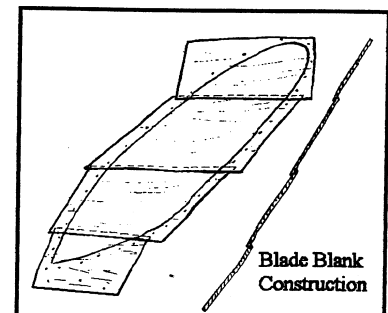
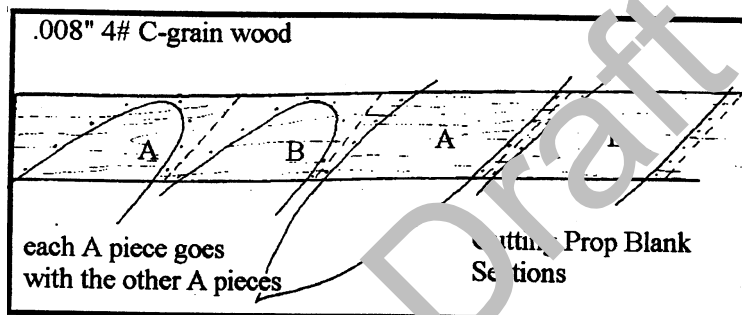


Prop Shaft - I have used several styles of prop hooks and the S hook works best for me. It centers the 0 ring and does not creep up the hook. Sharpen one end of .009" wire and punch a hole through the narrow portion of the spar.(see drawing) Hone the end of the .010" prop shaft and push it through this hole in the spar. Leave just enough wire to accept 1 thrust washer and clear the end of the bearing by 1/16". Place needle nose pliers at the front of the prop spar and push the prop spar back towards the hook. Bend a 90 degree angle in the wire. Leave .2" of wire to glue to the prop spar. CA the wire to the spar using a straight pin to apply the glue. It just takes a small amount of CA so do not overdo it..

Check the spar on the dummy motor stick for trueness. The .2" of wire on top of the prop spar allows for easy handling when truing up the prop spar.

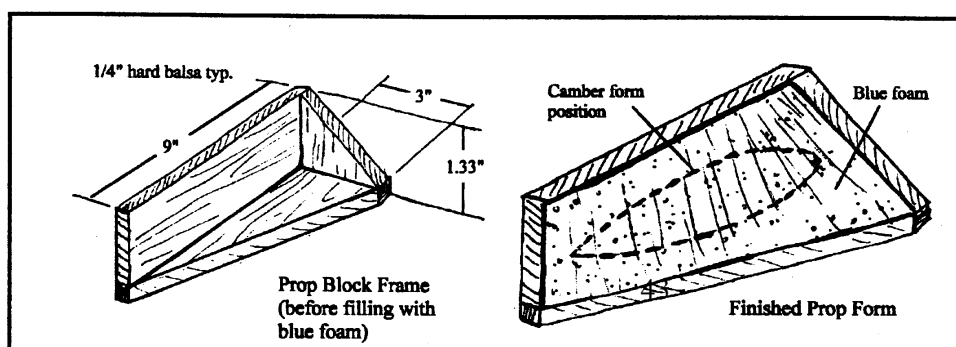
Blades - If at all possible, order .008" C grain from Indoor Model Supply. It's difficult to find good C grain at a hobby shop. If you want to use hobby shop wood for the prop you must choose the lightest piece of C grain 1/32" balsa that you can find. You can't use 5# wood and expect the prop to weigh .17 grams. The EZB will fly OK with a heavier prop, but the performance will fall off quickly with every bit of extra weight.

Blade Construction - The blades are assembled on a 4"x10" piece of the green cutting mat from the fabric or stationery department of Wal Mart. My prop blade template is cut from thin aluminum flashing material (available at any hardware store). Diagonal lines are drawn on the template to indicate the overlap. Place the lip of the template over one end of the balsa sheet. Outline the tip with a series of dots 1/8" away from the template. Move the template tip down the sheet and outline the tip again. Do each section two at a time. The reason for placing the two sections together is so the grain will match as closely as possible. After the pieces are cut out the first tip (A) goes with the first center section (A) and so forth. The sections are glued together so that the diagonal joints face the hub and toward the front of the spar. The tip will overlap the center section, and on down the line. Each overlap is about .025". Use very thin ambroid and lay a thin line of glue along each face to be glued. When dry, lay the tip over the center section .025". Hold the two sections together on the mat and run a small brush loaded with acetone across half the joint. After 10 seconds, slightly rotate the two sections so they won't stick to the mat. Now do the other half. Do not use any more glue or acetone. Repeat this on the remaining sections.



Place the glued prop blades in a heavy book and press overnight. The next day, lay the blades, stacked on top of each other, on the green mat. Make sure that the diagonal lines match up. Lay the metal prop template over the wood. Use a new razor blade and cut both sides of the template. As you come toward the tip make small straight cuts instead of trying to get the blade to follow the sharp curve of the tip. Work around the tip and rotate the mat as you go. If the cuts are small enough you will have a perfect curve and no sanding be needed. Weigh and record the weight of both blades. Draw a spar line on the back side of each blade where the spar will be placed. This can easily be done by stacking the blades together and pricking the wood with a straight pin. Place a straight edge along the two small holes, and draw the line with a very thin tipped marker. Do not use a sharp pencil or an ink pen as this will damage the thin balsa.

The thin blades need camber to help retain their shape. To get camber into the prop blades a camber form is made from 3/32" soft balsa. The camber form is made by taking the prop blade template and cutting it 1/8" larger than the template. From the hub to about 2/3rds the length of the form the

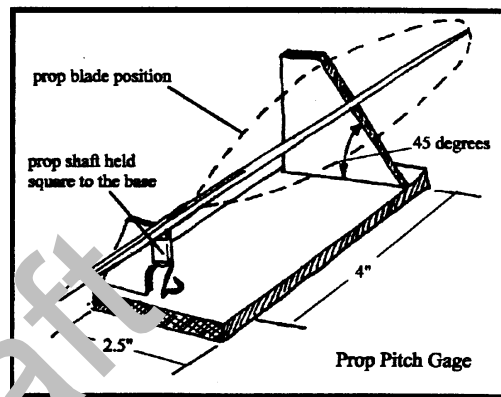


thickness is 3/32". Taper the last 1/3rd to .045" at the tip. Sand an airfoil into the form leaving the leading and trailing edges .020" thick.

From about one inch from the hub up to the hub the camber fades to nothing. The edges will get thicker than the .020" from the one inch point to the hub, where they will be 3/32" thick. Hold the form at different angles to the light and check for depressions or flat spots and use sandpaper to adjust as necessary. Soak the form in cool water for 30 minutes and then place the tip of the form 7" from the center of a 26" pitch block.

Wrap with an Ace bandage to hold the form to the block and allow to dry. After the form has dried soak the blades in cool water for about 15 minutes. Float one blade over the other while they are still in the water and line up one edge. Remove from the water and stack the wet blades on the camber form, and again place the tip end of the form 7" from the end of the pitch block. Use the prop template to cut a cap from 1/32" balsa to protect the blades from the Ace bandage. Run water over cap for a few seconds, and place over the blades on the camber form. Wrap the pitch block, form, blades, and cap with the Ace bandage. Let the blades air dry for two days. To separate the blades once they are dry, place a single edge razor blade between the two blades and run the blunt edge of the razor blade carefully around perimeter of the prop blades.

Prop Assembly - Take the prop spar and place it on the pitch gauge. Make a prop stop from scrap balsa and tape it to the top of the gauge at the 7" mark. Move a swing arm lamp directly behind the gauge next to the base. When the blade is placed close to the spar the light will show the exact position of the spar through the blade. Do not use Ambroid or other cellulose cements. The pitch will change as the glue cures because cellulose glues shrink too much. Use carpenters glue. The 45 deg. protractor at 4" will give a pitch of 25". Have a blade ready and place a small amount of glue at the hub, the center, and the tip of the prop spar. Immediately move the blade to the spar and attach the hub first, then attach the tip. The tip should be next to the stop. Reach behind the blade and press the blade to the center section of the spar. Check to see if the spar is on the reference line drawn on the blade. Adjust now if necessary. After 10 minutes, remove the spar and place two dots of glue between the hub and center of the blade. Add two more between the center and the tip.



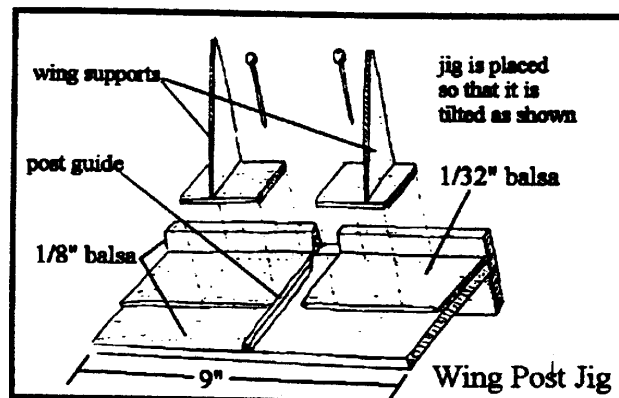
Place the spar back on the gauge and make sure that both edges of the blade touch the protractor at the 4" mark. If one of the edges is higher than the other, the spar can be tweaked, gently twisted to get the blade to touch front and back. Wet the spar by the hub and tweak it past the desired pitch after a few adjustments it should hold the position. Attach the other blade the same way. The prop is now complete.

**Final Assembly**

Fin- The motor stick and boom should be attached and straight in line with each other. Glue the fin to the left side of the boom, 1/16" in front of the stab. The stab is installed later.

Wing Posts - Before the wing posts are installed cut a step at the top of each post. Cut the step 1/32" deep and the depth of the wing spar. Bevel all four faces at the other end of the wing posts. Place the paper tubes on the posts and make sure that they fit snugly. This is important!

Wing Assembly Jig - The wing assembly jig is used to correctly position the wing posts while they are glued to the wing spars. The post guide holds the wing post square to the spars while the wing



supports hold the wing square to the face of the jig. (see drawing)

After the glue has set on the wing posts and paper tubes, install the wing on the motor stick. Place 1/32" positive incidence in the wing. One final adjustment needs to be made to the wing. Loosen the glue joint at the rear-wing post where it meets the rear spar with acetone. Put downward pressure on top of the right rear spar several inches from the center rib. You want 3/32" wash in (rear spar down) on the right wing panel.

This will slightly wash out in the left panel. Place the model in a stooage and support the wing until the glue has set. This model will not fly properly unless this adjustment is made.

Stab - Glue the stab to the boom with thinned carpenters glue. The stab is glued onto the boom with the left tip about 3/8" high. This is called "stab tilt" and is used to make the model turn to the left. The stab should be flat, or with a slight amount of wash in on the left panel. Warps can easily be removed during assembly by placing downward pressure on top of the L/E spar by the center rib while supporting the boom with your thumb. This adjustment is done on whichever side of the stab that needs it. Hold or support the stab until the glue sets.

### Set up & Trim

Final check- Before the model makes its first flight you need to make sure all the components fit together properly. Make certain that the wing posts fit snugly in the paper tubes. The side walls of the paper tubes must be stiff. If they are not the models flight pattern will be erratic. To fix loose or weak tubes use a bit of Ambroid on the outside of the tubes. If this doesn't tighten the tubes enough then use a very small amount of glue to coat the inside of the tubes. Check the thrust bearing for 2 degree of left thrust as per plans. The wing must be washed in on the outboard panel, with 1/32" positive wing incidence. Make sure that the wing is less than 18" in span and the chord is slightly less than 3" wide. Re-check the prop for 25" of pitch the stab should be 3/8" higher on the left side. Finally, the motor stick and tail boom should be straight in line with each other.

I am going to assume that you have no experience in trimming an indoor free flight model. Duration models fly to the left in a nose high flight attitude. We help the model turn left by tilting the stab so that it is higher on the left side. The prop thrust bearing is offset about 2 degrees to the left. Offsetting the rudder is not very effective and so it is not used on this model. Stab tilt and thrust offset are more effective. Next, the model must fly nose high, just under the stall, for maximum duration. This slows the model and also slows the rotation of the prop. Negative incidence in the stab is what causes the model to fly nose high. A really good tail boom will naturally flex to give the needed negative incidence. Here is an easy way to test the stiffness of your models tail boom. Hold the assembled model by the front of the motor stick. The prop does not have to be on the model. Lift the model vertically about 3" and then push it back to its original position. Repeat this procedure several times. This will load the stab and boom. A fairly stiff boom will flex up and down about 2 inches and a floppy boom will flex 5 to 6 inches. Now rotate the model gently on its roll axes from side to side. The wing and stab will follow each other on a stiffer boom. On a floppy boom the stab will twist one way while the wing twists another. In my opinion the tail boom is one of the most important components of an EZB. Its importance doesn't usually show up until the motor is really torqued up. My design has the wing mounted very close to the front of the motor stick. This makes for a longer tail moment arm and moves the center of gravity behind the trailing edge of the wing. This makes the stab carry a larger portion of the load. This is evident by the upward flex induced in the stab during flight. When the stab is loaded, the boom also bends upwards. The more power that is loaded into a motor the greater the boom will bend. If the model has a floppy boom it will stall or flounder around until the torque drops off. When the motor stick and boom match, the model will perform smoothly throughout the entire usable torque range.

First flight - Set the model up with 1/32" positive wing incidence. Tie up a loop of robber .033" X 10". Wind in 300 turns and place the motor on your model. Go to the center of the floor. Hold the model about eye level, with the nose of the model slightly elevated. Release the prop and gently push the model forward. The model should circle left in a 20' to 25' circle. If it stalls, move the front wing

post down slightly. If it dives, relaunch and make sure you launch with the nose raised, if it still dives make sure that you still have 1/32" incidence in the wing and check to see if the model has too much down thrust in the bearing. Increase the wing incidence another 1/32", but no more than 1/16" over all. If the model needs more than this you should tweak the tail boom to help get the nose up. This should correct any diving.

With 300 turns in the motor a .6 gram model should maintain level flight. A slightly heavier model (.75 g) will probably not maintain its height, but it should come close. When the model flies without stalling, check the circle. If the circle is greater than 25', twist the tail boom so that you have more stab tilt. Do the opposite if you need a wider circle. Hopefully your model will be flying with a nose high attitude. If not, an adjustment has to be made to the tail boom. If you had more experience I would suggest sanding the boom slightly so that it would flair. Lets do it an easier way for now. Starting about 3" behind the rear hook, bend the boom upward about 1 degree. 1 degree puts about 1" negative incidence in the stab. Wet the area where the bend is to be with saliva and be careful. Don't apply too much pressure as the boom may break. Rewind the motor and check for the 25' circle and a nose high attitude. If the model is doing both, start adding turns in the motor in multiples of 100. Do this until the model starts bumping the ceiling.

You could continue adding turns, but there is a possibility of damaging your model. Depending on your flying site, you now have two choices. Experiment with different rubber sizes and launch torque, to get the most out of your model, or start flying on quarter motors.

If done properly, quarter motor flying under a low (25') ceiling can accurately predict the time your model will do in a high ceiling. A 22' to 26' site is a perfect place to get ready for contests with ceiling heights of around 120'. If you decide to use quarter motors measure the distance from the rear hook to the back of the prop hook. Make a dummy motor 3/4 the length of your measurement from .015" wire. Wrap thread 1.5" on each side of center and apply a light coat of CA. This gives a place to add ballast and to hold on to when the motor is torqued up. The prototype performed well on a 3" loop of .033" tan II. To get the motor off the hook on the winder without losing turns an "O" ring is used. This is a very small plastic ring through which the motor is threaded before it is tied. These things are made from thin slices (.025" to .030") of the plastic stick found on the cheapest Q-tip copies. Use one O ring on the front end of the 3" loop.

You need a reliable way of balancing the quarter motor and dummy motor. The dummy motor must weigh three times that of the rubber. This is important. You can use a scale or build a quarter motor balance beam. See plans for my balance beam. Each time there is a change to the weight of the motor, you need to add or remove weight from the center of the dummy motor. Non-drying clay sold at toy and art supply stores is good for adding weight to the dummy motor. When flying on quarter motors the model and the prop need to be released at the same time. The torque drops off quickly on a quarter motor once the prop starts to turn. You can't tell if the model will handle the torque that is loaded on the model if turns are allowed to spin off before the launch. If your model stalls on a quarter motor it will certainly stall on a full motor.

I'll give you an idea of what the prototype looked like when loaded with .13 inches oz. of torque. Hold the wound model in front of you, and sight down the motor stick to get the proper view. The wing was flat with no warps in either wing panel. The motor stick and boom were bent downward in a slight arc. The stab had lost some of its tilt but was still high on the left side. This torque was more than enough to get to the 116 foot ceiling at Johnson City.

One last bit of information on motor sticks. If your model stalls at a high launch torque and you think the boom is OK the problem could be with the motor stick. It might be too strong. The model will fly great on low to moderate torque, but stalls when released at the desired launch torque. Try this. If the model stalls at .12 inches oz, wind to .15 inch oz. and relaunch. If it climbs 4 to 5 feet higher then stalls, the motor stick is probably too stiff. To make certain wind and launch at .18. If the model climbs to around 20 feet before stalling the motor stick is definitely too strong. Take a sanding block and sand the bottom of the motorstick from the rear post tube to one inch in front of the rear hook. Be

careful and only make a few strokes with the paper and make another flight. It's extremely easy to remove too much wood and ruin the motor stick. Relaunch at .12 in oz of torque to check if you have removed enough wood. When the stalling at this torque goes away stop sanding the motor stick.

Good Luck !! Larry Coslick

Draft

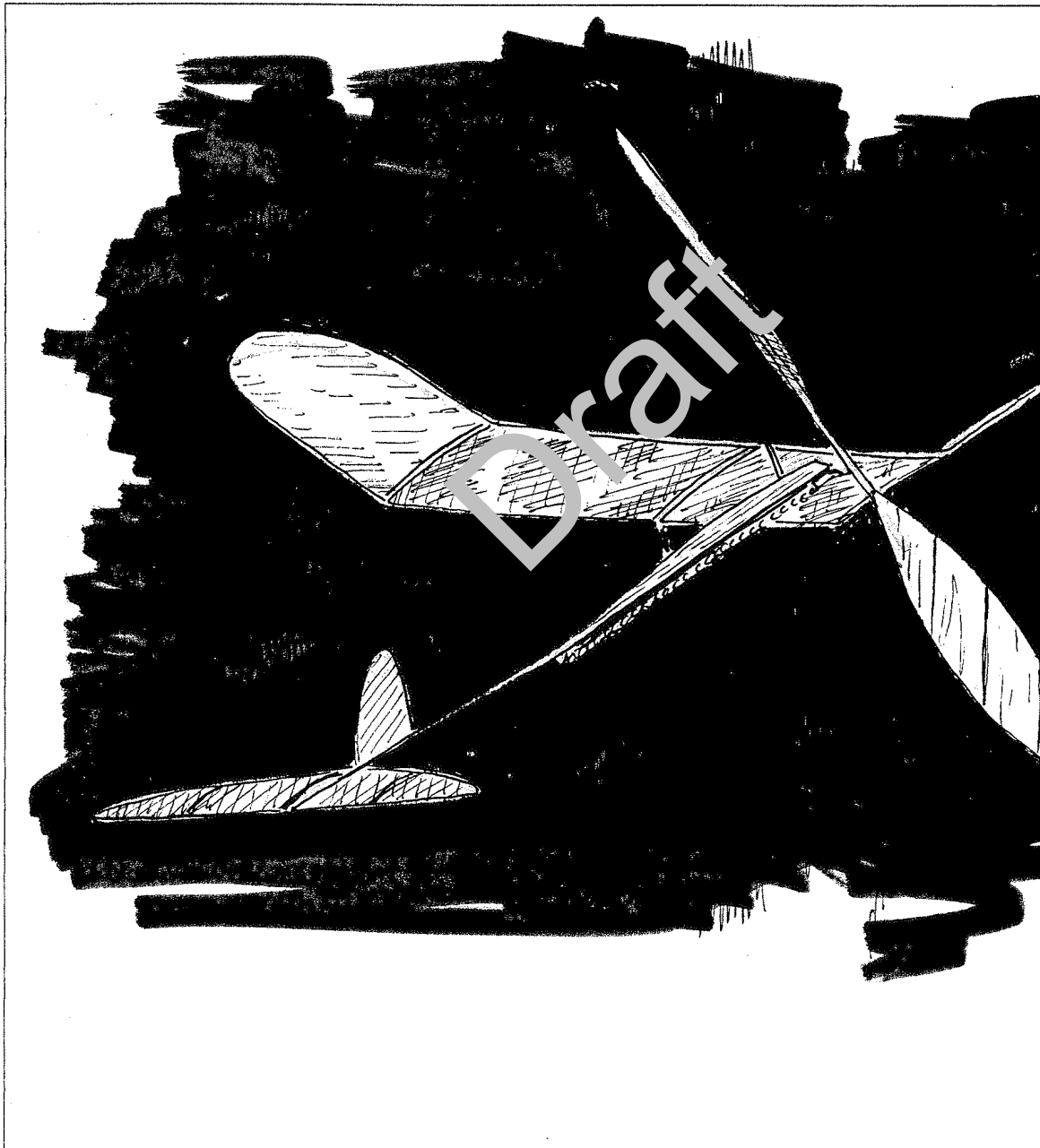
Issue 107 2002

Micro-B EZB Class

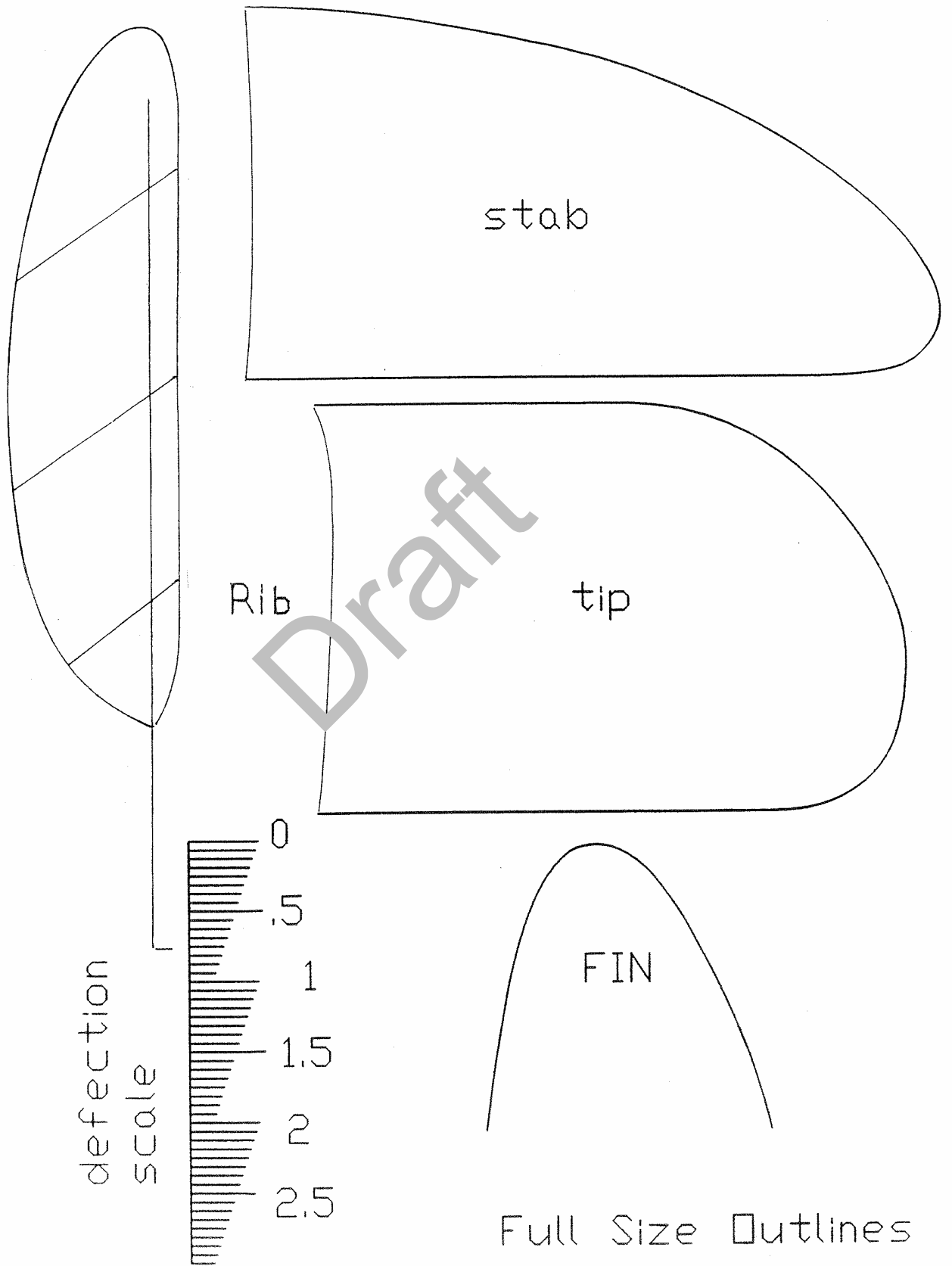
By Larry Coslick

Drawings By Steve Gardner

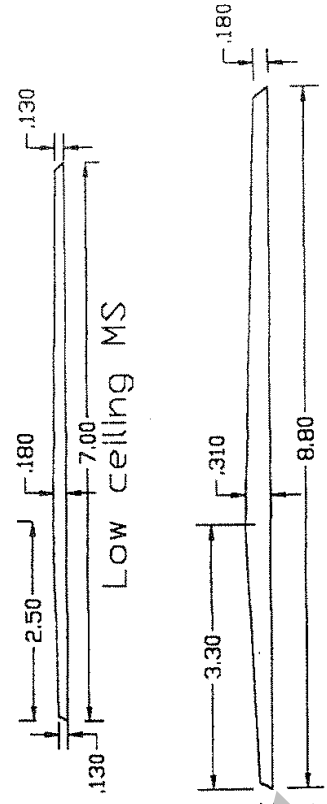
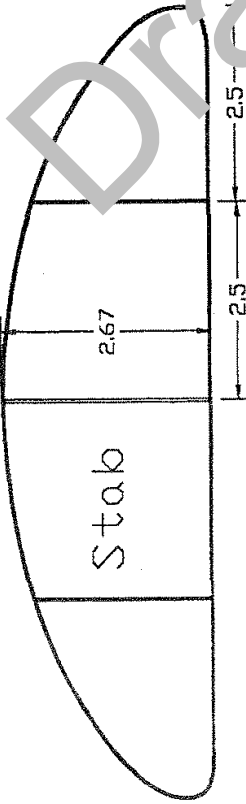
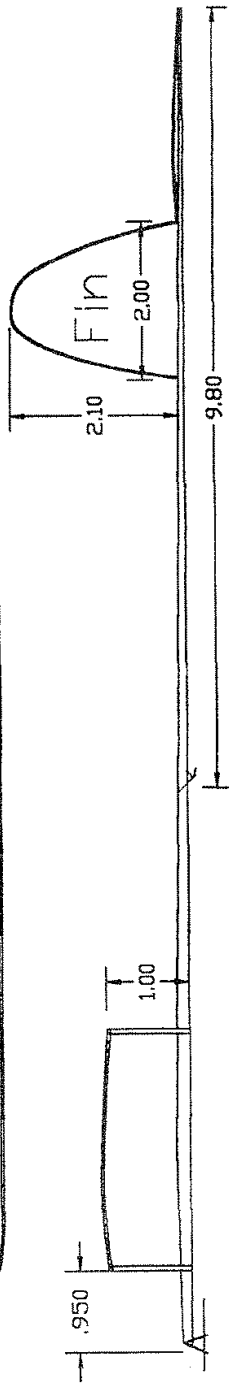
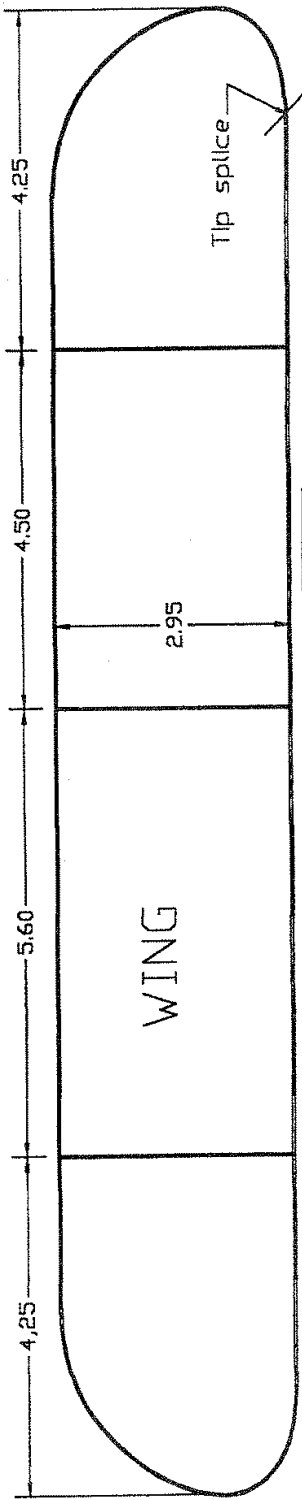
There are a lot of indoor modelers that don't go to Johnson City or fly for records in sites such as Akron or Lakehurst. If you fly an EZB for fun or competition in sites up to 60 feet that have dirty ceilings, you might want to build this micro light EZB. This model uses a 7" motor stick and by carefully selecting light stiff wood it can be built under 0.4 grams. The models light wing loading allows it to post no touch flights up to 17 minutes, in a 35 foot ceiling and over 24 minutes in a 60 foot site. With a good flaring prop and the right rubber combination, the prop RPM's are in the low 60's. It's like flying a miniature FID



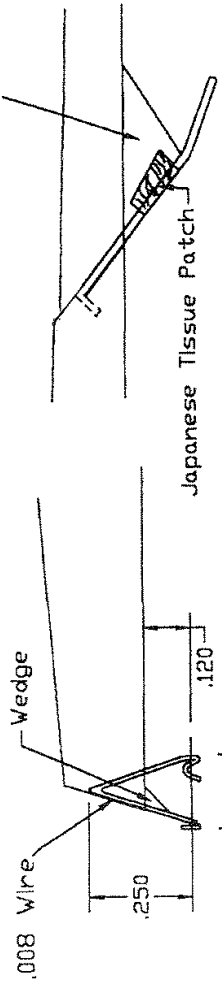
# Akron Light & Micro-B







.030 balsa gusset



MICRO-B

Designed by Larry Coslick  
 Drawn by Steve Gardner  
 3-11-02

## Wood sizes and Dimension Micro-B and Akron Light

	MicroB	Akron Light
SIZE	.095 x .130 to .095 x .180 to .095 x .130 x 7"	.101 x .150 to .101 x .310 to .101 x .180 x 8.8"
DENSITY	3.9#	4.3#
WEIGHT	.102 gram	.187 gram
SIZE	.055 x .070 to .025 x .025 x 9.8"	.075 x .090 to .030 x .035 x 10"
WEIGHT	.032 gram	.038 gram
DEFLECTION	.075 With a .27 gm weight at the end of the boom	5/8 with a .27. gm weight at the end of the boom
SIZE	.025 x .067 x 10.5" Only taper last 1" each end	.025 x .070 x 10.5" Only taper last 1" of each end to.06
DENSITY	4.8 # Unreal stiff	4.8# Unreal Stiff
WEIGHT	.025 gram before cutting to final length	.028 gram before cutting to final length
DEFLECTION	7/16" with a .34 gram weight at 5"	5/16" with a .34 gram weight at 5"
SIZE	.025 x .061 x 16.5"	.025 x .065 x 16.5"
DENSITY	4.8#	4.8#
WEIGHT	.032 gram before taper and cutting to final length	.036 gram before taper and cutting to final length
DEFLECTION	7/8" with a.2 gram weight at 8"	3/4" with a.2 gram weight at 8"
SIZE	.025 x .060 to .025 x .035 x 8.5"	.025 x .060 to .025 x .035 x 8"
DENSITY	3.4#	3.6#
WEIGHT	.018 gram for 2 No deflection test on tips	.021 gram for 2 No deflection test on tips
SIZE	.018 X .055	.018 X .055
DENSITY	4.5#	4.5#
WEIGHT	.01 gram for 3	.01 gram for 3
SIZE	.032 x .058 x 1"	.032 x .058 x 1"
DENSITY	8 to 9#	8 to 9#
WEIGHT	.01 gram	.01 gram
SIZE	.023 x .027 x 18"	.023 x .027 x 18"
DENSITY	4# Unreal Stiff	4# Unreal Stiff
WEIGHT	.020 gram for 2	.025gram for 2
SIZE	.008 X .030"	.008 X .030"
DENSITY	4.5#	4.5#
WEIGHT	Under.003 gram for 3	Under .003 gram for 3
SIZE	Same as stab spar	Same as stab spar
SIZE	.006 C Grain See plan	.006 C Grain Same outline as Micro-B
DENSITY	3.8# .006 x 1.2 x 18" Sheet weight .13 gm	4.3# .006 x 18 x 1.2 Sheet Weight .15 gm
WEIGHT	.06 gram for 2	.075 gram for 2
SIZE	.035 x .058 to .025 x .030 x 6.2" 2 Double tapered spars	.040 x .060 to .025 x .025 x 6.2 " 2 Double tapered spars
DENSITY	4.6#	5#
WEIGHT	.02 gram finished weight cut to 12.25"	.03 gram
DEFLECTION	.4" at 4.5" with a .2 gram weight	1/4" at 4.5" with a.2 gam weight
SIZE	.008"	.009"
WEIGHT	.005 gram	.007 gram

## Weight of Component Parts

	MicroB	Akron Light
WING DRY	.080 GRAM	.090 GRAM
WING COVERED WITH Y2-K2 AND DIHEDRAL	0.100	0.110
WING COMPLETE WITH POSTS	0.110	0.120
STAB DRY	0.013	0.018
STAB COVERED	0.02	0.026
FIN DRY	0.003	0.003
FIN COVERED	0.005	0.005
MOTOR STICK 7"	0.102	0.187
M/S WITH THRUST BEARING AND REAR HOOK	0.113	0.204
M/S WITH BOOM 10"	0.146	0.243
M/S WITH WEDGE AND TISSUE	0.149	0.246
M/S WITH CONDENCER PAPER TUBES	0.153	0.251
M/S COMPLETE WITH STAB AND FIN	0.180	0.285
PROP SPAR CUT AND GLUED 12"	0.020	0.030
PROP SPAR WITH .008 M/W SHAFT	0.026	0.040
PROP SPAR WITH BLADES ATTACHED	0.092	0.120
WING AND POSTS	.110 GRAM	.120 GRAM
FUSELAGE AND TAIL ASSEMBLY	0.180	0.285
PROP 13.25X25P	0.092	0.120
TOTAL	0.382	0.525

Y2-K2 Film weighs approximately .00033 g in and Super77 spray weighs about .004gm c EZB wing depending how it is applied

Motor stick side deflection was made with the penny test using the new 7.9 gm load weight 7" Micro-B M/S passed the test by clearing the dime.

8.8" Akron Light M/S cleared the base by .0

Motor stick torsion test was made using a 11 balance beam.

Micro-B M/S used a 0.4 gm weight to simulate .08 in/oz launch torque. Deflection was .6" Akron Light M/S used a 0.5 gm weight to simulate .1 in/oz launch torque. Deflection was .55"

## MICRO-B AND AKRON LIGHT WOOD SOURCES

I used balsa from three sources to build both models. Wood for the prop, tail boom, ribs and wing tips came from Indoor Model Supply. Wing and stab wood was ordered from Tim Goldstein and the motor stick and wing post wood came from Sig Mfg. I will only cover the items in this article that I consider helpful in building the Micro B. INAV has back issues of the Hobby shopper article that covers everything that is needed to build the Micro B and Akron light EZB. Issue 90 is also available on the INAV Archive CD. All you have to do is to substitute the wood sizes to build both models.

For the new EZB flier, don't be too concerned about building a model under .7 or .8 grams. It's much more important to build a model where all the component parts work together in unison than to build it light. After some time and experience the two will come together and the magic will begin.

## MICRO-B WOOD SELECTION

If you decide to build the Micro-B or Akron Light, wood selection is much more important now. There are going to be differences in the weight and stiffness of wing spars in any sheet of balsa. Indoor wood is no exception. Even though these variations may be slight, they can make a difference in the weight and stiffness of the model. Because of these differences, it's best to use the wood sizes and densities on my plan only as a guide. The wood weights for individual parts are included in this article, but it might be necessary to adjust the wood densities and sizes of your wood to match the required weight and stiffness of individual model parts. An example of these variations occurred while cutting spars for the stab. Two spars were stripped from a .023" sheet and weighed. From past experiences I knew that they should weigh about .02 gram but they weighed .025 gram for the pair. The sheet was turned over and two more spars were stripped from the other side. The second set weighed .02 gram and met my projected weight for the stab spars. A 20% savings over the first set. Sometimes it's necessary to cut spars or booms from four or five different sheets of wood to come up with just the right one.

I have built several of these 7" M/S EZB's under .4 gram using Indoor Model Supply wood with the lightest being .37 gram. That model was covered with the heavier poly-micro film.

I wanted to try Tim Goldstein's wood, which he calls Tru-Weight Indoor Balsa. He weighs each sheet to determine its density and makes a stiffness test on most sheets. I calculated the density on the sheets that were ordered and they were right on the money. I couldn't test the sheets for stiffness the way that he does but the cut spars exceeded my requirements for stiffness using my deflection jig. I really like the way that he grades his wood. It takes a lot of the guess work out of ordering balsa. Tim has a web site [WWW.F1D.BIZ](http://WWW.F1D.BIZ). The site lists the sheets that he has cut with its thickness, grain, density, width, length and stiffness on sheets over .019". It also tells of the wood is saw cut or surface ground.

## WING SPARS

I ordered 2 sheets of A grain wing spar wood (3.9# .025) & (4.8# .025) unreal stiff. A wing was built from each sheet but the spars were cut about .003" shorter in height for the 4.8# wing. Both wings were usable, but the 4.8# wing was stiffer and weighed the same as the 3.9#wing. In the past few years I have found out that it's a good idea to have 2 wings for each EZB. Even though they appear to be set up the same, one will work better.

## T/E WING SPAR

Taper the ends of the spar to .035". First, place a mark on one side of the spar to indicate the top. Put the spar on a flat surface and trap it between 2 wider strips of balsa, then tape it to the surface. Use a

straight edge as a guide & cut the 3" taper to .035". If the spar is not trapped, it will wander & you could possibly ruin the spar.

#### WING POSTS

Do not use soft wood for wing posts. I used 9# wood for both models. A strip .032 X .058 X 8" deflected .7" with a .2 gram weight. The difference between 6 & 9 # wood was about .003 gram for the pair.

#### STAB RIBS

I use 4.5# .008 C grain ribs on all of my new EZB's stabs. Reverse the airfoil so that the high point of the rib is closer to the T/E. The model will recover better if it tail slides. It's difficult to keep these thin ribs straight. So don't get frustrated if they are a little crooked.

#### MOTOR STICK – MICRO-B 7"

It takes 3.9# wood to get a M/S to weight close to .1 gram. Make sure to bend the cut M/S off to one side to see if it will spring back to its original shape. If it doesn't, don't use it. I cut 6 M/S's from three different sheets and they were tested for the side bending test with the new 7.9 gram weight. All but 1 of the M/S's passed the test without moving the dime. The torsional twist test was made with a .4 gram weight to represent .08 in. oz. of winding torque and registered a .6" deflection. This is a new test and I do know that a .6" reading is good on an 8.5" M/S.

#### TAIL BOOM 9.8"

The boom that I used for the prototype might be a little stiff for the model weight. A boom that deflects 1" would be good for ceilings up to 50 feet, because the launch torque will be much lower.

#### THRUST BEARING .008" MUSIC WIRE

Make the T/B .250" high and .175" from the front to the rear of the pigtail. Insert the bearing in the M/S so that the prop shaft is no more than .12" below the bottom of the M/S. See hobby shopper article for bearing installation.

#### PROP SHAFT .008" MUSIC WIRE

Make the hook small because there is very little clearance under the M/S.

#### REAR HOOK

I call this a cheater hook because it adds .1" to the length of the M/S. Use .007 wire and make it as shown on the plan.

#### PROP SPAR DOUBLE TAPERED

For this model cut the spar at the hub higher than the width for a better flair. The finished spar should not weigh any more than .02 gram and .025 gram with the .008 M/W hook.

#### PROP BLADES

To build a prop that weights under .1 gram you will need a sheet of .006" C grain that weights .13 gram or under. Don't cut down on the blade area to make the prop lighter. It needs the area and flair to keep the light model out of the ceiling. The finished prop is 13.25" X 25P. The Hobby Shopper article goes into great detail on EZB prop construction. It's a good idea to build 2 or 3 props for the model. Make one with the spar mounted .1" from the blade T/E and the other .2" away. The third could be built with the blade mounted right at the T/E. If the spar should be too stiff or too soft the blades can be removed and replaced on another spar without any weight gain. Soak the whole prop in slightly warm water for at least 30 minutes. Rotate the spar gently while the prop is in the water and if the glue is soft enough the blades will fall off the spar. If not, re-soak for a while longer. Take a soft tooth brush and gently go over each spot that looks white until all of the glue is removed. Don't rub hard or the balsa will tear. Rinse well and re-pitch the blades. With some care, you can use the same blades over and over again. The cover picture shows a EZB with a symmetrical blade prop. Don't use this type prop blade in low ceilings. The pitch has to be set too high to control the launch torque and the high pitch won't utilize the cruse torque as well as a flaring prop.

### SET UP AND TRIM

Follow the procedures in the Hobby Shopper Article, except for rubber sizes and torque readings. Always make a low power first flight to check the models circle and nose high flight attitude.

### RUBBER AND TORQUE RANGES

Depending on ceiling heights and air quality you can expect to use loops from 6.5" to 8" in length and .025 to .030" wide. The shorter loops use the wider cross sections to keep the torque up in low sites. In a 60 foot site a loop .025" X 8" would be better. You will have to do a lot of test flying to come up with the right prop rubber combinations. Torque ranges will be around .04 to .05 in ceilings to 50 feet and .07 for higher ceilings.

### DEFLECTION JIG FROM HOBBY SHOPPER ARTICLE

If you plan on building the jig, use the full size deflection scale that is included in this article. The distance between the two dowels of the test piece holder was not shown on the drawing of the deflection gauge. That distance is 1.6" from the left side of the first dowel, to the 0 mark on the larger dowel. Also, it's best to place a music wire stand off along the L/E of the deflection scale support. It keeps the spar from flexing away from the scale face.

### NO TOUCH CONTEST

The Micro B was originally designed for no touch flying, so it's perfect for this kind of contest. The contest is flown in rounds with a minimum and maximum flight time for each round. If the model touches the ceiling during any round it's out of the contest. Depending on the flying skills of the group, the first round could be set at 7 minutes with a maximum of 9 minutes. The next round might be 9 minutes and so on. The more experienced fliers could be handicapped with a higher flight time per round. This type of flying really improves your skills in selecting the correct rubber size, prop pitch and torque requirements for each flight. This kind of event can be used with any type of indoor model.

GOOD LUCK  
Larry Coslick

Torsional Twist Jig

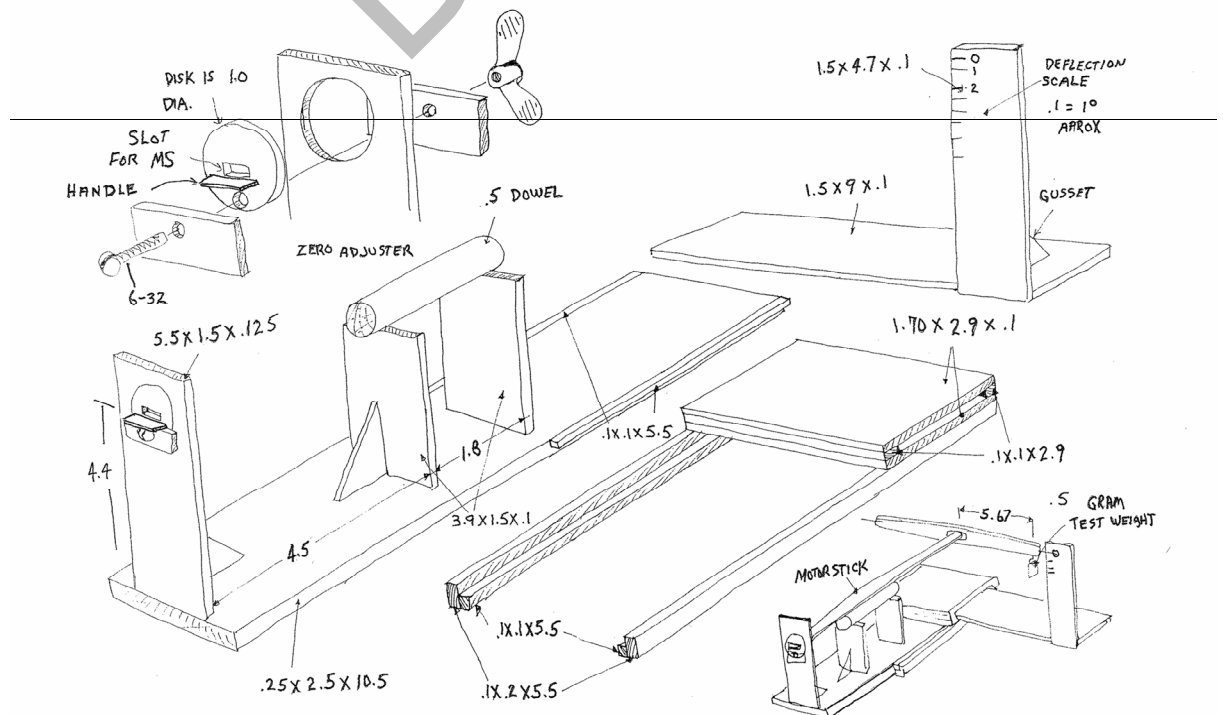
By Larry Coslick

I got the idea for this jig from Jerry Nolan in 1993 and finally built it this year. The jig consists of a support that holds the M/S and a balance beam that's attached to the hook end of the M/S. A .5 gram weight is placed on one end of the beam to simulate the twist of a motor wound to 1 inch oz. of torque. .1" of deflection equals about 1 degree of twist. Be sure to balance the beam for a more accurate reading. This jig is designed to make the test before any hardware is attached to the M/S. The base that is shown on the drawing will measure M/S's from 7" to 9" in length. The deflection scale can be pinned to the base but the one that is shown is easy to build and is very handy. Since I use 3/32" balsa for my M/S's, the rectangular slots in the front support and the balance beam are cut slightly smaller than 3/32" to insure a tight fit. If the M/S is too loose a balsa wedge can be used to tighten it up. Most of the time the balance beam won't line up with the 0 mark on the deflection scale. Steve Gardner came up with a way to rotate the M/S and align the beam to 0. When the M/S is removed from the jig, the ends will be marred from the tight fit. Dip each end in water for a few seconds and the wood will swell to its original shape.

I tested the same M/S's that were re-tested using the 7.9 gram weight for the penny side bending test. The test were made on M/S's 8.5" to 9" in length and I got torsional twist reading from .55" to .9". Some 8.5" sticks deflected .9". Since this is a new jig, I haven't had a chance to test what the upper limits will be. I did test one of the M/S's that I used at Johnson City and that one deflected .6". The side bending test has some importance but I believe that this jig will give a better indication of how that M/S will perform.

Balance beam weights for jig

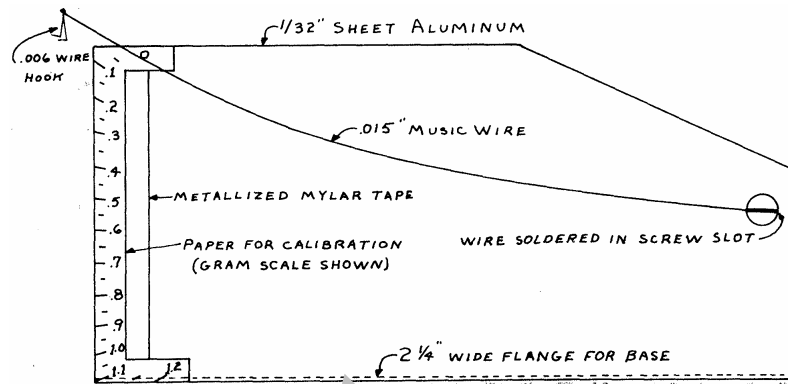
Weight in grams	In. Oz. of Tq.
.4	.08
.5	.10
.6	.12
.7	.14



### Simple Scale

Jim Richmond submitted the scale design shown below, which was patterned after ones used by the Czech team at the 1968 World Champs in Rome. Although this is not a new idea, it bears repeating. This type of scale is as accurate as you make it (typical with most indoor scales) and indefinitely repeatable to that same accuracy. It is also capable of being packed in small spaces and rugged enough to be dependable in the flying site - which can't be said of most scale designs. Note that this design has a "mirror scale" similar to precision laboratory meters; this is done by using metallized mylar tape adjacent to the scale.

In practice, you align your eye so the pointer appears to cover its reflection in the "mirror", and thus errors due to parallax are eliminated. If you are really finicky about weights, make a second spring for the other side of the scale, using smaller wire. For example, .008" diameter wire would be about 4 times as sensitive (full scale deflection of .3 grams), and would permit greater accuracy in weighing lighter parts.



Issue 106 2002

### Poonker Mini Stick

By Rob Romash

The Poonker arose from a need to get a ministick to the top of the hanger at Lakehurst. I needed a plane that could climb rapidly without the attendant stalling like the little minies usually do. Construction is typical depending on wood strength. My wing does have a tiny bit of flex on launch augmenting the adjustments built in. This ministick is an evolution of Joe Krush's K-777 which is always a consistent performer.

The prop was formed on a 2" dia. cylinder which is made from a thin deformable styrene, when the prop is put on about an 18 deg angle, I then deform the tube to give it a more radical shape: more twist is evident at the base of the prop rather than the tip. I also run a bit less pitch than is usual I am not sure how much, I use the looks-about-right method and am always tweaking depending on the mood of the aircraft. Walt Van Gorder says it looks pretty low.

I use a lot of space between the rubber and the motorstick so as to avoid hang ups. Be sure to have the wingtips very straight as to avoid any drag. Wingtips are covered on the inside using separate pieces of mylar this makes for a very clean transition at this joint. On launch it does a lot of flying on these tips. I adjust to conditions as I fly this thing so the plans show about what I had that day.

Conditions were in the low eighties and in the afternoon when the high time was set. You have to get a lucky day to do big times. There were several flights over 14 min with Poonker the same day but it wasn't until early afternoon that conditions became optimum. This ship runs on smallish rubber that has the living bejeezus wound out of it; for these flights, learning to wind until the next turn on your winder is the last is important, I also massage the knots before launch this helps a good deal with getting this rubber to unwind all the way.

Poonker works well in the hanger but I have trouble keeping it out of the ceiling at Johnson City. This is where I will tweak in more pitch and make it do some tricks before the climb. I think this design will work well for low ceiling with a bit more prop area and a bit more airfoil.

[www.Indoorduration.com](http://www.Indoorduration.com), Tim Goldstein's site, has an updated plan of Poonker with a bit more in the way of sizes and I encourage all to go get it. This ministick was named after my late cat Poonker who never would give a passing glance to my models flying around her head but would bring me a dead bird on a weekly basis, go figure.





# THE POONKER

MINISTICK

BY TOB ROMASH

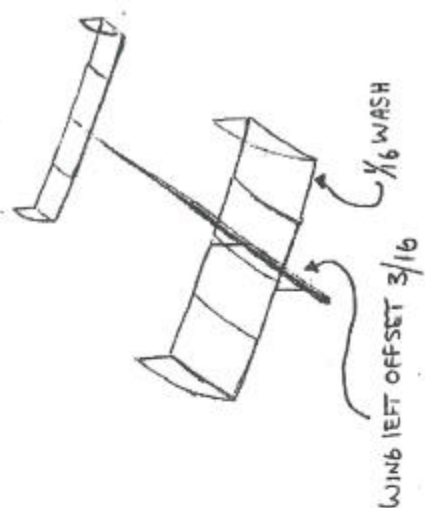
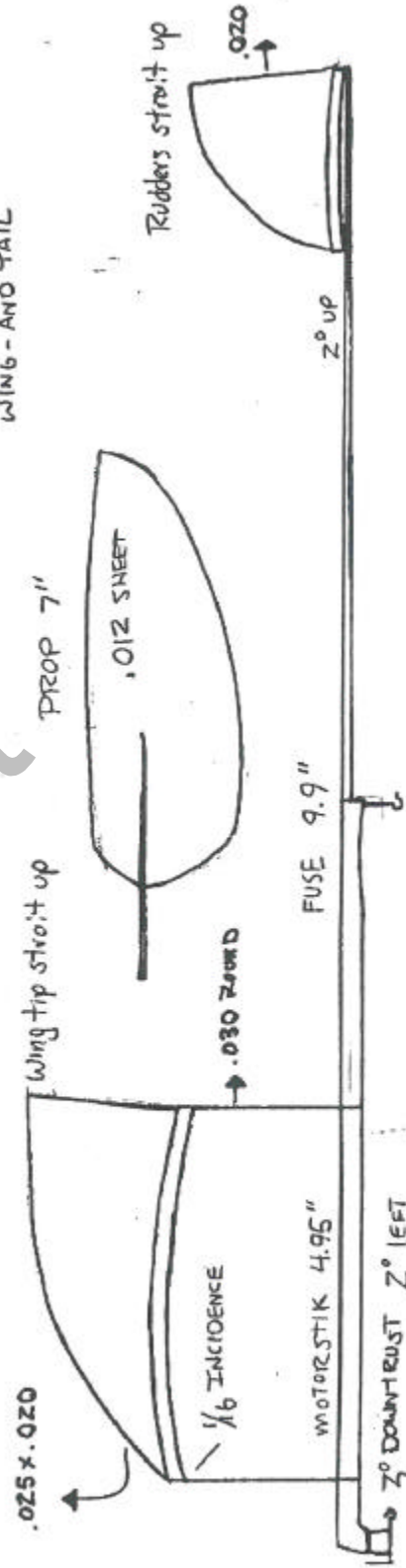
WING 7" CHORD 2.5"

	CAT II RECORD RUBBER MAY 99 .018 x 14"	SPAR .030 x .025
	4160 TURNS NO BACKOFF NO "O" RINGS	

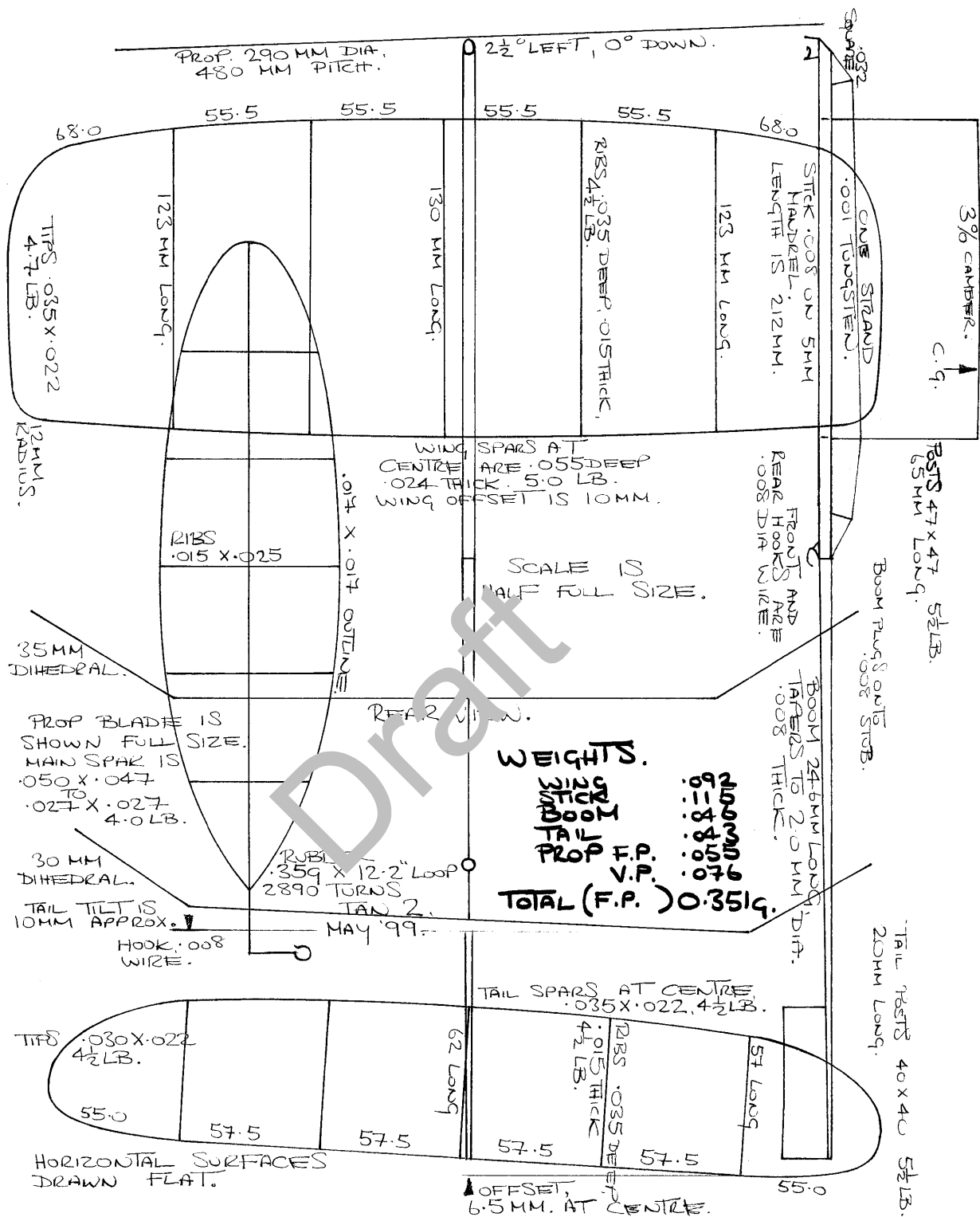
STAB 7" CHORD 1.25"

		.025 x .025

FLAT CENTER SECTION



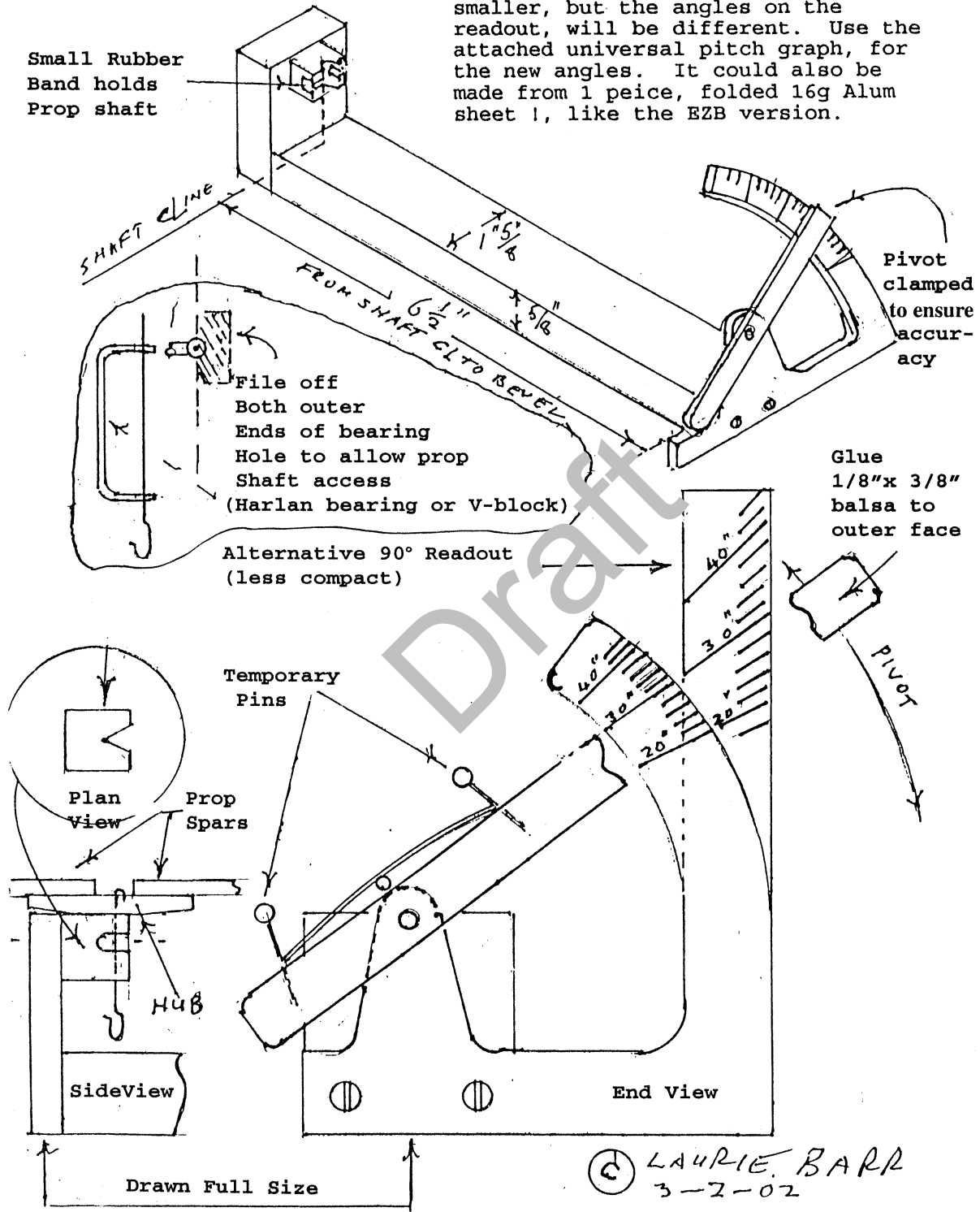
WING LEFT OFFSET 3/16  
 1/6 WASH  
 CAT IV RECORD SEPT 1/01  
 LAKEHURST NJ  
 15:06  
 1ST PLACE USIC 2001 12:37  
 WEIGHT .431 gm  
 COVERING - POLYMICRO (WRINKLED)  
 1/8 POLYFEDERAL  
 WING - AND TAIL



35 CM MODEL BY BOB BAILEY.  
32.03 + 33.19. 1ST PLACE AT THE 'CARGO LIFTER'  
OPEN INTERNATIONAL. 13-14 OCT. 01. DRAWN BY  
UNOFFICIAL 36.23. NICK HIKMAN.

My original design was all Acrylic, but it could be made from Hard Balsa and Ply. The Pivot Pitch Arm, was riveted so it had a "stiff" action. I made the distance from hub centre to the pivot arm, 6 1/2" inches, for that is where most of the blade area will occur, on a typical F1D prop.

You can make this checker, larger or smaller, but the angles on the readout, will be different. Use the attached universal pitch graph, for the new angles. It could also be made from 1 peice, folded 16g Alum sheet !, like the EZB version.



Issue 106 2002

Boron Jig For Motorsticks And Tailbooms  
Laurie Barr

Cut the motorstick to the length required, and slide back over the form rod. Mark the position required for the boron around the circumference of the motorstick (see method below). Cut boron 1" longer than the M/S. Remove a fine hypodermic needle from a syringe and fill with Duco and acetone of clear dope consistency. Pass boron through mixture in the needle and hang up to dry.

Find some 0.040 to 0.060 rubber and tie a single knot tight around boron near ends and cyano in place. Cut rubber 4" long and make a loop and cyano. Place form rod with M/S on the 2 wedges and allow to roll down slope, up to the two stops marked "X".

Stretch the rubber bands and stick modeling pins into the 4" uprights at each end. Slide this up/down until the boron is resting on top of the motorstick. If needs be, wrap bands around the rear of the 4" uprights. Rotate the motorstick until the boron sits over the mark made before, where you want the Boron to be.

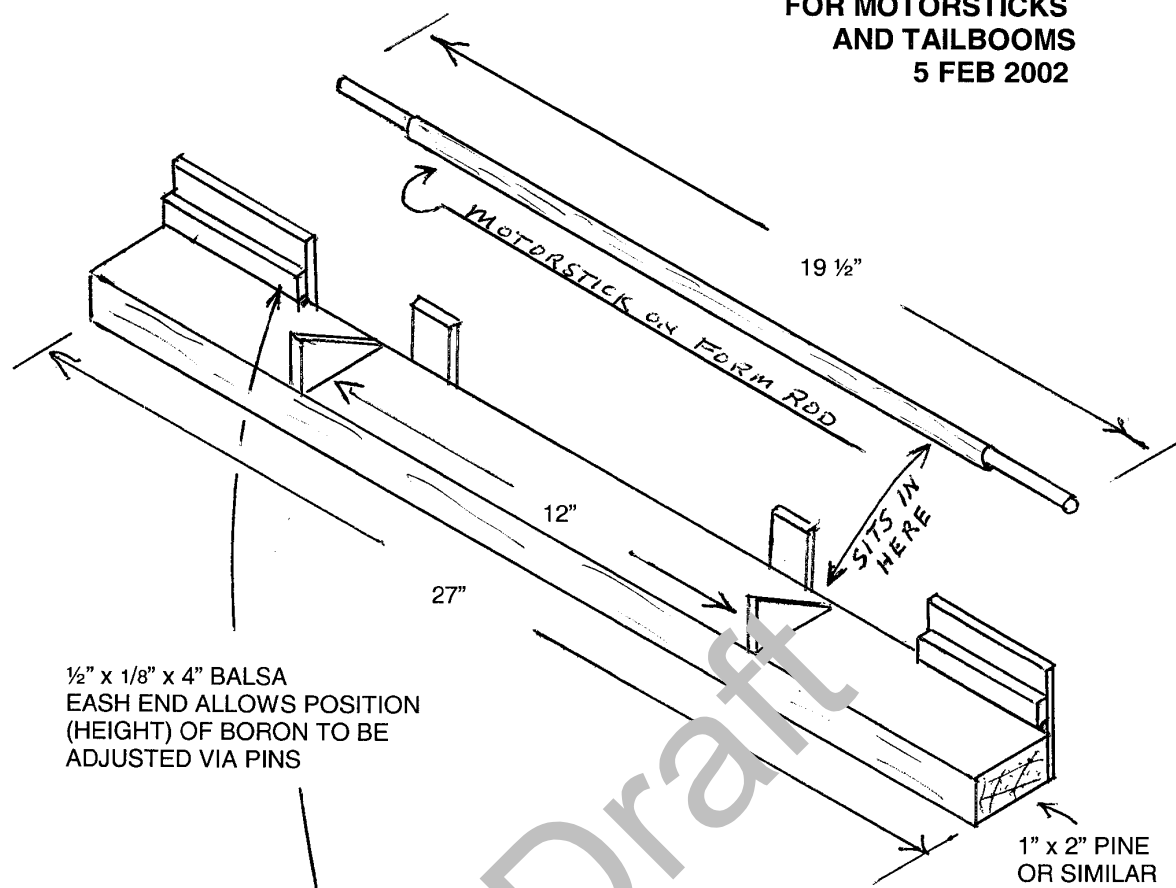
Using a medium-sized brush, apply acetone, starting from the right end (for right-handers!) and wet approx. 2" at a time, and press the boron down hard, using the metal end of the brush holding the hairs.

Remove the rubber, and rotate the M/S to the next position. When all 4 are done, remove from jig and snap off the over-length ends of boron. Do this over a white sheet of paper to allow you to see any shards. Apply stick tape to any shards, fold and dispose. Re-stitch the loose ends of boron.

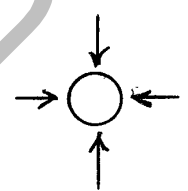
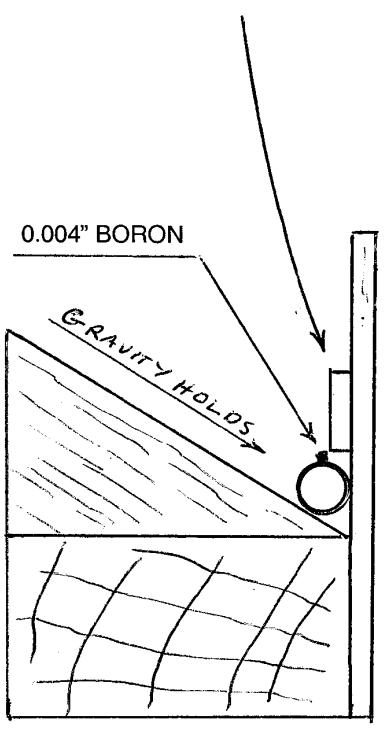
Allow 10 minutes ? to set, and slide the M/S off the rod, and lightly holding each end, bow the middle away from you. Any boron not attached will show as a kink. Re-glue as required.

This jig can be made in minutes. The boron will be dead straight, under modest tension, no boron will be loose, and it is done for the least weight.

**Laurie Barr's Boron Jig  
for Motorsticks  
and Tailbooms**  
5 FEB 2002



1/2" x 1/8" x 4" Balsa  
EACH END ALLOWS POSITION  
(HEIGHT) OF BORON TO BE  
ADJUSTED VIA PINS



PRE-MARK EXACT LOCATION OF 0.004" BORON.  
WRAP A THIN STRIP OF A 'POST-IT' NOTE  
AROUND THE CIRCUMFERENCE, STICKY  
SIDE DOWN. CUT, FOLD IN TWO, THEN FOLD  
AGAIN IN FOUR. LINE UP THESE MARKS WHERE  
YOU WANT THE BORON AND 'DOT' MARK  
LOCATION ON THE MOTORSTICK.

Issue 106 2002

VP Prop Hinge System

By John Kagan

1) Polyspan "L" hinges, double glue w/Ambroid

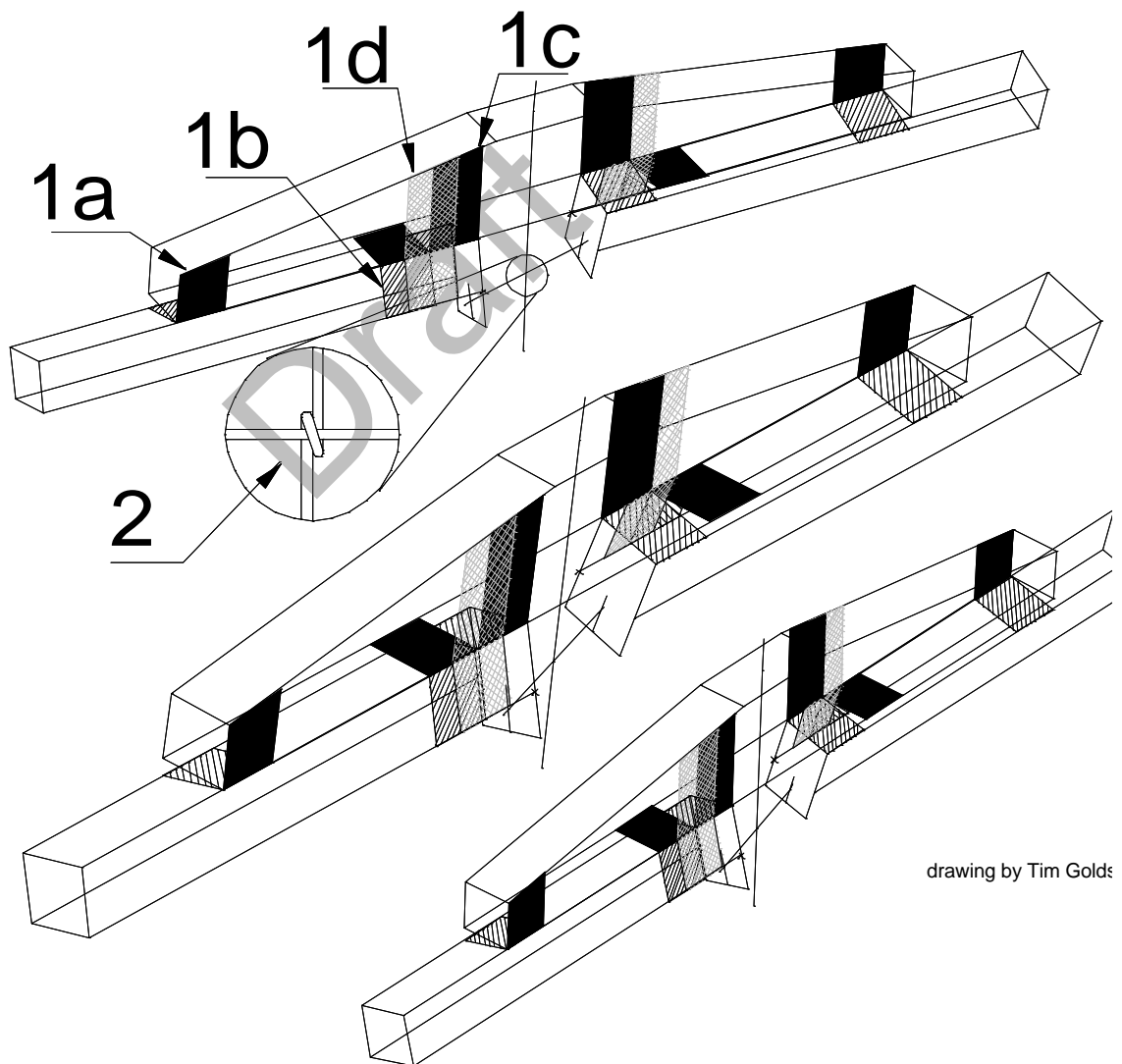
1a & 1b counter prop torque

1c counters spring torque

1d prevents separation

2) Actuator arm attachment, solder

Reference Steve Brown's VP article INAV 89



### Making Tissue Decals For P-Nuts & No Cal And Any Other Scale Models.

By John Tipper

First of all photo copy the plan 1 or 2 copies is enough.

Next select the first marking you wish to reproduce, start of with a simple letter or number on the wing.

Roughly cut out the letter from the plan leaving a 1/4" boarder around the template.

Using a can of non permanent spray mount, give the under side of the template a very light spray, this just needs to be enough to stick the template to a piece of coloured Japaese tissue, lightly press template on to tissue.

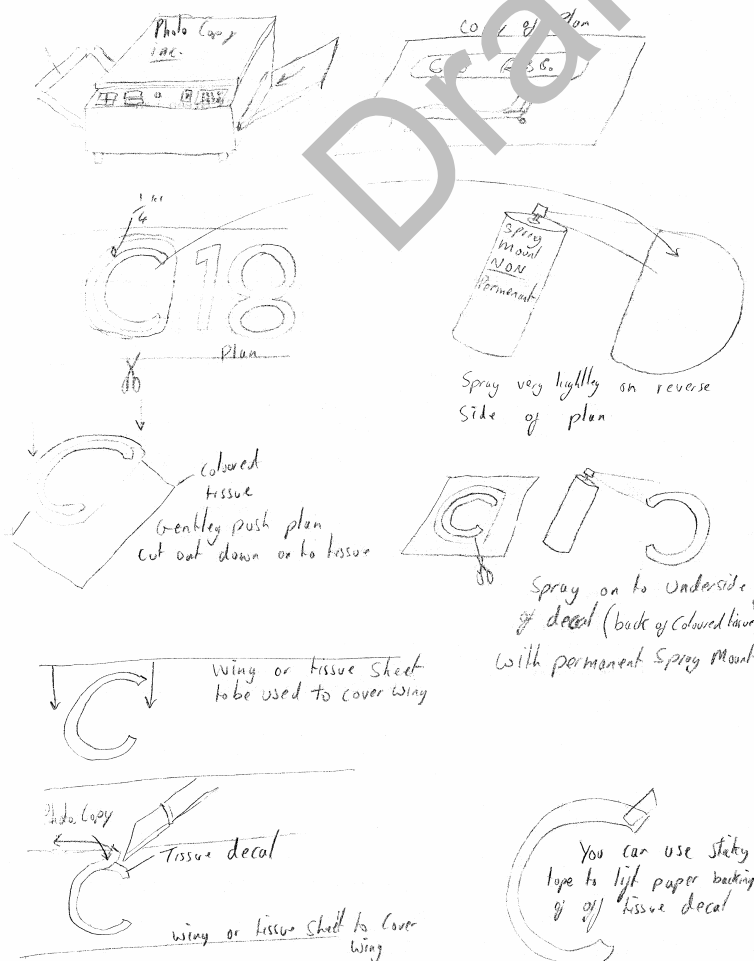
Next carefully cut out the decal with a sharp knife or good pair of scissors.

For the next stage use a permanent spray mount to give a good spray on to what is the underside of the tissue decal , at this stage the paper backing must still be in place, this helps to keep the decal in good shape and flat.

Lay the decal down on to its place on the model, once in place, gently press down and allow tissue to bond to wing tissue.

When set use a fine point of a scalpel to gently peel the paper backing of off the wing leaving the tissue decal in place.

For best results lay decals on to flat tissue then cover model when decorations are finished.



## In Search Of The Perfect Sheet Of Balsa

by Tim Goldstein [tim@IndoorDuration.com](mailto:tim@IndoorDuration.com)

For the past 2 years or so in my normal compulsive and excessive manner I have been talking with fliers, researching methods, looking for sources, experimenting with techniques, and buying equipment to get myself a supply of top quality indoor balsa. This search has had many twists and turns and the pursuit has often times taken over my time that should have been spent building planes. Initially my quest was focused around finding the supplier that would ship me the exact wood I needed and eventually turned into developing a method to be that supplier for myself. Along the way I have spent much time, effort, and money. This article is an attempt to document what I have tried, what I have learned, what is working for me, and what has been a dead end.

In the beginning God created perfect balsa. Then we had the deal with the apple and now we have to scrap and fuss to find a decent piece of wood. My search started as a result of my coming back to the hobby of indoor flying and I had the good fortune to get a copy of INAV 90 with Larry Coslick's article on the Hobby Shopper EZB. In that article he describes a process of building a relatively competitive EZB using only hobby shop wood. Much of the process revolves around selecting the best parts of the wood and then carefully sanding them to thickness. Having had a tiny bit of experience with indoor about 10 years ago I knew that real indoor wood was very expensive and this idea of using regular sheets seemed quite appealing. So, I dug into my stack of light balsa I collected over the years when I had the occasion to visit the LA area and stop in a Superior Balsa (<http://www.superiorbalsa.com>). From that I was able to pull out a couple of sheets that looked more promising than the normal hobby shop stock and I proceeded to start building a Hobby Shopper. The results were encouraging, but I realized I needed a larger stock of light wood to select from. Some browsing through magazines, searching the Internet, and calling around lead me to Lone Star



(<http://www.lonestar-models.com>). They had a pretty reasonable price on contest grade balsa and a good reputation of delivering wood that was what you ordered. Out came the credit card and I soon had about \$100 worth of contest wood on the way. I waited expectantly. When the wood arrived I was pleased with what I got. Densities ranged from mid 4# to just over 6# and the grain was decent. I proceeded to build some Hobby Shoppers and they came in at the target weight and flew well. I was happy.

With a little success under my belt I now wanted to get the weight of my Hobby Shopper models down a little to get the times up. I decided that my 250 mg props would be a good place to start. I dug through my growing pile of light wood which I had carefully graded for density and picked the lightest I had. I

proceeded to sand it down until I could read the newspaper through it and then washed it in water as instructed and let it dry. On a lark I decided to weigh this piece of Ecuador gold and was shocked that my mid 4# piece was now 5-1/4# wood. How disappointing. I had used a brand new piece of paper and gone very slowly with as little down pressure as I could. Oh well, It was my best piece of wood and while heavier than it started it was still lighter than what I had used previously. The prop came out about 25 mg lighter than past attempts. I continued to build using pieces I laboriously sanded down and started paying more attention to the before and after weight. I started to reach the conclusion that while I could easily sand down 5# wood with very little density gain, that was not true of low 4# wood. Time to do some more thinking about the whole wood thing.

I reached the conclusion that maybe I should try some of the expensive indoor wood and see if there was really something to it. Out came an order sheet and the checkbook and soon they were on the



way to the supplier. Expectant waiting followed and was rewarded with a box on my door step. I eagerly open it up and the thought jumps in my mind, this is not much wood for all the money I spent. I take it off to the workbench to touch, study, caress, weight, and measure the sheets. I go through my 15 or so sheets and find that they are not exactly what I ordered. There were a few sheets that were the density I expected and there were a few sheets that were the thickness I expected, but unfortunately they were not the same sheets. Oh well live and learn, but for the most part this wood was lighter than anything I was able to sand down myself. Off to build a new prop with this costly lumber. Well, the new prop finally allows me to break the 200 mg barrier and is actually about 185 mg. Definitely an improvement over the sanded down stuff and my times continue to improve.

I start thinking some more about this indoor wood thing. It seems like there really is something to having the wood sawn to the proper thickness and not sanded. I started asking around about sawing indoor balsa and it seemed to be a black art. There were a few select wizards that were cutting successfully, but no one wanted to talk in detail about how they did it and what worked. The few references I could find all indicated that indoor balsa sawing was done with a circular type saw and not a band saw. This gave me a place to start. It was time to experiment.

It seemed that a lot of the mystery around wood cutting was the actual blade. I figured that choosing the blade I wanted to use would be a good place to start. From the little bit I could find the saw blade needed to have no offset on the teeth and be hollow ground to give some clearance. I started looking at wood blades and could not find anything that seemed to meet this description. Another one of my hobbies is metal machining. Through this I was familiar with a circular type blade that seemed to meet all the requirements. It is referred to as a jewelers saw or slitting saw and I knew they were available in a variety of diameters from 1" on up 5" diameter and range of thicknesses from .010" up to .125". This sounded like just the ticket and I just happened to have a few .020" x 2" blades on hand. So I mounted one up on an arbor and put it in the chuck of my metal lathe and tried cutting some sticks off of a 1/8" sheet and it worked great. Now I just needed a bigger diameter blade and some balsa blocks to experiment with. I jumped on the Internet and ordered some .030" x 4" blades from a tool supplier and stopped in to a local hobby shop to find the lightest block they had.

A week or so later I was ready to test out what I thought would be a great way to slice indoor wood. The machine I was using is a Shoptask 3 in 1 metal machine and the cross feed has 12" of travel. I have converted the machine to be a computer controlled CNC unit. I again set up the blade in the lathe and now attach a 6" long x 1-1/4" thick balsa block to the cross slide and instruct the computer to feed it through at 5 inches per minute. The blade starts cutting into the wood and the cut is looking good until I have the blade complete into the wood. Then things go drastically wrong! The blade is suddenly wobbling all over the place and the smell of scorched balsa hits me. Of course the computer could care less and it is still trying to feed the wood into the blade that now is looking like a rotating potato chip. I am desperately diving for the stop switches to stop the feed and the spindle motor before something breaks. I get everything stopped and it is just a mess. Gouged, singed balsa, warped blade, and what a stink. I stand there assessing the damage for a few minutes and while I am watching the blade miraculously start straightening out and goes back to the proper shape. Curious. Post mortem analysis revealed that the blade has so little clearance with the slight hollow grinding that it was rubbing against the balsa block. Once enough of the blade got into the balsa wood the heating effect of the drag was greater than the cooling of the blade on the part that was not in the cut. The ensuing expansion caused the blade to warp. Once the blade was allowed to cool it contracted and regained it's shape. Great lesson, only about \$30 wasted and now I was at a loss regarding how to cut balsa.

Good fortune came my way. I heard of a book offered by Joe Maxwell of Scotland titled "Balsa for Indoor Models" (now out of print, but Joe is allowing INAV to publish excerpts from it). Quickly my money was in the mail for a copy. What a great book! It covered so many aspects of balsa that were a mystery including a complete chapter on how Joe went about cutting indoor wood. I was now convinced I could master the art as there was nothing Joe was doing that was beyond a mere mortal. The major difference in approach between Joe and I was in the blade. Joe was getting his results with

a Dewalt Thin-Kerf carbide blade. (Kerf is the width of the cut made by the blade – Ed.) Even with that name the blade has a .095” or so kerf, but Joe thought that the wood wastage was more than offset by the smooth finish and zero density gain he was getting. So armed with new knowledge and after some e-mail exchange with Joe I was in search of some carbide blades to try. While looking I saw some carbide saw blades that were designed for use on battery powered circular saws that were 5 – 6” in diameter and only had a .065” or so kerf. These appealed to me as the size was more appropriate for my equipment and the thinner kerf was attractive. So, \$50 later and I had a few different brands of these cordless saw blades to try. Back into the workshop I headed. This time I was ready for the worst as I instructed the computer to feed the wood into the blade with the kill button in my hand. The saw entered the wood and just kept on cutting to the end. No problems at all!

Now I had a blade that seemed to be cutting just fine, but I was limited to a 6” block. Time for some more head scratching and scheming. I was convinced that the consistent feed that the computer controlled equipment delivered was something that would be very beneficial to top quality results. This meant that I needed to cut the wood on a machine that had a maximum 12” of travel. A little more looking it over and the thought occurred to me that I could get enough travel to cut a 12” long block if I were to move the table on a diagonal. Normally this would be out of the question on a manual machine, but with the computer control it would be easy. To take advantage of this I would have to put the blade in the mill spindle sitting horizontally and pass the wood through it diagonally and then lower the quill for the next cut. I didn’t see any reason this would not work so I set it up and tried cutting the hobby shop test block I had. Wonder of wonders, I was getting nice consistent sheets of mid 5# balsa! They were a little more coarse on the surface finish than the commercial Indoor balsa I had purchased, but it was very usable and I cut it myself. I proceeded to build some parts with it and they worked great.

With some successful results under my belt I decided to start looking for some light balsa logs to cut and began thinking about what a machine optimized for indoor balsa cutting would look like. I found a vendor that claimed to have some under 5# balsa block so I order \$100 worth. It was very costly on a board foot basis, but they delivered what they promised. I was happy and bought another couple hundred dollars worth while they had some light material to sell. On the machine side I analyzed what is was that allowed me to get the results I did.

Some of the attributes that I felt important was an automatic feed to get consistent cuts, moving the balsa on a fixed track so that the blade stayed centered in the kerf, a cross feed to set the sheet thickness that had a sub-thousandth of an inch resolution, a very stiff spindle to reduce vibration, and a smaller than normal blade diameter (All the balsa cutters I could get to tell me anything admitted to using a 10” saw) to help eliminate vibration in the blade. I then created a design for the carriage portion of a dedicated balsa cutter and set out to build it. It has a 24” lengthwise feed with a 6” cross feed. The carriage is moved with ball screws that are driven by stepper motors. The contraption was completed and tested and it did indeed move as expected and looked like it would do the job of moving the balsa block past the saw blade perfectly. Now I needed to come up with a spindle and drive system for my balsa cutter. My two requirements for the spindle were that it allowed speeds in the 6000 – 8000 rpm range and that it was very stiff. I started thinking about how I could build a unit that would accomplish these goals and every design I could come up with require more complexity than I was willing to create. I then started looking if there was a commercial spindle I could use. About this same time I ran into a deal on a 5500 lbs computer controlled Bridgeport series II milling machine. I jumped at the opportunity and was soon the proud owner of some serious iron. Unfortunately, I had no place to put it. This quickly led to a decision to buy a 10’ x 20’ storage shed and to remodel the house. The goal was to end up with half the car garage as a metal working shop and a wife that was happy to have it that way. This endeavor put all hobby projects on hold.

Once the house was about done and Bridgett (the Bridgeport) had been moved into place I set to work getting her running. I quickly realized that the 30” of travel she offered would let me cut 18” strips of balsa quite easily. Out came the credit card and an order was placed for an arbor to fit the saw blade to the machine. Once the blade arrived I was ready to give cutting another try. I took my test piece of

balsa and attached it solidly to the table. The motor was spun up and the computer was commanded to go. The blade parted the balsa and the cut was better than I had previously achieved. I proceeded to cut off a number of sheets of B grain stock in thickness from .008" on up. Success seemed at hand. I took my balsa in the house and compared it to the commercial indoor wood I had. Close but no cigar. While the wood had no visible saw marks the carbide blade was just not sharp enough to cut cleanly with the RPM of the machine. So close I could taste it, but a little more scheming still required.

E-mail exchanges with Laurie Barr and an brief explanation of cutting techniques from Stan Chilton got me thinking that I needed a steel blade to get a clean cut. Stan uses a wood working blade that he has reworked to his specification. Laurie pointed me toward 6" x .0625" metal working slotting saw blade. I had never seen ones quite that large a diameter, but armed with the knowledge that they existed I was on a quest. I found a German made cobalt steel blade that seemed to fit the bill. Was a little pricey at \$85, but thought I would give it a try. Of course it took a different sized arbor than the previous blade so that was added to the order for about \$35. At the same time I decided the results were encouraging enough that I would buy the industrial type dust collector with the optional 5 micron filter bags that Stan Chilton told me would cure the gagging on balsa dust problem. The dust collector and the blades arrived and I was ready to try again.

Out with the balsa block and power up all the equipment. Punch the button on the computer and the block heads to the blade. Wow this is great, the dust is streaming off the blade and into the dust collector hose just like smoke. No gagging, Stan was right. Even more important, the balsa sheet now looks spectacular. It is as smooth on the surface as the best I have from the commercial indoor source. I finally feel I have this balsa cutting thing figured out.

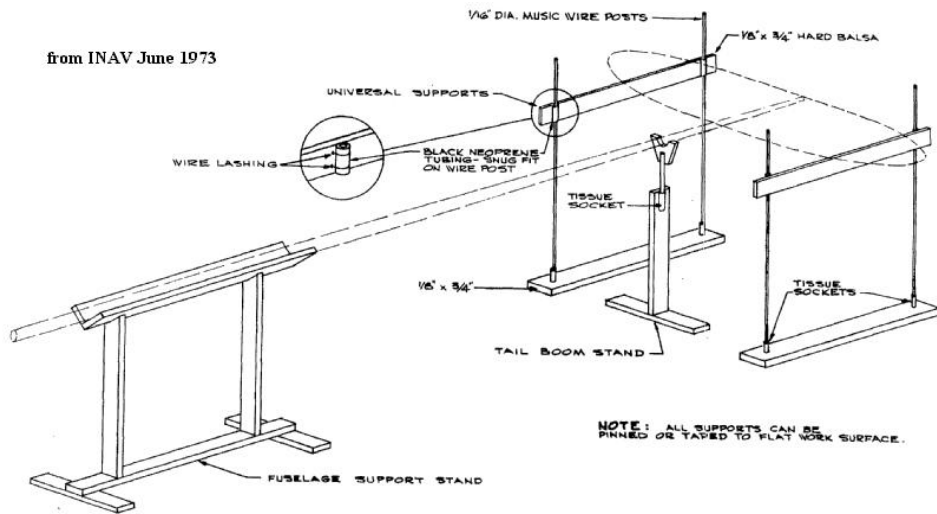
What did not work for me:  
Cutting on a table saw  
Carbide blades  
Hand feeding  
Small diameter thin blades

What is working:  
HSS blades  
Computer controlled feed  
5 micron filtered dust collector  
Tramming the blade a few thousandth

Reprinted Issue 105 2002

Fuselage and Boom Assembly Jig

Author Unknown

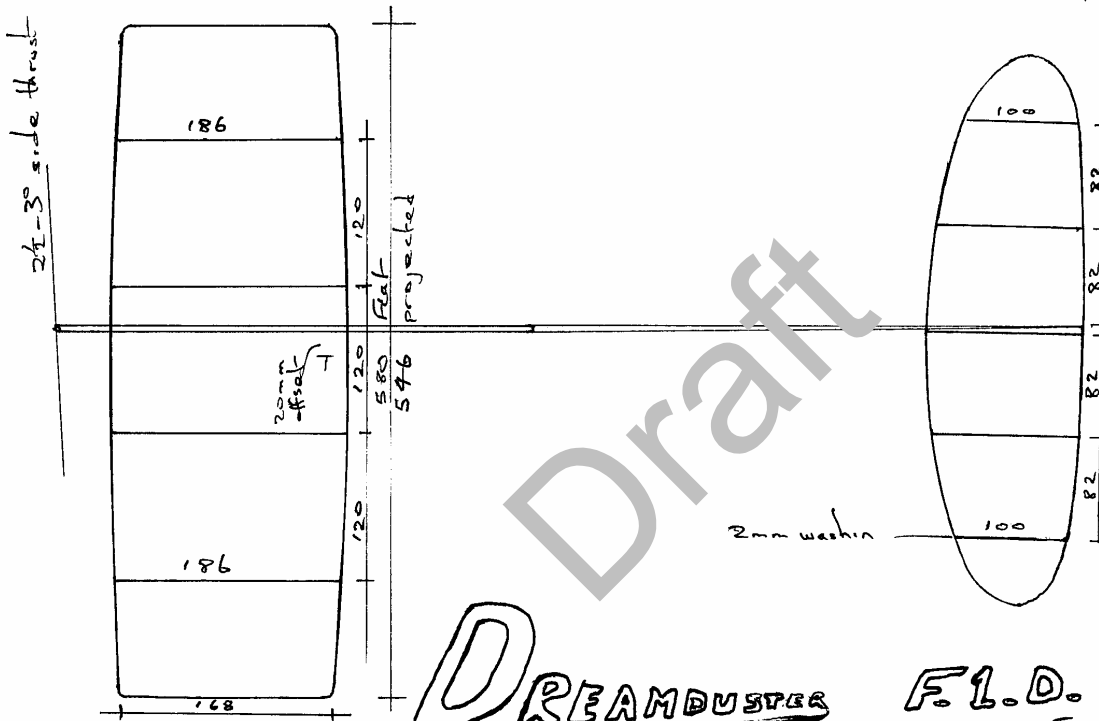
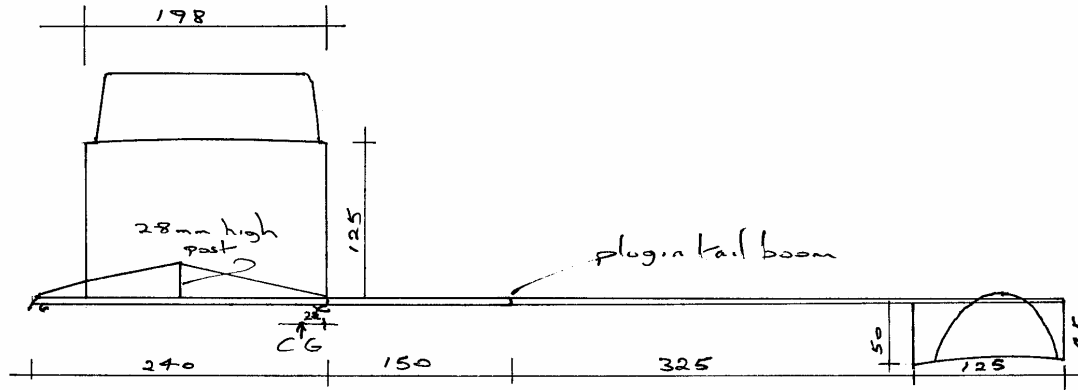


**FUSELAGE AND BOOM ASSEMBLY JIG**

Draft

Dreamduster F1D

by Ron Green

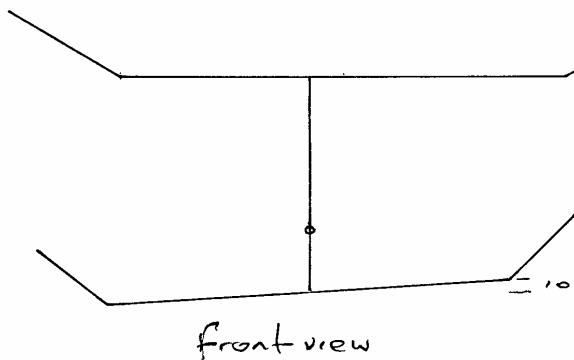


**DREAMDUSTER F1.D.**  
 Sco

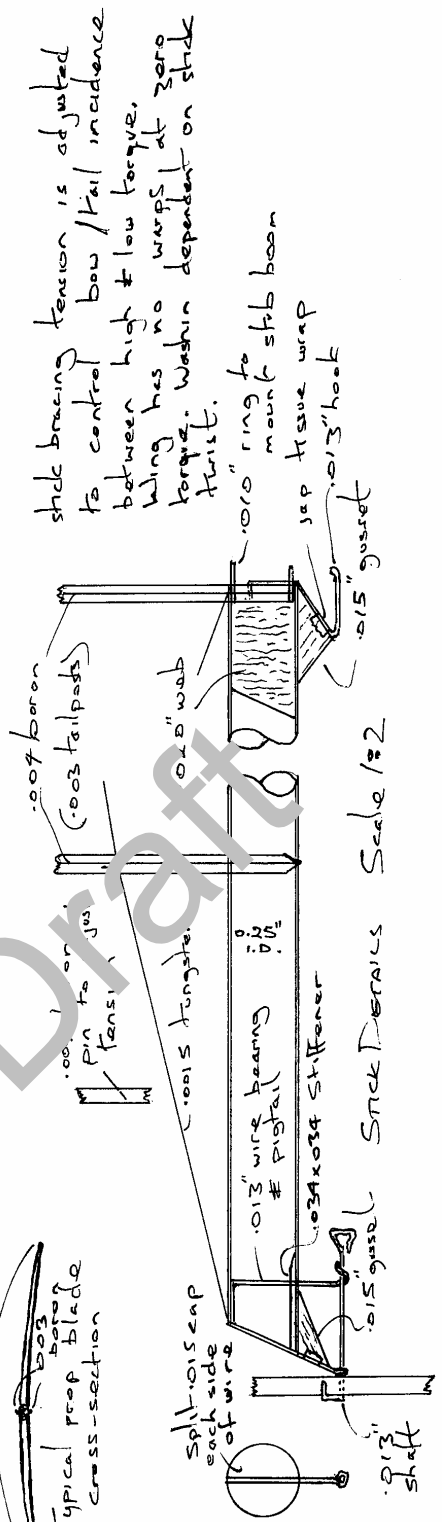
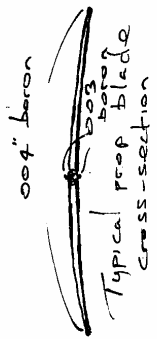
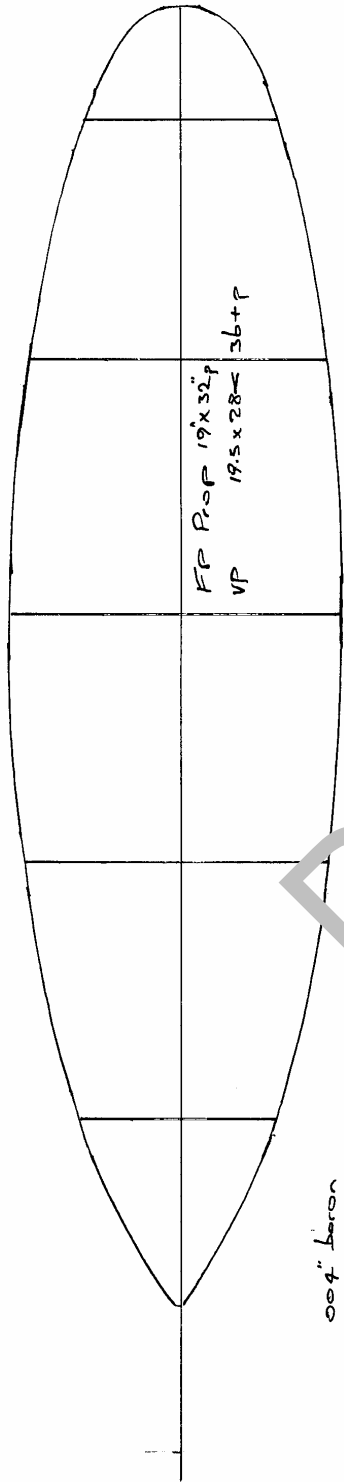
designed & drawn by R.

Best times to d

V.P. 34:06 Cardington  
 F.P. 35:25 Cargolift



10mm tail tilt  
 but adjust for size of s



Typical Weights,  
 Stick & stub boom  
 Boom  
 Wing  
 Stab  
 FP prop  
 VP prop

Typical Wood Sizes  
 Stick .0013"  
 Stub boom 0.010  
 Boom 0.009

Wing  
 spars .090 V .05  
 tips .055 V .035  
 ribs .060 V .04 x .02

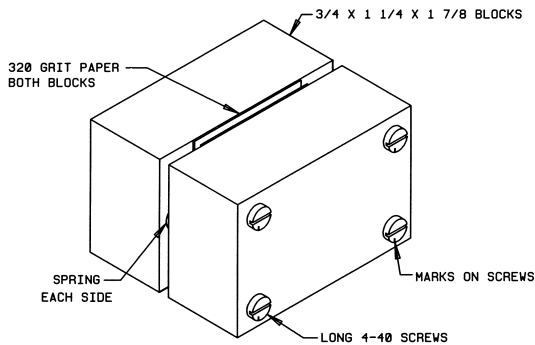
Stab.  
 spars .050 V .0  
 tips .029 x .0  
 ribs .030 x .02

Note  
 Wood density sizes vary dep on stiffness

Prop  
 Outline .004  
 ribs .024 x =  
 spar 0.070" dia + 2 .003

VP hub similar to Steve Brown b. wire top stop gap tissue tubes allow adjustment replacement of

Wing Post Sander  
by Ray Harlan



Recently I devised a wing post sander that works so well I had to pass it along. After 40-odd years of indoor building I got tired of sanding posts to get good fits in tissue tubes. I always liked round posts and have not gone with the rectangular-post crowd. The sanding rig I came up with not only gets posts round (to .0002" or better!), but can let you ease into a very nice tight fit on the tube.

Start with two wood blocks about 3/4 x 1 1/4 x 1 7/8. Tape them together and drill .089" holes near each corner. Mark the blocks so they can be

matched in the same positions later. Separate them and open the holes in one block to .120". Tap the other block 4-40. Even though the blocks are wood, if the screws are long (1 1/2") the threads will hold just fine. Mark the inside faces of the blocks between the upper and lower screws so counter bores can be drilled to hold the springs. Choose two light springs to hold the blocks apart against the screw heads. Drill counter bores so the springs have good clearance and the springs hold the blocks apart about .2" with no load. Glue two one-inch wide strips of 320 paper to the inside faces of the blocks. Assemble them with the springs in place and run the screws down until the faces of the blocks touch. Now put a mark on each screw head in the same spot relative to the block (e.g. down). If the screws are backed off the same amounts, the blocks will stay parallel.

To use the sander, first shape extra-length posts to a rough octagon shape by planing or sanding off the corners of square stock. Start with a piece that is at least .010" over the required final size, so the sander can round it without having any low flat spots. Put the post in a drill press or electric drill by lightly holding it in the chuck. Run the drill at low speed (about 600 RPM). Open the sander blocks so the post fits in loosely and slowly run the sander up the post and back again. All of the screw-head marks should be in the same position. Close the screws 1/8 turn and repeat the sanding. Be careful not to twist the block so as to put a bending load on the post. Repeat this process until the post is a tight fit in the tissue tube. Remember, each 1/8 turn reduces the post diameter about 003". The final passes will have less than 1/8 turn changes on the screw. When finished, twirling the post in a dial thickness gage will show no movement of the needle, and the posts will be the same diameter their full length. Even Middle School Science Olympiad students have used it successfully.

Ray Harlan

Issue 105 2002

### Balsa Facts

by Bernard Hunt as posted on the Yahoogroups Indoor mailing list:

There is a lot of folklore about what grain (more accurately described as medullary ray orientation) is best for particular duty (wing spar, wing rib, solid motor stick etc).

There is pretty full description of the mechanical properties of balsa (density, strength, stiffness etc) in the scientific literature. Balsa is highly anisotropic in that its properties vary strongly with direction. Here are some data from a standard textbook on timber for 12lb density (200 kg/m<sup>3</sup>) balsa:

E Lengthways	6300	G LT	203
E Radial	300	G LR	312
E Tangential	106	G TR	33

Where E= Youngs modulus and G= shear modulus.

Lengthways= along the trunk and parallel to the TRUE grain.

Radial= from the centre to the outside( the direction in which the medullary rays run).

Tangential= parallel to outer circumference (or bark) of the tree.

The plane Lengthways-Radial (LR) is one we call "C grain".

The plane Lengthways-Tangential (LT) is the one we call "A grain".

The anisotropy is even more extreme for lower density balsa.

Strength properties follow a similar pattern to these stiffness properties with the added complication that tensile and compressive properties differ.

These data tell us:

Balsa is 20-60 times stiffer along the true grain than across it.

A "C Grain" balsa sheet is 3 times stiffer across the sheet than an "A grain" sheet.

The stiffness of a spar or sheet along the true grain is exactly the same whether it is "C" or "A" grain.

You should not be able to tell them apart on an Euler buckling test.

Balsa has great stiffness along the true grain for its weight but it is poor in shear. This means that resistance of a spar or stick to twisting is not naturally good - you need to make them thick.



## A New Method of Joining Prop Spars

Steve Fujikawa

I have never been satisfied with the customary method of joining 2 prop spars with a scarf joint. Spars joined in this manner have their thickest dimension parallel to the shaft and the blades glued on along the spanwise edge. There are a couple of things wrong with this. First, a rectangular cross section spar is in theory intended to take loads parallel to the deepest dimension and we're applying them at an average  $45^\circ$ , an inefficient use of the beam's section. Second, if the spars are double tapered, the blade longitudinal axes are not exactly radial, a negligible aerodynamic inefficiency to be sure, but more importantly it complicates blade set up by not being able to sight along the length of both spars to determine straightness.

The new method eliminates both shortcomings by orienting the spars at  $45^\circ$  to the shaft while providing a full span reference line for alignment, and in addition presents a more stable mounting surface for the blade by allowing gluing to the flat top of the spar rather than the edge. It is compatible with both sheet wood and built up props. And the wood joint is simple and requires no compound mitering.

Referring to the illustrations, notches are first cut in the top of the spars at the hub. Experimentation will show that the notches can be interlocked in a right or left hand manner. We only want the right hand as shown, so get this right before you glue it! The spars are glued using a straightedge and a flat bench top for alignment. A filler piece is added to the bottom side at the hub to provide a flat surface for the thrust bearing. The location of the exact geometric center of the spar is at the center of the joint. Initially I thought that drilling square through the joint might be complicated by the harder glue deflecting the drill, but this is actually not a problem.

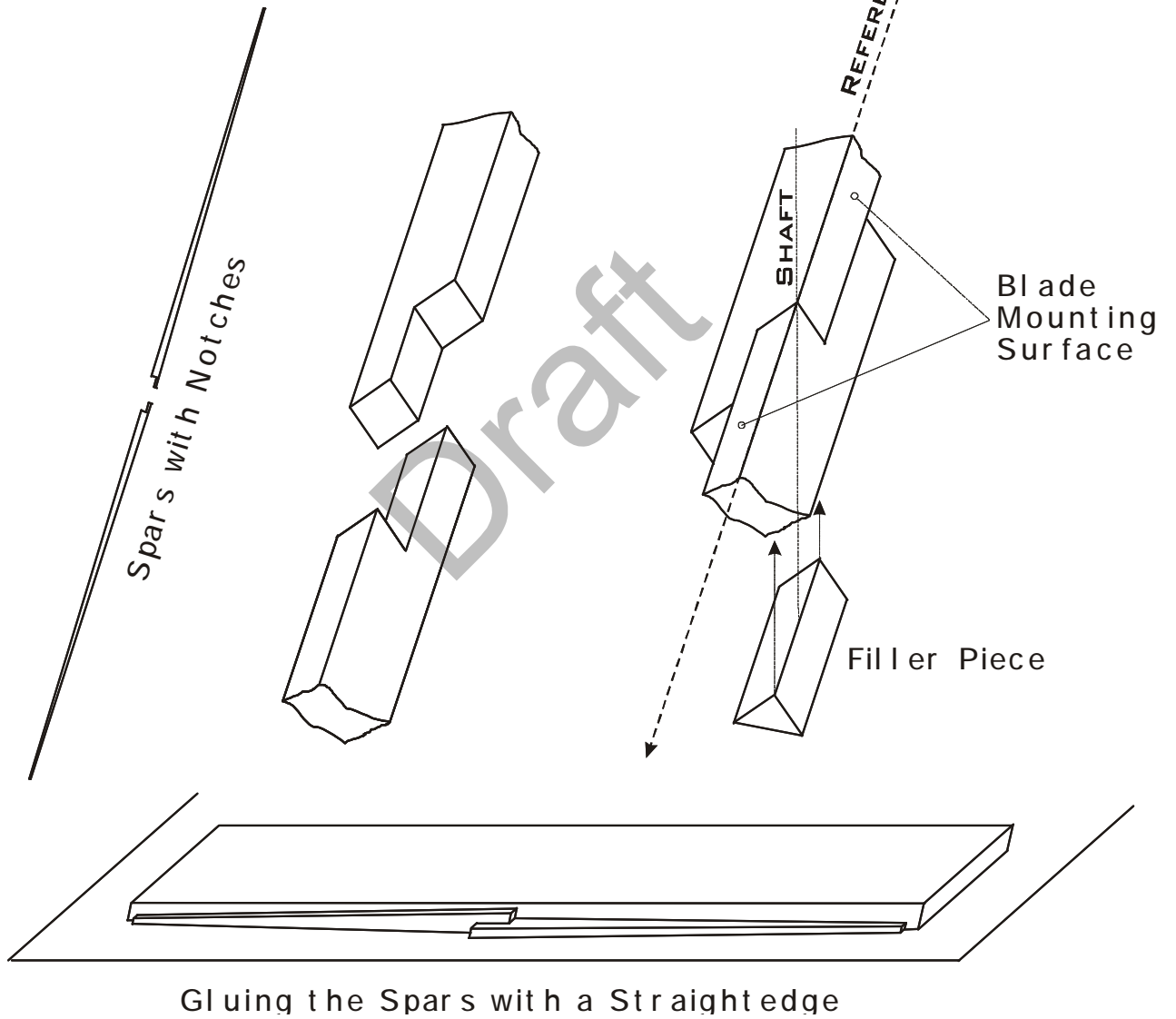
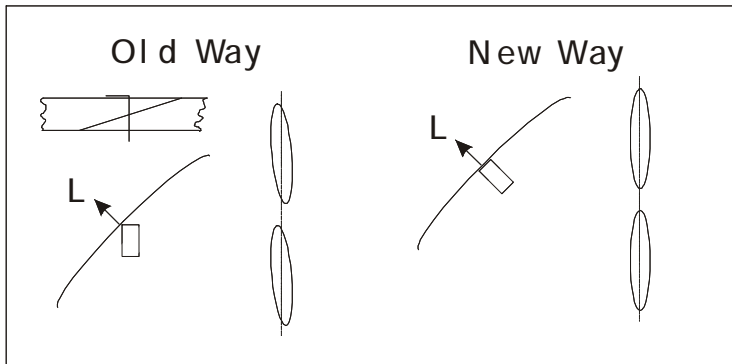
The hub itself thus created is extremely stiff and some weight could be saved by shaving off a little wood from the overlapping section, if desired. In theory, a lighter weight spar could also be used as its section is now being employed more efficiently.

When the spars are joined using a straightedge, a perfectly straight full span reference line is created for gluing the blades. I like to check blade alignment by sighting spanwise along the prop spar. Straight lines drawn down the longitudinal axis of the blades should appear perfectly co-linear, any blade misalignment is immediately apparent.

When gluing the blade to the spar, lay the spar top flat on the blade axis and put a single drop of glue at the  $45^\circ$  point. When then placed on the pitch gauge the angular distribution should be very nearly perfect, and completing the gluing is easy.

I suggest that this joint also be used with the EZB blades described in INAV #96 pp. 16-18. The author had the right idea with gluing the blades flat but the described wedge doesn't facilitate pitching or alignment. Although a straightedge/bench top can't be used as a gluing jig with the blades already attached, blade alignment and pitching will still be simplified.

# A New Method of Joining Prop Spars



On EZB Motor Sticks  
Bill Dodson

“Does anyone here fly EZB’s?”

“Yes, the fellow at the end of the line. Just follow the sound of the cussing...”

Few things are more challenging in indoor modeling than finding a light EZB motor stick. I built my first model from the IMS kit, then ordered a bunch of indoor balsa from Mr. Gitlow. I had been sent a copy of INAV #90 by a generous modeler, and started slicing and testing wood bits with the intention of building a .6-.7 gram Hobby Shopper EZB. I sliced a motor stick sized stick off the bottom of a piece of IMS fuselage stock, trimmed it to size, and it met the deflection tests. It only weighed .145 grams, and my model came out to .515 grams finished. It climbed right up and out of sight in the rafters at Tustin never to be seen again. I then proceeded to try and duplicate this feat (the model, not the rafters), but could not even come close to that motor stick’s weight or stiffness, even from the rest of the motor stick stock sheet. My lightest effort came out to .185 grams, and was not adequately stiff.

I spent many afternoons and evenings going through contest balsa in hobby shops, and brought home a bunch of promising pieces, and I thought a lot about the subject. What I wanted was a way to test 9” lengths of 1/4” by 3/32” balsa right off to tell if I had a winner or not, without having to go to the trouble of turning them into motor stick blanks first. I have tons of blanks – my best pieces to date came from a 1/4” thick piece, so I could not just slice them out directly, as one can from 3/32” sheet. It stands to reason that if you test a fuselage blank for stiffness in bending, a strip of wood in “pre-blank” condition could also be tested, I just needed to know what deflection to look for. I tried some sanity check calculations to see if the problem can be brought from the realm of the abstract into engineering terms. From the Hobby Shopper article, the dimensions of a finished motor stick are roughly:

.094” thick, 8.5 “ long  
.150” high at the nose increasing to .225” about 2.8” back  
.120” tall at the tail end

To calculate its volume:

$$V = .094 \times [ (.150 + .225) / 2 \times 2.8 + (8.5 - 2.8) \times (.225 + .120) / 2 ] = .142 \text{ cubic inches}$$

Assuming 5.5 lb density balsa, this motor stick should weigh:

$$W = 5.5 \text{ lb / cu. Ft} / (1728 \text{ cu in/cu ft}) \times .142 \text{ cu in} \times 453.6 \text{ grams/lb} = .205 \text{ grams}$$

( Eavg = 220,000 psi )  
5.0 lb balsa -- .186 grams ( Eavg = 180,000 psi )  
4.5 lb balsa -- .168 grams ( Eavg = 140,000 psi )  
4.0 lb balsa – .149 grams ( Eavg = 100,000 psi )

Since I have sheets of 3.8 lb wood, a .145 gram motor stick is possible, but can one reasonably expect to find a piece stiff enough? J. H. Maxwell gives us the following formula for average balsa stiffness (Eavg) as a function of its density, which I added to the above listing :

$$E_{avg} = 0.08 \times (\text{Density} - 2.75) \times 1,000,000 \text{ psi} \quad (\text{eq. 1})$$

Larry Coslick, in the Hobby Shopper article, writes that a good fuselage stick should deflect no more than (.120 - .051) = .069 inches when a 31.9 gram weight is applied to the top of the stick, or when a 10.7 gram weight is applied on it’s side. I will assume that the 8.5 “motor stick is supported 1/10” in from each end, for an unsupported length of 8.3”.

To estimate the value of E required for the fuselage stick, I turned to NASTRAN, a finite element analysis software package used to calculate structural deflection and stresses, and for aircraft flutter analysis. It is akin to hunting mice with a Bazooka, but it has been far too long since I have used my brain to derive a closed form solution. I modeled a 5.5 lb/cu. Ft. balsa beam ( Eavg = 220,000 psi ) to

the requisite dimensions, broke it into some 400 solid elements, and applied the proper loads (Figures 1 & 2). Running the model, I obtained:

Volume = .142 cu. In.  
 Weight = .205 grams  
 Vertical Deflection = 0.072” for a 31.9 gram load  
 Lateral Deflection = .096” for a 10.7 gram load

Which checks out well for volume and weight, but requires a sanity check for the deflection values. To this end, I also modeled a .094 x .25 x 8.5 and a .125 x .25 x 8.5 strip of 5.5 lb balsa (Eavg = 220,000 psi) in NASTRAN, to compare the results to the beam deflection equation for a rectangular strip:

$$\text{Deflection} = ( \text{Load} \times \text{Length}^3 ) / ( 4 \times \text{Thickness} \times \text{Depth}^3 \times E ) \quad (\text{eq. 2})$$

Distance between pivots = 8.3” ( “Length” ) – this assumes the sticks bridge the pivots by .1” on each side. Since the deflection is proportional to the length cubed, this dimension is important to the final result.

I found a passable closed form solution for the deflection of a tapered beam and attempted to express it in spreadsheet form. I input the same constant width and depth sticks for a sanity check:

	HAND CALC	NASTRAN	SPREADSHEET
.094 x .25 x 8.5 beam:			
Vert Def -- 32.9 gram load	0.031	0.031	0.031
Lateral Defl – 10.7 gram load	0.074	0.074	0.074
.125 x .25 x 8.5 beam:			
Vert Def -- 39.5 gram load	0.023	0.023	0.023
Lateral Defl – 10.7 gram load	0.031	0.031	0.031

From the above table, we can at least conclude that the NASTRAN and spreadsheet results for the straight beam are reliable. For a Hobby Shopper motor stick made from average stiffness 5.5 lb wood we calculate:

	NASTRAN	SPREADSHEET	
.094 x .150/.225/.120 x 8.5 fuselage:			Difference
Vert Def -- 32.9 gram load	0.072	0.082	14%
Lateral Defl – 10.7 gram load	0.096	0.095	---
.125 x .150/.225/.120 x 8.5 fuselage:			
Vert Def -- 39.5 gram load	0.054	0.062	14%
Lateral Defl – 10.7 gram load			---

From this table we see the hazards of collecting enough information that the various answers conflict. Had I used either method by itself I could have believed my answers were perfect. This is the danger of trying to predict reality from mathematical approximations – they are just approximations. There is great value in these approximations, however, for predicting general trends, as we will see shortly. I tend to go with the NASTRAN results (NASTRAN costs \$120,000 and is specifically for structural analysis, EXCEL costs \$200 and is very general purpose, and, of course, I - the weakest link - generated the inputs for both) for deflection, as I am not sure how well the closed form deflection equation handles a lot of taper. NASTRAN handles any shape pretty much the same way and gives good results provided the input is correct. The spreadsheet, however, can be posted for general public use, and one can always reduce the output by 14% or so.

Using the constant section beam bending equation above we derive the following relationship for scaling bending deflections (eq. 3) :

$$\text{Def1} / \text{Def2} = \text{Load1} / \text{Load2} \times \text{Length1}^3 / \text{Length2}^3 \times \text{Thick2} / \text{Thick1} \times \text{Depth2}^3 / \text{Depth1}^3 \times \text{E2} / \text{E1}$$

We can now determine the wood stiffness required to meet the Hobby Shopper deflections Larry wrote up in his construction article. Using the NASTRAN results, to get .069” deflection in both directions for a Hobby Shopper fuselage of the same dimensions, the balsa stiffness required is:

$$\begin{aligned} \text{E2vert} &= \text{E1v} \times \text{Def1v} / \text{Def2v} = 220,000 \times .072 / .069 = 229,565 \text{ psi} \\ \text{E2side} &= \text{E1s} \times \text{Def1s} / \text{Def2s} = 220,000 \times .096 / .069 = 306,087 \text{ psi} \end{aligned}$$

This answer mirrors what I have seen in motor stick testing, that is; “It is relatively easy to find a motor stick stiff enough vertically, by very hard to find one that meets the side bending requirements”.

Assume for the moment that balsa stiffness is the same in either direction. To size a motor stick that meets the Hobby Shopper requirements with the same E in both directions, we use equation 3 above (or the spreadsheet) to solve for the ratio of depths required, which turns out to be an ~ 15% reduction in overall height, but requires E = 352,000 psi to meet bending requirements. If we keep the same vertical dimension, we can get a motor stick that meets the bending requirements by going to a width of .111” from .094”, and now we only need a stiffness value of 184,000 psi to meet deflection criteria. The following table details the motor stick weight and stiffness ratio required for various densities of balsa for these two cases:

Volume = 0.124 cu.in.  
 Stiffness Required = 352,000 Psi

Wood Density =	6.0	5.5	5.0	4.5
Motor stick Weight =	0.195	0.179	0.163	0.146
Average Stiffness (Eavg) =	260,000	220,000	180,000	140,000
Stiffness Ratio Required =	1.35	1.60	1.96	---

Going this route, I doubt we could come up with a viable motor stick. If we leave the height the same, and increase the width to .111”, we get:

Volume = 0.168 cu.in.  
 Stiffness Required = 184,000 Psi

Wood Density =	6.0	5.5	5.0	4.5
Motor stick Weight =	0.264	0.242	0.220	0.198
Average Stiffness (Eavg) =	260,000	220,000	180,000	140,000
Stiffness Ratio Required =	.71	.84	1.02	1.3

One can measure the directional stiffness of an un-tapered blank, and input these in the spreadsheet to get some direction on what size the final blank should be to meet stiffness criteria, and how much it should weigh. Although the spreadsheet can handle it, I have not experimented with tapering the stick in width as well as in height. It would be interesting to see if there is any advantage to doing this.

Tweaking motor stick dimensions for 140% stiffness wood in my spreadsheet (dividing vertical deflection numbers by 1.14 to match the NASTRAN results) gives a weight of .190 grams for a straight-sided motor stick blank in balsa densities from 6.5 to 5.0 lb. Weight increases slightly for 4.5 – 4.0 lb wood to .195 and .200 grams. From these numbers it appears that a .185 gram motor stick from a good piece of wood is possible, and that anything much lighter (if we hold to the same stiffness requirements) is exceptional. This agrees well with my experience testing dozens of motor stick candidate strips, and finding that many of those that meet stiffness weigh over .225 grams (those go in to my giveaway box). I'd like to know how this matches other people's experience.

This study assumes uniform density across the motor stick. If you follow Larry's advice and cut a motor stick out of the "light" area of a good balsa sheet, but with a touch of darker and stiffer wood around both edges, you could beat the weight numbers. The .145 gram motor stick I had was from a dark/light striped band on the edge of a sheet of IMS fuselage stock.

Other non-wood factors contribute to the success of an EZB motor stick:

Installing the propeller shaft and rear hook at exactly the right distance below the motor stick is critical. If this distance is increased at all by sloppy building you will have too much down thrust with full winds, and the model will either dive into the floor, or speed up enough for a wing tip to tuck under. If either one is much off center the motor stick will want to bow sideways under a fully wound motor. You can turn this to your favor by bending the rear hook a little to one side or the other to help fight a bowing tendency in the motor stick.

When walking out to launch on a fully wound motor, wait until just the moment before launch to hook up the motor to the rear hook. This will prevent the stick from taking a set in the minutes before launch. You can also bow the stick away from a problem direction immediately before launch.

The lighter you build a model, the less rubber/torque it will require, and the less stiff the motor stick will have to be. For a very light model, say under .45 grams, you might be able to relax the motor stick stiffness a tad. A lot of weight can be saved in other areas if pursued with some thought and diligence. Look closely at models that are turning in higher times in contests and you will see a lot of tiny details that shave off weight.

I would also recommend a tail boom that flexes no more than 3/4" under the recommended test load. The high value of over an inch mentioned in the Hobby Shopper article was inadequate for my models, while the 3/4" test booms have been fine.

Editor's Note: Bill's spreadsheet associated with this article can be found at [www.indoorduration.com](http://www.indoorduration.com) under "Utilities".

The Hobby Shopper article by Larry Coslick can be found in the same site under "Articles", or from the INAV archive CD in Issue #90.

Balsa Facts

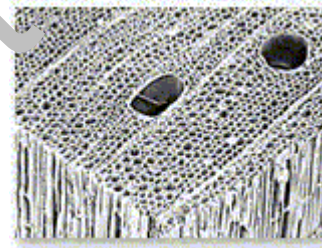
Collected by Tim Goldstein

Botanical Name: *Ochroma pyramidale*

**VITAL STATISTICS:** Tropical Height 80 feet to 90 feet tall with a trunk diameter of 12 to 14 inches. A medium-tall, thin tree, balsa grows extremely fast. It is ready to harvest in 5 to 6 years from planting. The best balsa wood comes from younger rather than older trees. Balsa trees are widely distributed throughout Central and South America, from southern Mexico to southern Bolivia and Brazil. Ecuador, however, has been the principal area of growth since the wood gained commercial importance. It is often grown there in 5,000 acre balsa tree plantations with on-site milling and production facilities.

A very surprising feature of balsa is that it can withstand some corrosive chemicals better than stainless steel! Balsa's value is chronically underestimated because of its association with model building and novelties - most familiarly that most wonderful toy from our youth, the model airplane glider. In fact, only 10% of balsa production goes into models and novelties. Balsa has a long list of very interesting uses. Due to its buoyancy it is primarily used in floatation devices, life preservers, rafts, boat hulls and speed boats. Due to its light weight it is used in aircraft flooring, recreational vehicles, off road vehicles and subway cars. Also, in artificial limbs, bathtub and shower stall bottoms and theatrical props. Due to its porosity it is used in insulation, cushioning, sound proofing, vibration modifying and other musical and theatrical needs

**WHY IS Balsa WOOD SO LIGHT?** The secret to balsa wood's lightness can only be seen with a microscope. The cells are big and very thinned walled, so that the ratio of solid matter to open space is as small as possible. Most woods have gobs of heavy, plastic-like cement, called lignin, holding the cells together. In balsa, lignin is at a minimum. Only about 40% of the volume of a piece of balsa is solid substance. To give a balsa tree the strength it needs to stand in the jungle, nature pumps each balsa cell full of water until they become rigid - like a car tire full of air. Green balsa wood typically contains five times as much water by weight as it has actual wood substance, compared to most hardwoods which contain very little water in relation to wood substance. Green balsa wood must therefore be carefully kiln dried to remove most of the water before it can be sold. Kiln drying is a tedious two week process that carefully removes the excess water until the moisture content is only 6%. Kiln drying also kills any bacteria, fungi, and insects that may have been in the raw balsa wood.



**IS Balsa THE LIGHTEST WOOD IN THE WORLD?** No! Most people are surprised to hear that botanically, balsa wood is only about the third or fourth lightest wood in the world. However, all the woods which are lighter than balsa are terribly weak and unsuitable for any practical use. The very lightest varieties don't really resemble wood at all, as we commonly think of it, but are more like a tree-like vegetable that grows in rings, similar in texture to an onion. It is not until balsa is reached that there is any sign of real strength combined with lightness. In fact, balsa wood is often considered the strongest wood for its weight in the world. Pound for pound it is stronger in some respects than pine, hickory, or even oak.

## Surface Grinding Indoor Wood

Ray Harlan

Although I have only a little experience grinding indoor wood, I was asked to write a short article on the subject. I am fortunate to have an old, mechanical Brown and Sharpe (ca 1956) that I bought cheaply some years ago. When Stan Chilton told me he was grinding wood, I asked about the particulars and he even supplied a 2" wide wheel of 60 grit aluminum oxide. I built a vacuum chuck for it, but wasn't inspired to grind wood until talking with Tim Goldstein last year. I had been hung up on balsa dust getting everywhere, which I didn't want on my other good machines. He assured me that the dust was minimal, which is true. However, if a lot of balsa is to be ground, some sort of dust vacuum is useful.

The vacuum chuck is just a piece of ¾" x 2" x 18" aluminum with .040 holes every ¼". It is relieved on the bottom and a tapped hole in the end of the plate holds a hose barb. The bottom reliefs let air get to this exit port but provide stiffening webs so the top surface remains flat under vacuum. The aluminum plate is epoxied to a ½" plate of steel that is held to the magnetic chuck. After building the chuck, it must be ground on the machine to get the top surface flat and parallel to the travel. Don't use the balsa-grinding wheel.

My first attempts at grinding seemed quite successful, until I discovered that the finished .006 balsa (for EZB props) appeared to have hinges running along the sheet. Close examination under a microscope showed that several rogue grains were sticking out of the wheel and nearly slicing through the balsa. They couldn't be felt on the wheel. If metal was being ground, they would have popped off immediately, but the balsa didn't offer enough resistance. A couple of touches to the running wheel with 320 paper managed to dislodge them and the wheel has been fine since. I am not sure of the best wheel to use, but generally a hard wheel (silicon carbide) would be chosen. It might not have rogue grains. A coarser wheel would not load as easily, but the present wheel isn't bad. I blow off the imbedded dust every few sheets.

To grind wood, I place it on the vacuum chuck and add strips of paper if the sheet is narrower than the chuck, so no holes are open in the chuck. The hose from the chuck goes to a shop vac, which provides plenty of downward force to hold the balsa. The wheel is started, brought down to just touch the surface of the wood and the table is hand traversed at a speed of about 4"/sec. For each new pass, the wheel is lowered .001-.002" until a surface sheen can be seen over the whole sheet. Grinding leaves a very smooth, almost polished, finish. When the whole sheet has this, there are no low spots. The sheet is turned over and the other side is ground. Usually only .002" needs to be removed from this side to remove saw marks (the chuck pulls the wood down and forces the bottom to be flat, so grinding the first side gets a uniform thickness). The final thickness will be uniform to .0002" or better!

I have not tested the density or stiffness coefficient of a sheet before grinding it, so I don't know how grinding affects these. To get density of the unground sheet, the thickness must be accurately known and it often varies several thousandths. Furthermore, the surface roughness will influence the measurement. The stiffness coefficient also depends on the density. There would be a large uncertainty in these parameters before grinding.

Some might think that the polished surface must be, in part, due to crushing cells when grinding. In looking at the surface under a 30-power microscope, I don't see any evidence of this; it may take higher power to assess it. One test could be performed with a sheet of, say .025 A-grain balsa. It could be ground flat on both sides and the density measured. Then it could be ground again, taking off .005 total and the density again measured. This could be repeated several times until the sheet was about .005 thick and all of the density measurements could be compared. If the surface were compacted by grinding, it would increase the density near the surface. One would expect that this crush layer would be a fixed thickness, not proportional to the sheet thickness. Therefore, as the sheet got thinner, the density should increase, because the crush layers would be an increasingly higher proportion of the



total sheet thickness. If the test shows a constant density, there is no crush layer. I haven't made this test, but the thin wood ground (.006) had a density of 4#/cu-ft, so the effect, if present, can't be very significant.

Draft

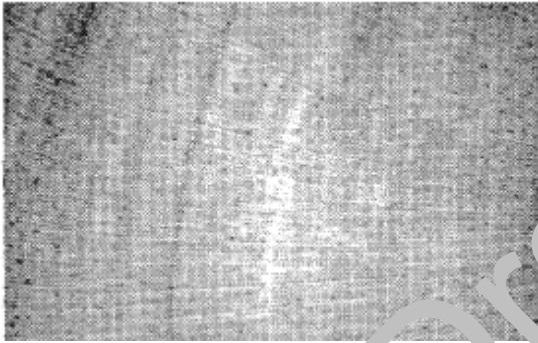
## Balsa Grain

by Joe Maxwell From his book "Balsa for Indoor Models"

What we call grain is, to be more precise, the position and orientation of the cells which make up a piece of wood. These cells fall into two main categories, Longitudinal and Radial. Longitudinal are those cells which were vertical when the tree was growing, and consequently run lengthwise in a sheet or a strip. Radial, as the name implies, are cells radiating from the centre of the tree, and so they lie at right angles to the longitudinal cells.

The cells in the longitudinal direction are further divided into two varieties, namely Fibres and Vessels. Of these, the fibres are the more important since they give the wood its strength, and the thickness of their walls determines its density. In balsa, the fibres are thin-walled and enclose a high proportion of air, making the wood very light. Vessels are the long tubular ducts through which the sap flowed up the tree. Botanically, balsa is a diffuse-porous hardwood, which means that the vessels are evenly distributed rather than being concentrated in annular rings, as they are in softwoods.

All this description of cells is more readily understood if you look at a transverse section through a block, similar to the one shown here.



The photograph is actually of a thin slice from the end of a plank, lit by a back light to show up the grain.

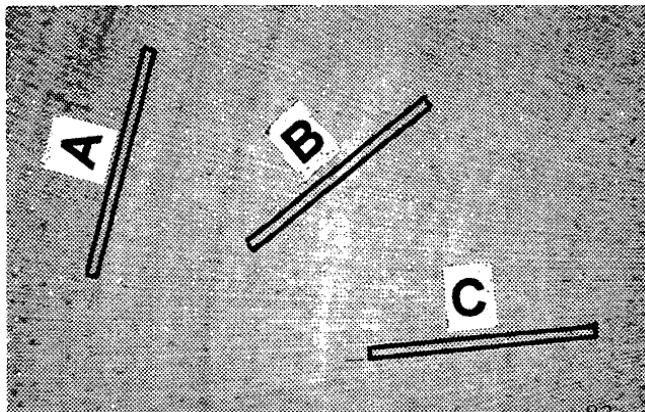
Visible in this photograph of the end of a plank are the growth rings, the rays, and the pin-holes formed by the vessels. Note how the rays are bent.

A section like this cuts through the vessels and fibres, and, although the fibres are too small to be distinguished by the naked eye, the vessels show up as pin-holes scattered about randomly. Also clearly visible are the rays which appear as fine lines fanning out across the block.

Another feature of this section is the pattern of rings, seen as light and dark shaded arcs. These are not annular rings which, in low density balsa, are about 1-1/2" apart. Rather they are the result of seasonal changes as the tree was growing, and I prefer to call them growth rings. Mostly, the rays pass through the rings at 90°, although this angle can vary slightly.

Sometimes it is difficult to see the grain on the end of a block, because it has not been cut with a fine saw. The solution is to clean up a small area with a sharp knife or a razor blade, then dab it with a damp tissue. This will make the grain stand out.

To illustrate the practical application of this knowledge of grain, the ends of three different sheets have been drawn on the end-grain photograph to show how they would lie within a plank.



Sheet A is tangential to the rings, sheet C is in line with the rays, and sheet B is somewhere in between.

The position of each sheet within a plank determines its grain. A is tangential to the rings, and C is line with the rays.

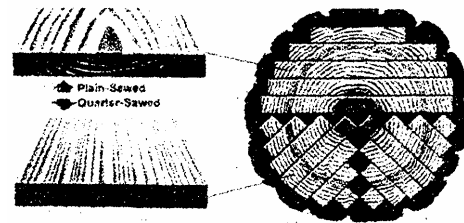
Using the letters A, B and C to identify the grain of sheets is a long established practice,

and its origin is another interesting piece of Indoor history.

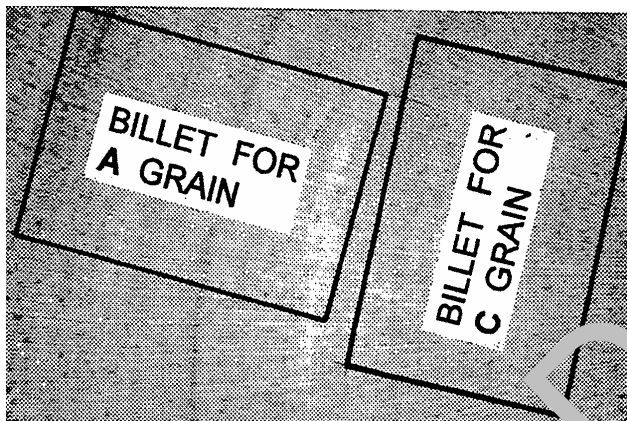
In 1933, when JASCO started to produce balsa specifically for Indoor models, they found that some of the sheets could easily be rolled into tubes for motor sticks, while others were stiff and tended to crack when rolled. Examination of the two types of sheets revealed that there was a variance of 90° in their grain. To differentiate the grain cuts they introduced a code in which A indicated the easy-to-roll stock, C was the stiff cut, and B was for general use. Later, they discovered, from a Belsaw catalogue, that their grain coding agreed with the way logs are sawn in the timber industry.

Plain and quarter sawed. These timber trade terms correspond to A and C in Indoor balsa.

The Belsaw diagram shows that A grain corresponds to plain sawn and C to quarter sawn (now generally called quarter grain). Note, however, that, of the quarter grain boards, only the middle one is actually in line with the rays. This is a point I shall return to later.



Billets must be cut from a plank at the correct angles to yield the different grains of sheet. This involves some awkward sawing and a lot of waste.

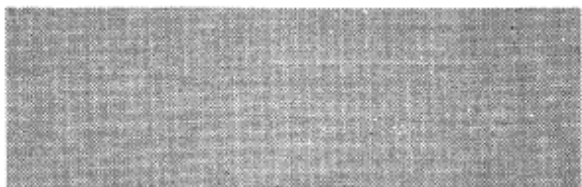


The planks, as they are received by the Indoor balsa specialists from the importers, may have been cut from any part of the log, and, as a result, every plank has a different pattern of rays and rings on its ends. From these the sawyer has to extract the billets from which he will saw the final sheets.

To yield sheets with the required grain, the billets must be correctly orientated in the plank, and this often necessitates sawing at some very awkward angles, as well as generating a lot of unavoidable waste.

The illustration shows how two billets, one for A grain sheets and the other for C grain, might be obtained from a plank.

Given a suitable billet, A grain sheets are relatively easy to produce. A series of parallel cuts will result in sheets all of which will be A grain, and will look like the one shown here. You can see that it is fairly featureless except for the vessels, which appear as darker lines.

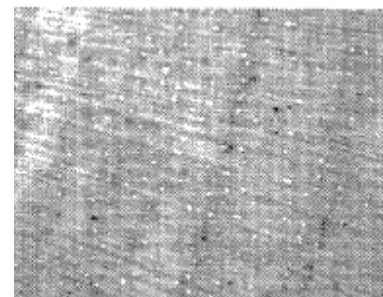


A grain sheets are featureless, except for the vessel lines. The longer these lines are the better.

Long vessel lines are desirable because they indicate that the sheet was cut in line with the longitudinal grain. If the vessel lines are short, the grain is running through the sheet at an angle, and strips, such as spars or motor sticks, cut from it will be weak.

For a sheet to be true A grain, the rays should run through it at 90° to the surface at, or near, the centre line. The only way to check this is to examine the end of the sheet with the aid of a magnifying glass.

A grain has two main attributes - its uniformity and its flexibility across the sheet. Uniformity results from the fact that the whole sheet was growing at, more or less, the same time. When a number of strips are sliced from an A grain sheet, there is a good chance that they will



all have the the same density and stiffness. The flexibility allows the sheet to be bent to very small radii without cracking. This is particularly helpful in rolling tubular tail booms.

In this enlargement of a small area of the end-grain photograph, the vessel holes show up clearly, and can be measured.

In very thin sheets, you will often find slits going right through. This occurs when the thickness of the sheet is less than the diameter of the vessels. Then the opposite walls of those vessels which happen to come midway in the thickness will have been cut away, leaving gaps through the sheet.

To put this into perspective, I have enlarged, by a factor of 2 a small area of the transverse section photograph. In this, the vessel holes show clearly and can readily be measured. The average actual size is 0.02" diameter, so any sheet with a thickness less than that is liable to show slits.



Greatly enlarged section of a very thin sheet shows that where the opposite walls of a vessel are cut, the result is a slit right through. Slits can be clearly seen in the photograph of a 0.005" sheet.

This phenomenon can appear in sheets of any grain, but it is more prevalent in A grain. This is because, although the vessels are tightly packed between the rays, they are less constrained radially. Thus the holes tend to be oval, rather than round, with the longer axis in the radial direction, that is through the thickness of an A grain sheet.

C is a more complex grain. Strictly speaking, a C grain sheet should be sawn in line with the rays, but we can reasonably relax this a little and say that any sheet that is within 5° of the rays is true C gain. Sheets complying with this definition look like the one shown here, where the rays appear as narrow stripes running right across. As the angle between sheet and rays increases above 5°, the stripes get shorter, then become mere speckles, and, eventually, disappear altogether.

In C grain the rays are parallel to the surface of the sheet, and appear as stripes running right across.



[If you would like to see perfect C grain, find a block with a split in it, and open up the block along the split. The split will almost certainly be radial, and perfect C grain will be revealed]

When a billet for C grain is sawn in parallel cuts, only two, or at the most three, sheets (depending on the thickness) will be true C grain, with an extensive pattern of stripes. All the other sheets will be speckled, to a greater or lesser extent.

In order to produce more C grain sheets from a billet, the angle of the saw has to be adjusted every few cuts. This process is time-consuming, as well as being wasteful, so - understandably - the main producers of indoor balsa avoid it. It is significant that, in their literature, Micro-X, I.M.S. and SIG all describe C grain as "mottled" or "speckled". This is a misconception, fostered by the supplies people, to justify the sale of sheets with even a hint of speckling, as C grain. To be realistic, speckled sheets should be termed CB grain, and any sheet sold as C grain ought to display a good proportion of distinct stripes.

When the rays run through the sheet at an angle, they appear as speckles. Such sheets should be called CB grain.

Another common misconception is that C grain and quarter grain are one and the same thing. Reference back to the diagram on page 16 shows



that not all quarter grain sheets (or, in this case, boards) are in line with the rays. Thus speckled sheets may correctly be regarded as quarter grain, although they are not true C grain. Paradoxically, all C grain sheets are quarter grain, but not all quarter grain sheets are C grain.

A further problem in producing C grain sheets is that the rays, as seen on the end of a billet, are often not straight, but bent. Also the pattern of rays may be twisted, from one end of the billet to the other. All of which explains why a complete sheet of C grain is a rarity.

Stiffness across the sheet, which is the main attribute of C grain, is simply due to the rays acting as stiffeners. Note, however, that although the rays give stiffness across the sheet, they do nothing to improve the stiffness lengthways. Bending tests I conducted on A and C grain motor sticks, cut close together in the same piece of balsa, showed that they were exactly equal in stiffness.

The combination of longitudinal fibres and lateral rays makes C sheets a kind of natural plywood. In fact, a good way of deciding where to use C grain is to imagine that you are designing a very large Indoor-type model with no weight constraints, and then think "Would I use plywood for that component?"

Two obvious applications are propeller blades and tubular motor sticks, where another quality of C grain comes into play. That is its ability to maintain a curve after it has been formed. If the rays are bent by some moisture/heat process, they will retain that shape after drying and cooling. This means that propeller blades will keep their camber, and motor sticks will stay circular and resist crushing.

For some motor sticks C grain may be too stiff and the rays too prominent to permit forming to the radii required. In these cases it is advisable to use CB grain.

Issue 90 Feb, 1997

“My Way” Penny Plane construction  
by John Barker (of Georgia)

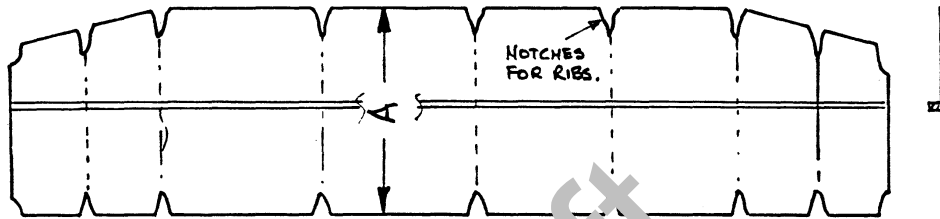
This article is intended for those who have never built a duration type indoor plane, are convinced that they can't, but don't realize that, with a little help. they CAN.

Where to start? My preference is the Limited Pennyplane (Most of my friends still call it a Novice Pennyplane and so do I ). Get a plan of a successful plane e.g. Banks Pennyplane or copy a model of a club member. If you don't have a building board try a piece of plain ceiling tile. Buy sharp dressmaker pins. You need some good quality cardboard for templates; I bought a sheet of picture matt material from Michaels, a local general handicraft store that also frames pictures. Any light color is O.K.

The Wing.

Draw and cutout the wing outline template.

It will look something like this:



Dimension A is important. The completed wing must not exceed 5.0 inch chord. Lets assume that the L.E. and T.E. are 1/16 sq. (medium). Lightly sanded assume .06 in. Make Dimension A =  $5.00 - .06 - .06 - .04 = 4.84$  in.

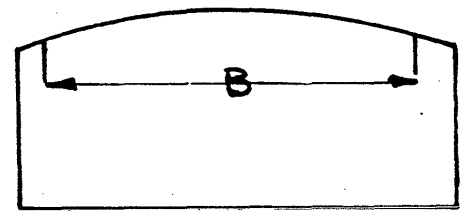
The .04 is insurance against exceeding 5.00 in. finished chord . The spar is to stop the d--- ribs falling over and to stiffen the template.

Draw and cut out the wing rib template. Mine look like this:

The two marks are the ends of the completed rib.

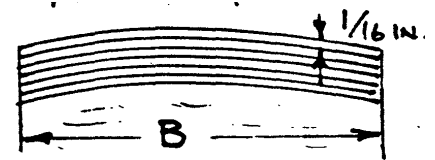
Make dimension B a hair more than dimension A.

Ribs. Get your rib material . probably 1/32 medium light sheet, and cut. a piece length B (a hair more than A) off the end of the sheet. Both ends of this cut must be clean cuts. Use the template and a sharp razor blade (not a balsa knife) to slice off ribs that look like this:



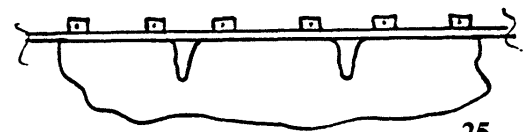
Eye bail the 1/16 in.

Some ribs may be deeper than others. Save these for the dihedral joint and center ribs.



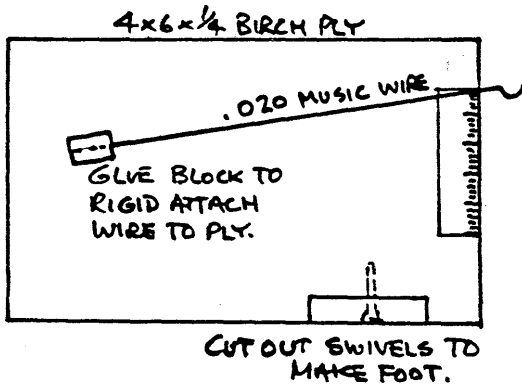
Assembling the wing. Put the usual wax paper etc. on the board and pin the wing template securely down on top of it. Make sure that the board is flat. Find some old medium soft 1/8 x 1/16 strip. Cutoff a zillion little blocks about 3/16 in. long. Use these with pins to fasten the L.E. and T.E. against the template like this;

Do NOT push the pins thru the structure OR against one side of it.



Now insert the ribs in place. If you made B a hair more than A. they will be a nice snug fit. The dihedral ribs should canted inwards by about half the dihedral angle. Use Cy glue (not the thin stuff) or acetate glue. Put a tiny drop on the end of a tiny screwdriver (or similar 1/32 across) and apply to each rib joint. When dry remove all the pins. When doing this stick a finger on the structure so you don't lift it with the pins. Pry the wing structure off the template with a lot of patience and a few well chosen words! With the wing finally free you will be appalled at its floppiness (technically called low stiffness). Don't worry, compared with an EZB its like iron !!

Weight recording. You should get in the habit of weighing parts as you go along. You can jot them down on the wing template. Do not rush out and buy expensive scales. I made one like that described in Ron Williams excellent book (Alas, not available). It looks like this:



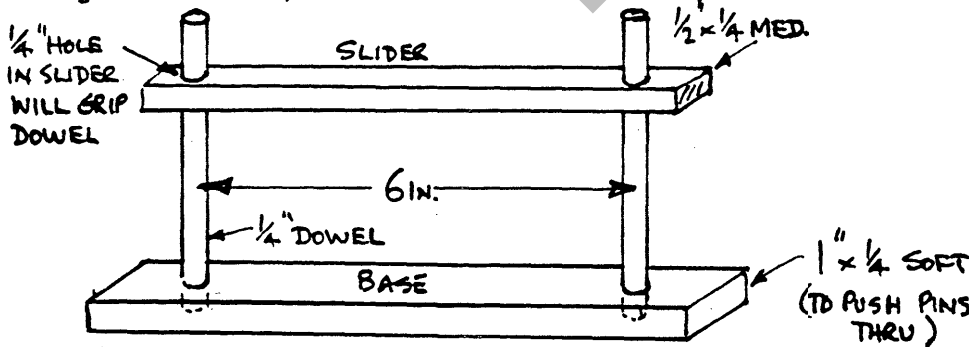
When finished you must calibrate it. A NEW penny weighs very close to 2.50 grams. The old copper ones were 3.1 grams. From which the Pennyplane gets its name. Use a very small piece of thread and sticky tape to hang the new penny on the wire hook. Measure EXACTLY how much the wire deflects at the edge of the wood (C in.). Remove the thread and tape and Hang this on and measure the deflection (D in. not much).

Make a paper scale C - D in. long graduated linearly from 0 to 2.5 and paste it along the ply edge. Tweak the wire if necessary to sit on zero. The use of a linear, equal length divisions) is not quite accurate

but will do for now until you can locate some accurate 0.50 gram weights. Beware ,some mail order weights are way off. Like I said, weigh the bare wing and later covered. Do this for every part of the plane. For future models this will indicate where you need to reduce weight or add material for more stiffness.

Stabilizer and Fin. The method is similar to the wing construction. Should be a breeze , except that you may be using thinner Wood.

NEXT MONTH. Covering with plastic film. In the meantime make a couple of wing stands like this;



These will be used for setting up wing dihedral, and for on the field repairs after you get clobbered by a HLG, some other clod. or your sleeve catches a wing tip !!

Part 2 COVERING - IT AIN'T EASY (UNTIL YOU'VE DONE A FEW)

INTRODUCTION. By now you should have built your Novice (Sorry! 'L i m i t e d') Pennyplane wing and tail feathers. If not. GO TO PART 1 and do it! For the good guys, you should cover your indoor duration plane with one of the modern plastic films. These vary from .000060in. down to around .000023in. One supplier quotes .000006in.( 6 millionth's) which I find hard to believe ! Any of these will be OK. but you may find the thicker stuff easier to handle . I buy mine from Wayne

Trivin and Dick Obarski. It comes in 15ft. rolls. Expect to waste quite a bit with your first attempts to use it.

Covering with this type of material is totally different from Jap tissue or condenser paper. It has no inherent stiffness and is full of static. If you let go of a piece it will collapse into a heap like Handi-Wrap only worse. From a strength point of view its a bit like cellophane. Once you have something covered it is surprisingly resistant to puncture. But, if you get a tear started then watch out.

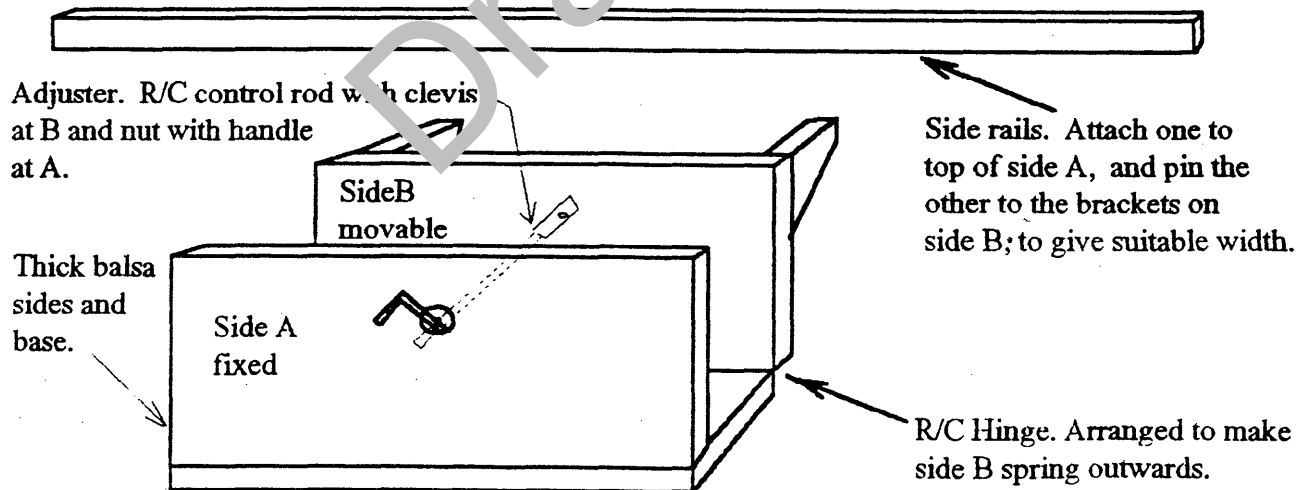
Let's cover the Pennyplane wing and tail which you built last month along with the pair of wing supports. The covering sequence will be:

1. The wing and tail must be flat with no dihedral.
2. Construct a film mounting frame.
3. Mount the film on the frame.
4. Place the wing (or tail etc.) on the framed covering.
5. Adjust the frame to roughly match the rib contour.
6. Apply adhesive.
7. Trim the covering thus cutting loose from the frame.
8. Add dihedral and remove the resulting slack.

You may read articles which describe different covering sequences. but start with my way and you will be less likely to get into a mess. But do experiment later. Now for details.

**FILM FRAME.** First construct a lightweight rectangular frame whose inside edge is at least 6.5x20in.

However you fashion this frame, it must be flat to start with and have stiff spanwise sides. With the film mounted on the frame, you must be able to introduce slack by pulling the sides together. This will let the covering conform to the rib contour. One way to achieve this is to have bendable end pieces made from aluminum wire or possibly strips cut from a soda can. Another rather more complicated method which works great is my way. This uses a screw adjustable gizmo that looks like this:



The hinges are essentially flat pieces of nylon. Arrange them to make the moving side to spring outwards. The top rails are hard balsa or spruce etc. The rail on the moving side can be pinned to the side B brackets to allow different frame widths for other models. The idea of this contraption is that the film slack can easily be adjusted by turning the handle. It is a bit cumbersome, but it works fine.

**MOUNT THE FILM.** Use a slightly damp cloth to wipe off your work board. When dry lay the roll of film down at one end and start to unroll it. Don't worry if it starts to cling together, but be very careful not to start a tear. With a brand new razor blade cut off a piece at least 1 in. larger all round than your frame. Go slowly because the razor may snag in the film and tear it. Roll up the remaining film and



stow it. Now pick up your cut piece and wad it up (you heard right!) real tight. Now spread it out again, as flat as you can, on your board.

It will have fine wrinkles and less static. Fasten it down to the board with about ten little bits of tape and, if possible, tighten it a little at the same time.

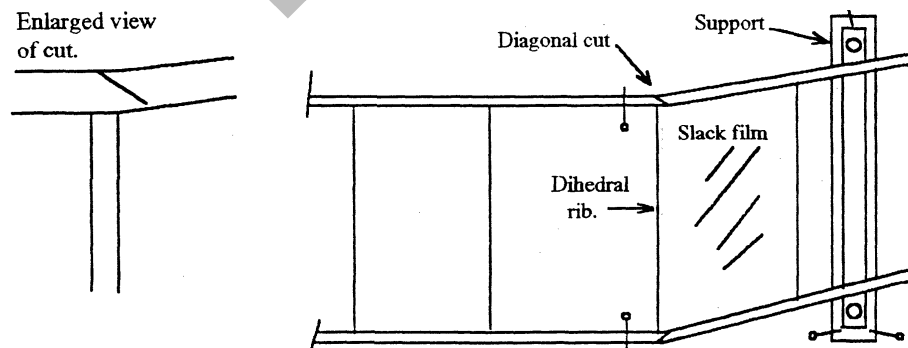
Prepare Adhesive. Use any type of contact adhesive including rubber cement that can be thinned to a rather watery consistency. I use Elmers SAF-T Contact Cement. This is water soluble. Check building supplies and craft shops. Carefully lay the frame topside down, on the film. Using a small brush apply the thinned adhesive so that it wicks between the frame and the film. Let it dry. Press down on the frame to make sure it adheres to the film. With a razor cut loose the bits of tape and slowly lift the frame and support it right side up.

COVERING. Covering is done with all surfaces flat just as they came off the building board. Do NOT sand cute airfoil type tapers into the L.E. or T.E. : it will not improve the aerodynamics, but it will weaken the members considerably. Let's start with the wing. Lay it upside down on the film. Introduce slack by bending the frame wire ends or by cranking the handle of my frame. You need just enough slack so that both L.E. and T.E. sit down on the film thus:



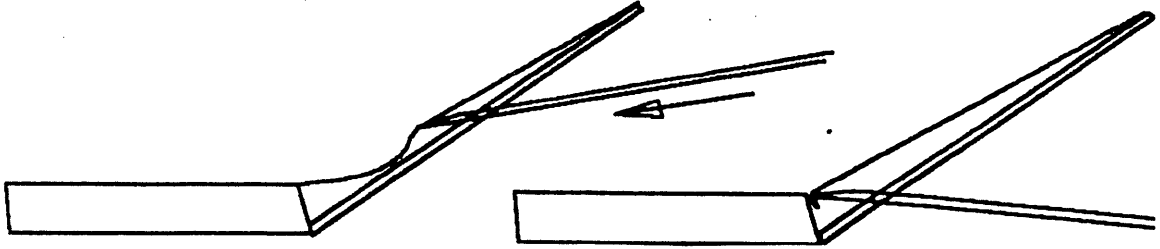
Apply adhesive. With a tiny brush apply a little thinned adhesive to wick in on the L.E. and T.E. at the dihedral ribs. Let it dry. Go around the entire outline and across the dihedral ribs with adhesive, using as little as possible and let it dry. It may be necessary to push down on the structure to make it stick. Now for the fun part! The film must be trimmed all round the outline to cut it loose from the frame. There are two ways. The first is to use a brand new razor blade from which all traces of stickiness have been removed to minimize the chance of snagging the film. The second is to use a hot wire or cautery having first practiced on a spare area of film, being careful not to pause at any one spot since you may burn the balsa or melt a hole in the covering. I have used both methods but I prefer the hot one. Which ever you choose you may want to put something under the wing to support it as it drops.

DIHEDRAL. Fasten the center wing to the board on wax paper with pins angled across the L.E. and T.E.. Slice almost thru the L.E. and T.E. at an angle just outboard of the dihedral rib, so that the rib remains attached to the inner

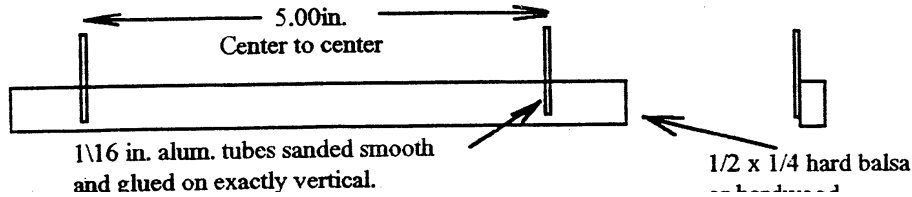


wing. Lift the wing tip to crack the spars and prop up on a wing support (you did make the supports I hope!). Pin the base of the support to the board and raise the slider to give the correct dihedral plus washout if the plan calls for it. Add pins if necessary to hold the dihedral joints together\_ Repeat for the other tip and check that the span does not exceed 18.00in. Glue the joints with Cya and remove the supports.

Cover the tail feathers in like fashion.



NEXT MONTH. Prop, motor stick etc. and final assembly. In the meantime make a jig to set up the wing attach tubes to the motor stick like this:



BALSA DENSITY TABLE

Sheets: thickness	Density, lb/cu-ft										K
	4	5	6	7	8	10	12	14	16		
1/32	3.54	4.43	5.32	6.20	7.09	8.86	10.6	12.4	14.2	1.13	
1/16	7.09	8.86	9.43	12.4	14.2	17.7	21.3	24.8	28.4	.564	
3/32	10.6	13.3	15.9	18.6	21.3	26.6	31.9	37.2	42.5	.376	
1/8	14.2	17.7	21.3	24.8	28.4	35.4	42.5	49.6	56.7	.282	
3/16	21.3	26.6	31.9	37.2	42.5	53.2	63.8	74.4	85.1	.188	
1/4	28.4	35.4	42.5	49.6	56.7	70.9	85.1	99.2	113.	.141	
3/8	42.5	53.2	63.8	74.4	85.1	106.	128.	149.	170.	.094	
1/2	56.7	70.9	85.1	99.2	113.	142.	170.	198.	227.	.071	
Strip size	No. of strips										
1/16 x 1/16	16										
1/16 x 1/8	8	2.36	2.95	3.54	4.13	4.73	5.91	7.09	8.27	9.45	1.69
1/16 x 1/4	4										
3/32 x 3/32	8										
3/32 x 3/16	4	2.66	3.32	3.99	4.65	5.32	6.64	7.97	9.30	10.6	1.50
1/8 x 1/8	8										
1/8 x 1/4	4	4.73	5.91	7.09	8.27	9.45	11.8	14.2	16.5	18.9	.847
1/8 x 1/2	2										
3/16 x 3/16	4										
3/16 x 3/8	2	5.32	6.64	7.97	9.30	10.6	13.3	15.9	18.6	21.3	.752
1/4 x 1/4	4										
1/4 x 1/2	2	9.45	11.8	14.2	16.5	18.9	23.6	28.4	33.1	37.8	.424
1/4 x 1	1										

For sheets 3 x 36 in. and strips 36 in long.

For closer work, or sizes not listed:

$$\text{Density (lb/cu-ft)} = \text{weight (grams)} \times K$$

$$\text{Weight (grams)} = \text{Density (lb/cu-ft)} / K$$

K appears in the right column in the table.

For sizes not listed, K may be calculated from the formula:

$$K = 3.81 / (L \times W \times T \times N)$$

Where L, W, and T are the length, width, and thickness in inches, and N is the number of pieces.

### Part 3 STICK & TAIL BOOM ASSEMBLY (THEY DO MORE THAN YOU MAY BARGAIN FOR!!)

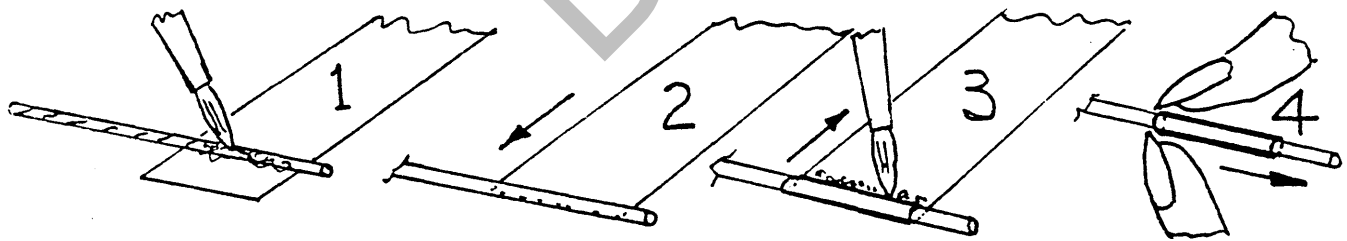
**INTRODUCTION** If you read Parts 1 & 2 you may by now have ventured into the field of indoor duration. You may also have built and covered the wing and tail feathers of your Limited Pennyplane. together with a jig to position the wing mount tubes on the motor stick. Last month I got carried away and indicated that we would be finished with this article right here. I bit off more than I could chew , so you will have to be satisfied with words of semi-wisdom on the motor stick and tail boom assembly. Why so much space for such mundane items? Read on.

**MOTOR STICK DISCUSSION:** The prime function of the motor stick is to support the wing, tail boom, prop and rubber motor. Unfortunately it does more than that! Let's consider what it does when you wind up your motor

1. It Bends. i.e. it arches up in the middle due to the tension between the motor hooks. This induces some negative tail incidence and some downthrust. Both of these are quite small for a fairly robust limited Pennyplane.
2. It Twists. For the tail this imparts a left tip down tilt, which tries to make the plane turn right (not desirable). For the wing, it twists the left wing L.E. up and T.E. down (wash in) which assists the normal trim for left turn. It also imparts a small deflection in the yawing direction.
3. Both the above will change as the motor unwinds, especially during the initial burst of power.

For early flying it is easier to trim if the above effects are minimized by keeping the motor stick stiff. Bear in mind that a stick of lightweight wood (up to 7 lb./cu.-ft.) and generous proportions will be much stiffer than a thinner stick of heavier stock. Enough talk, let's build.

**WING AND TAIL MOUNT TUBES.** These tubes are made by rolling Japanese tissue around a mandrel and impregnating with cement. Start with the 1/16 in. inside dia. tubes which carry the wing pylon sticks. Cut a strip of Japanese tissue about 3/4 in. wide and several inches long. Use the shank end of an undamaged 1/16 drill as the mandrel. Rub the shank end on a candle stub and remove any residue with your fingers. Thin some Ambroid (or similar) about 50/50 with acetone. Lay the tissue flat on the work board and proceed as in the diagrams.

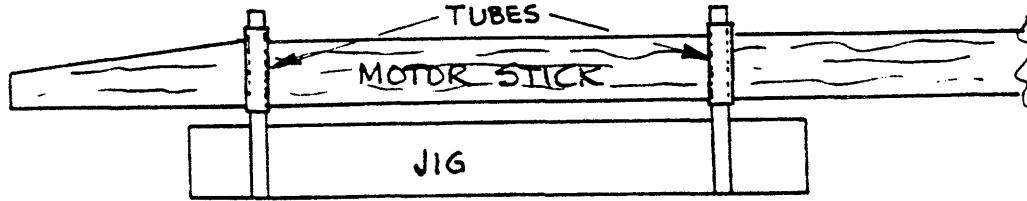


At (1) paint the mandrel with the cement. (2) roll back to pick up the tissue. (3) roll forward to start the first layer -- use of the brush will help eliminate any slack -- none allowed here. Continue rolling and adding cement for several turns. Cut off the spare tissue and twirl between your fingers to lay the end flat and tighten the coils. (4) Immediately pull the tube off the mandrel with your finger nails and let it drop on the work board. You will ruin a few until you find it is easy. The trick is getting step (3) O.K. Make several spares and when dry store them on snug fitting rounded balsa sticks. With an 1/8 drill and tissue about 1 in. wide make the tail mount tube, plus a spare or two.

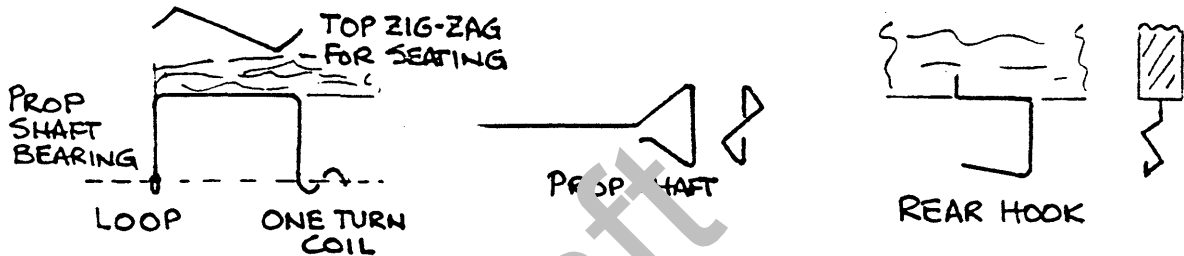
**MAKE MOTOR STICK AND TAIL BOOM.** Cut the stick and boom per your plan with a bias towards being slightly deeper than shown. When sanding leave the motor stick essentially rectangular cross section. The tail boom can be rounded. Just ahead of the tail position sand the boom to a hair more than 1/8 in.dia. for an inch or so . Later this will be the place for the tail mount tube.

Get the wing mount tubes and slice them to length with a sharp razor while still on the storage sticks. Slide them off the sticks and on to the wing mount jig. Lay this whole thing in the correct position on the motor stick side. Shim under the stick or jig so that the tubes sit nice and flat on the side (usually

left) of the stick. Glue in place with Cya. Remove the jig.



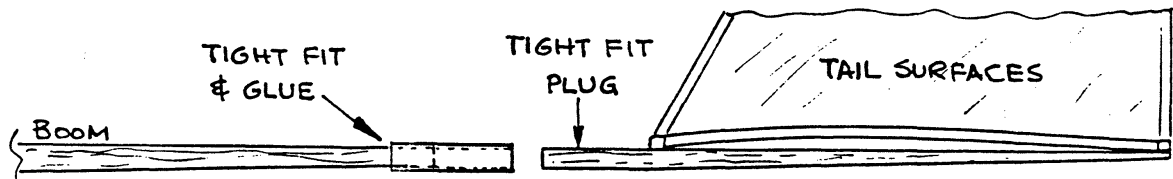
Now for the prop shaft and rear motor hooks together with the shaft dual bearing. Every one has their favorite hook shape and rubber sleeves 0-rings, etc. My hooks look like a Z shape when viewed from the rubber band side. When wound, the motor tends to center itself on this type hook. The shaft bearing has to do two things. First, it must hold the thrust line you want and second it must let you remove the prop complete with shaft for storage. Ray Harlan does a good bearing, but I make my own from music wire. The general principle of all dual bearings is similar. The front bearing is a plain hole thru which you thread the prop shaft hook. The rear bearing is a devious shape which allows the hook to be 'screwed' thru or snapped in place and then grips the shaft when in the running position. Here are some sketches (enlarged) of my hooks and bearings.



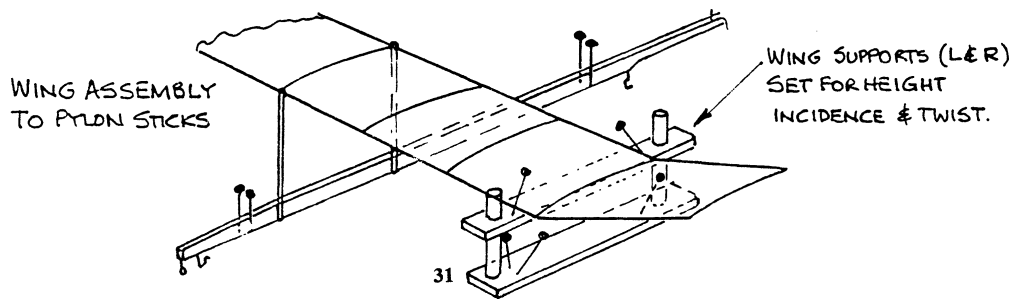
I make my bearing loop and spiral by clamping two pieces of wire in a vice and then winding one around the other. Takes a lot of practice to get it just right. The front face is then stoned to remove any sharp projections. The front bearing and rear hook are both attached by binding a few turns of a strip of Japanese tissue and thinned Ambroid. A short piece of wire the same dia. as the prop shaft will help you align the bearing. You will need about 2 degrees of left sidethrust. Remember to allow for any slop which will straighten out with a wound motor.

Now for the tail boom. Fasten it down on the building board with pins and blocks. Set the horizontal stabilizer in place and cement it. Likewise for the vertical. If you have a droop down tail block it up to clear.

Remember the approx. 1/8 in. dia. bit sanded ahead of the tail? Cut thru it about one third back from its front end. Get the paper tail tube and cut it to length (approx 3/4 in.). Sand the front part of the cut to make it a tight fit on the tube. Insert about 1/4 in. and glue it. Sand the tail half of the cut to be a tight but removable fit. This will tend to loosen in time but a thin coat of Cya will take care of it. If you fly in a site where the plane can hit obstacles (and Who doesn't?), put a small smear of Ambroid to secure the plug in part. Have a small bottle of acetone with you to loosen it later. If the boom is separate from the motor stick, they can now be joined.



WING MOUNT ASSEMBLY. Sand the lower 1/2 in. or so of the wing pylon sticks for a stiff fit in the motor stick tubes. Insert them in the tubes flush with the bottom. Pin the motor stick to the work board with the pylon sticks vertical. Support the wing using the props you used earlier so that the wing sits at the correct height between the pylon sticks. If all is well, the sticks should rest lightly



against the L.E. and T.E. At this time you should include any wing twist called for, usually some left wing wash in (T.E.down) . I use less than 1/8 in.

When everything is in the correct position. glue the pylon/wing joints with Cya I stopped using Ambroid for these joints after a small amount of creep occurred in storage which ruined the trim. If the plan calls for any diagonal braces these can be added now. Remove the wing assembly and weigh it. Likewise the motor stick + boom and tail assemblies.

NEXT MONTH We will make the prop and give brief flying hints. However let's conclude with some fun. Add some ballast to the nose to make the model balance at about 65% of the wing chord. Set the wing at a slight positive incidence relative to the tail. Set the right tail tip about 1/4 to 1/2 in. down. Test glide in your best clear space indoor (Air OFF). Adjust wing setting until almost stalling. It should turn slowly left and amaze your friends by its lack of speed!! Maybe not. It reminds me of a morning when I was giving an indoor flying demo to a bunch of about 80 sixth graders. My Pennyplane was steadily climbing to the gymnasium roof accompanied by ooo.s and ahhh's from all except one boy who asked " Sir, can you make it fly any faster?"

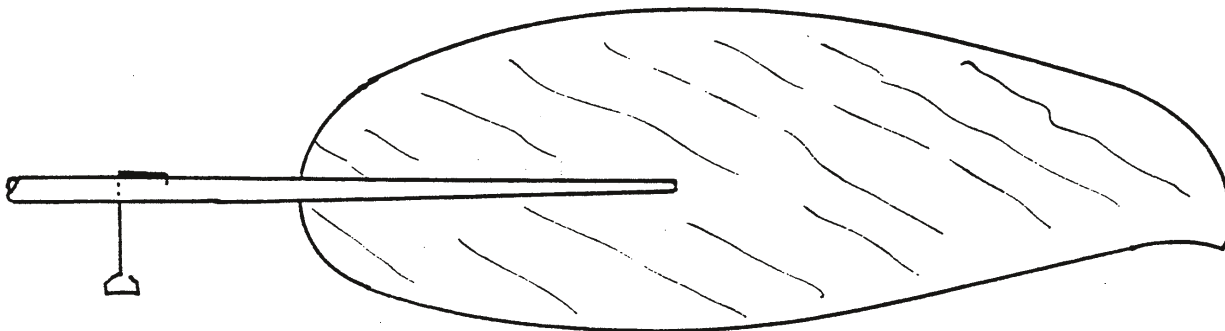
Part 4

## INTRODUCTION

If you read Parts 1 thru 3 you may already have built and covered the airframe and perhaps had some fun with test glides of a Limited (Novice) Pennyplane. However to get that model to the roof of the local school gym. or tangle with the roof at E.T.S.U. in Johnson City you need a propeller and rubber band motor. For the novice to indoor free flight these easily can be the most neglected items. Volumes could be written about them, but we only have enough space to touch on some of the basic principals to get started. If you get hooked on indoor duration flying, the rubber motor can get quite expensive because you will need a rubber stripper. a winder with counter and one or two torqueometers. However let's start with the propeller.

## PROPELLER BASICS

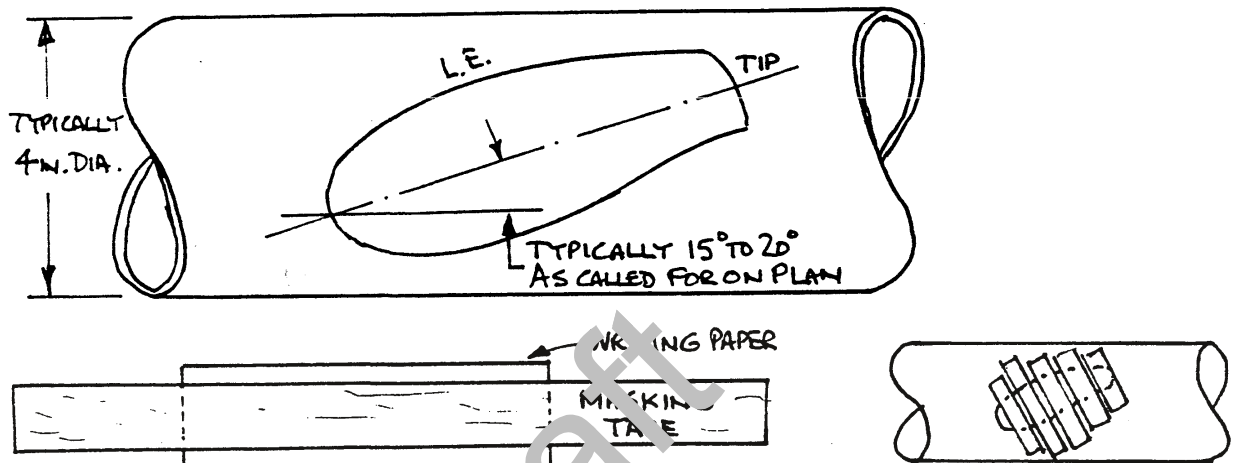
Your plan will give you a good idea of the propeller construction. It will have thin molded light sheet blades attached to a single stiff spar.



The Bare Blade. This will usually be made from 5 to 6 lb. C grain balsa. The grain may be shown straight or on the diagonal. The blades must be cut from the sheet so as to give a good stiffness match.

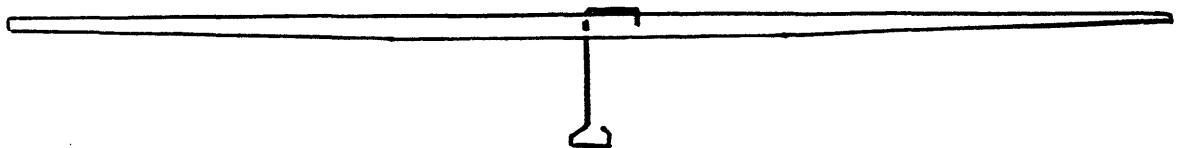
Blades are usually sanded to taper in thickness. Typically from about 1/32in. at the root to perhaps half that at the tip. For sanding this thin, you must set the blade on a very flat surface (I use a 12in. square tile) and the sandpaper must be glued to a very flat block such as a piece of 1/2in. sheet balsa. It is important to match the blades for thickness and weight. The spring scale and a micrometer will help.

Molding the Blade Twist. Theoretically the optimum blade twist is for helical pitch which requires a carved block former, but we will use a simpler and quite good method which involves setting the blade at an angle on a cylindrical surface. This method also induces an airfoil section to the blade. You need a smooth can, bottle or pipe of 4 in. dia, or as indicated on your plan. If the item you find is not quite the right diameter then the angle must be changed. The bigger the diameter the steeper the angle. Mark this angle on the former twice 180 deg. apart together with blade outlines. Mark the spar lines on the blades, tip to tip. Prepare about 12 strips to hold the blades on the former, like this:

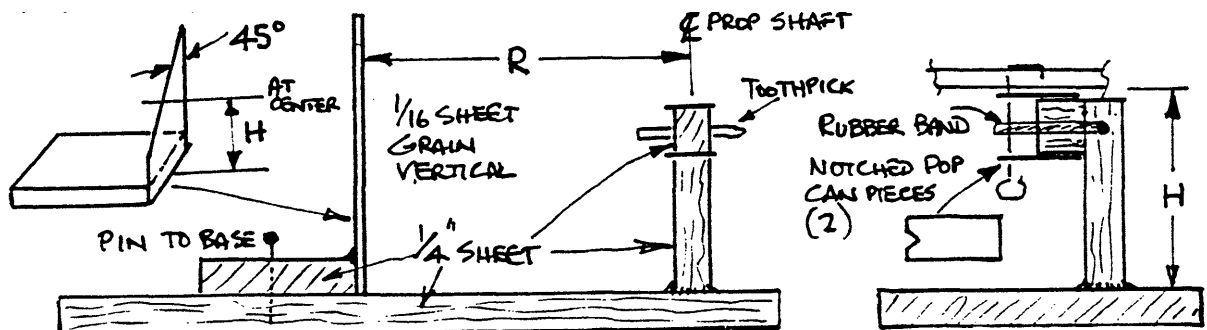


Get an Ace bandage [no. don't steal it from the first aid kit!]. Set the oven to heat to about 200 to 230 deg. Boil water, pour into a pan and add about two table spoons of household ammonia for each cup of water. Throw in the blades. Cover or otherwise keep hot for ten minutes. The heat plus ammonia softens nature's glues in the wood and will clear your sinuses. Fasten the blades on the former using the prepared strips. Bind the whole thing with the bandage and bake for an hour. Remove from the oven and let it cool. I usually let it sit overnight. Uncover and carefully ease the blades off the former. Cut a slot for the spar if the plan calls for it.

Propeller Assembly. For the spar cut and sand a piece of medium hard 3/32in. or 1/8in. to the shape shown on the plan. Make a tiny hole in the center and insert the prop shaft. Bend and cement like this:



Make a propeller assembly jig as follows:



It is important that the notches for the shaft are aligned exactly vertical and that the center of the 45 deg. support is close to the height 'H'.

Fasten the shaft/spar item in the notched part using a small band hooked on to the toothpick. Rest one blade on to the spar and the 45 deg. piece. The blade will want to slide off the support. Use a pin to provide a stop. You may need to reposition the 45 deg. piece laterally to get the right height. The spanwise position 'R' sets the pitch.  $R=0.159 \times \text{Pitch}$  (For 20in. pitch  $R=3.2\text{in.}$ ) When it all looks good, apply Cya at the ends and at several points along the spar. Repeat for the other blade. Remove and admire your superb handiwork. Add a small nylon washer and weigh it.

Balancing. Clean off any ballast from the front of your motor stick and insert the propeller. Make certain it revolves freely. If one blade appears much heavier than the other, do some careful sanding. Don't worry too much about static balance. Go fly it. If it wobbles, it means that the blades are set at or are flaring to, unequal angles. Check and tweak as necessary. Suffice to say that usually the wobble is affected more by unequal blade angles than by static balance.

### RUBBER BAND AND FLYING

Weigh the complete model without rubber. It must be at least 3.1 grams. For power, TAN II is the best. However it only comes in widths suitable for outdoor flying, 1/4in. etc. If your model is close to the nominal 3.1 grams you will need some cut to .075, .080, and .085in. for starters. If your model is heavier the sizes will have to be bigger. The way to get rubber of various odd sizes is to call Indoor Model Supply or get someone who has a stripper to cut it from your 1/4in. strip. Please DO NOT ask a friend to do this on a contest day. Whatever you choose, make a small loop, say 4in. Lube it (I use STP Son of a Gun protectant), break it in, then stretch wind it until it breaks. Calculate the breaking turns/inch. Make an 18in. loop of .080 and wind it to about 70% of breaking and then back down to 50%. With these turns trim the model close to the stall with wing post settings and the desired left turn with stabilizer tilt right side down. If it climbs at this 50% [backed off] turns, the motor is probably too thick or too short. Similarly if it sinks, the motor is too thin or long.

Either way, just wind up some more until you get a decent flight. MAKE NOTES for each flight: trim settings, motor size & weight, and flight time. Count the number of turns left at the end of each flight and calculate prop revs;  $(\text{Turns wound} - \text{turns left}) \times 60 / \text{flight time secs.} = \text{R.P.M.}$

Set a target flight duration for your site (be realistic!!). Calculate a motor length assuming you use 90% of breaking turns :  $\text{Length (inches)} = \text{R.P.M.} \times \text{Duration Minutes} / [0.9 \times \text{break turns per inch}]$

Bear in mind that a short motor will not run long enough, but an extra long one will be too heavy. You need to do a lot of flying to get the motor just right for one flying site. So get started and have fun. Nice talking to you.

John A

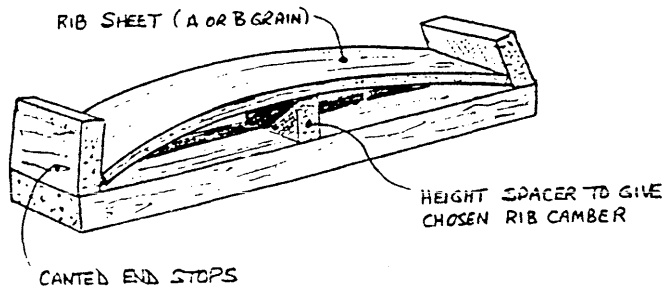
Issue 84 1995

### Making Ribs

by Brian Kenny (GB)

I have recently been using moulded ribs for all my EZB/F1D wings and built-up props. A sketch of the type of jig I use is attached for your interest.

The end locators and the central transverse "height" spacer are superglued to the base (all from balsa wood). The height spacer of course determines the % camber of the rib and hence the same height of spacer ensures the same maximum rib height for both chordwise and diagonal ribs if these are used on the same wing.



*Brian Kenny. 8/19/93.*

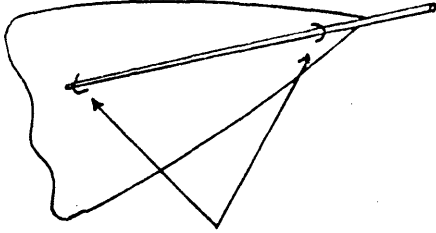
I trim the length of sheet from which the ribs are to be sliced, whilst it is dry, and by trial and error till, when spring into place, it fits snugly and is held securely by the angled end pieces. The rib sheet is then soaked in hot water for ten minutes, replaced in the jig and dried in a low heat oven (or if I am in a rush as usual, I use a hair drier to dry the sheet & set the curvature). A "Laurie Barr" type of slicer is then used to slice off the required number of ribs from the edge of the permanently curved "rib sheet". Since the grain is along the rib, the bending stiffness of these ribs is optimized for their depth & thickness. So far they have not lost curvature in the sometimes damp Cardington conditions and you don't have to use C-grain wood.



Issue 80-81-82 1994

Prop Construction Tip  
by Larry Coslick

Here's an easy way to hold and position prop blades to spar while glue sets for Ministick, EZB, Ltd. Penny, etc.



### Music Wire Staples

Instructions: Affix blade to spar with music wire staples. Wire size varies with project (.010 or larger). Tack glue blades at spar tip and hub with thinned aliphatic or solvent cement. Set desired pitch. When dry, place small drops of glue every 1/4" along the prop spar. When dry, remove staples.

Draft

Issue 84 1995

## Microfilm Techniques

CHILTON'S CORNER By Stan Chilton

Over many years other modelers have asked me how I get the solid color silver and straw brown sheets of microfilm. I used to think anyone could produce this kind of film but I've learned if you don't have the right equipment, tank and frames, pouring and lifting satisfactory microfilm sheets can be quite frustrating. Following is my procedure.

### EQUIPMENT:

**WATER Tank:** The first requirement is a proper size water tank, or pan. I built one out of a 4 x 8 ft. .040 thick aluminum sheet, or rather I took the sheet to a sheet metal fabricator and had him make a tank 4" deep by 3' 4" wide and 7' long. The top edges are folded over and the corners are overlapped and riveted, making a quite water tight assembly. This size tank is larger than needed or useable but I tailor the width by means of a 2" x 2" "L" angle aluminum just shy of 7' long so it will fit snugly lengthwise inside the tank so the width can be adjusted to restrict the spread of the microfilm.

A tank larger than 2-1/2 x 7 ft. will allow the poured film solution to spread too far and you will not be able to pour a large enough quantity of solution to get a sheet thick enough to pick up. I think a tank size of 30" x 72" x 2" deep is just about optimum and should be able to handle sheets up to 12" x 48".

The Cadillac of all tanks would be made of .032 to .040" thick stainless steel with welded corners, and a drain plug in one corner.

Some modelers use a 1" x 4" wood framework with a plastic sheet liner. This should work just as well as my aluminum tank, and take less storage space.

**MICROFILM FRAMES:** I used to use balsa wood frames of about every dimension, whatever I had on hand. But if you're serious about microfilm model flying take the time to build some frames that will assist you in picking up the film colors you want. Buy some clear 1" thick white pine, any width and strip it into strips about .66" wide. Since the 1" white pine is really only .625 thick your strips are .625" x .66".

I use 3 sizes of frames: (all outside dimensions) 10x30, 12x36, and 12x48. The 12" outside width produces a sheet of film wide enough to cover a 9.75" chord wing.

Assemble the frames using Titebond glue and small gussets in the corners. Apply one coat of sanding sealer, sand smooth then spray paint with whatever color of spray paint in cans you have on hand.

There is a reason for building these sturdy, heavy frames. If you've ever picked up a sheet of film intact, then had it go splat and disappear, it probably shrunk too tight on the frame. The white pine frames press down on the film sheet on the water and stretch it slightly so you won't lose it after getting it picked up. An additional benefit is the extra rigidity. Thin sheets are hard to pick up and retain with flexible frames.

I make up enough frames so that I can make up a 3 to 4 year supply of microfilm sheets. But if you already have balsa frames on hand they are useable. To get the balsa frames heavy enough to press down on the poured film I lay a 15" metal drafting machine scale (ruler) across the center of the frame, leave this extra weight on the frame for about 5 minutes to stretch the film before attempting to lift the sheet off the water.

**MICROFILM:** I have used Erv Rodemsky's various formulas of microfilm and the only one I didn't like was his GP83M and S. I think his current batch is GP-90 which is the easiest of all to pick up. I really liked his GP-84-2P and still use it. I have also used Micro-X Red Label and Lew Gitlow's IMS film. Both these films produce satisfactory sheets, dry and stable. Use whatever product you have the most confidence in. I prefer Erv's batches because they, work well for me and I know more about what's in them.

Very important. Any microfilm you purchase that is bottled in plastic bottles should be transferred to glass bottles immediately. Use glass bottles with an aluminum gasket on the lid. Avoid the lids with paper or waxed liners for gaskets. The solvents in the microfilm will escape through the plastic bottles. Very rarely you will need to thin the mixture with acetone but go very slow, thinning only as much as absolutely necessary.

**APPLICATORS:** I apply the microfilm solution to the water differently than anyone I know. But it's the main reason I can pour solid color sheets in the color and thickness I desire. It also wastes very little microfilm mixture.

I use a glass 5cc hypodermic syringe with a large 2-1/2" long #12 needle. I'd use a larger needle if I could find one. There are other methods of dispensing the microfilm fluid onto the water. Erv Rodemsky uses a short piece of 3/16 or 1/8 brass tubing, filling it with the precise amount of film desired, letting gravity flow the film out onto the water. An added benefit is if the liquid film mixture won't flow evenly out of the tube, it is too thick.

Bernard Hunt uses the same system but with an 8" long graduated approximately 1/4" diameter glass tubing and he varies the orifice by heating and forming the size of the orifice to produce the desired outflow (about .050" diameter). He recently picked up solid silver sheets and 6 out of 7 attempts at gold straw brown colors.

**THE WATER:** I used to purchase 3 - 5 gallon containers of distilled water, and still do occasionally, depending on my results with tap water. I bought a charcoal and sediment filter and use these to filter the tap water into the microfilm tank. Erv Rodemsky uses distilled water and saves it for reuse. The distilled water definitely will not leave mineral deposit specks on the film. If the filtered tap water leaves any residue on the first few sheets of film, I immediately switch back to distilled water. Our tap water in Wichita comes from 3 different sources, a nearby lake, drilled wells and underground aqueous beds about 90 miles away. Depending on the particular source, sometimes the filtered tap water works well and sometimes it doesn't. But it's always cheaper than distilled water. The water must be clean and potable, that is you'd drink it.

Be sure the tank is hospital clean. The microfilm solution will not spread well on contaminated water.

**TIMING THE POUR:** About 25 years ago I was pouring microfilm and having no luck whatsoever picking up almost any kind of sheet. I decided to call it quits for the evening and came upstairs from my model shop. It was raining outside and I just happened to check the barometer. It was 29.40. About 3 or 4 days later it was cold and clear, barometer 30.30 and I refilled the water tank. The next morning I lifted 15 sheets out of 15 poured, all in silver and gold, some 12 x 48 sheets.

Since then I wait to produce microfilm until the barometer is at least 30.20 or higher. This condition is normally associated with dryer air, which also may be helping. There seems to be more high pressure conditions in winter than summer. A couple of days before I pour, I disconnect the humidifier from our house furnace, helping keep the air dryer.

**PRODUCING THE FILM:** Prior to producing the film you should have on hand sufficient frames, the tank, aluminum divider bar, water, hypodermic syringe and of course, the microfilm solution.

Fill the tank 1 1/2" deep with water. Let stand 6 to 8 hours, or overnight to stabilize in temperature evenness. Make sure the atmospheric pressure stays high.

For the amount of film you can dispense on the water through the #12 needle of the syringe, position the divider "L" angle aluminum so your effective water width is 30", times the length of your tank. Different film dispensing methods may require more or less water width, depending on the total amount of film solution laid on the water. Absolutely, the amount of film on the surface area of the water determines the thickness of the film, provided the water surface area isn't too large, and the liquid film has been dispensed evenly on the water.

Fill the syringe with about 2.7 cc's of film. Turn upside down and set for a few minutes for the microscopic bubbles in the film to rise. For a holder, I epoxied a 2 oz. glass jar's base to a 5"x5"x3/8"

base of balsa. I cut a piece of foam rubber and inserted it into the jar so the plunger end of the syringe rests on the foam and the syringe flange resets on the top of the bottle. (Syringe is still upside down). The plunger must be supported or it will fall down.

Grab a soft hand tissue and cover the needle end of the syringe and top off the film to 2.5cc's of solution.

Standing beside the long dimension of the tank start dispensing the film solution at the left end of the tank and run a stream down the center, hopefully running out of film at the same time you reach the other end of the tank.

During the pour, the syringe will be held at about a 30 deg angle to the water and the tip of the needle, filed square, held as close to the water as you can without dipping it into the water.

Just enough pressure is exerted on the plunger to let the microfilm solution escape the syringe, evenly and smoothly.

If the film on the water has circular stripes, the ejected solution has been forced under the water. Try again with less plunger pressure.

Dispensing the film solution is a matter of feel and patience. You must use all the film each try and you must lay the film entirely end of tank to opposite end of tank, at the same time keeping an even dispersion of the film. Keep the same speed traversing the tank every time.

I generally get in the groove of evenly dispensing the film within 4 or 5 trial runs. Even if the laid down solution isn't the exact color and thickness I want, part of it may be, so use one of the smaller frames. When you are comfortable dispensing the film evenly and accurately you can adjust the amount of film in the syringe to get the thickness you want. 2.5 to 2.6 cc's gives me silver, 2.8 or 2.9 cc's gives me very dark blue. 2.7 cc's is straw brown.

After I've completed a satisfactory pour I fill the syringe for the next pour, set it in the jar holder upside down, getting ready for the next pour.

Leaving the previously poured film on the water, I take whatever size frame I want outdoors and spray it lightly with 3M 77 contact spray or 3M 75 with a fine spray mist nozzle.

If 1/2 the film on the water is silver and the other 1/2 is blue or off color, I'll use the 10x30" frame and place it on the desired silver end of the water. If the poured film is of even color I'll use the 12x36 frame. Place the sprayed frame gently on the film. Next tear off the excess film outside the frame and remove this debris from the water. Wait about 5 minutes then lift the film and frame off the water.

Hold very still just above the water with one corner down to allow the water to drain off. This will take about 30 seconds, and when mostly dry, carefully set the frame vertically at the other side of the room. The film and frames must be absolutely dry before putting in the storage boxes.

Lifting the film off the water is a technique all in itself. I have heard of some who lift off one end and slide the film and frame lengthwise out of the water. I don't think you can lift silver sheets this way. Lew Gitlow says you need help from the "Lift Angel" to get off good light sheets.

I grasp the frame by the ends and pull the frame slowly close to me before I start the actual lift. Then raising the long edge farthest away from me, and a little side to side movement, I move the raised edge further from me and rotate this edge to vertical by the time the trailing edge is leaving the water. Gentle is the name of this game. The most critical times of the lift is the first movement off the water and the free film/frame that is just off the water. The lift movement must be all in one smooth motion -- if you stop or hesitate during the lift all is generally lost.

Ron Higgs lifts the edge nearest him and sometimes gently blows under the film helping it lift off the water. Here again there are slightly different techniques achieving the same result.

After you've set the finished film/frame to one side, the syringe will be ready to pour the next sheet. But before this, examine the water surface and clean it of any residue left from producing the previous sheet.

I use either silver or straw brown for FID wings, solid silver for stabs and blue for props. Don't worry about the strength of the silver and straw brown film if you are using Rodemsky's film. It is plenty strong enough.

There's probably not much weight saving between gold and blue film. But I know a gold patch on gold film is blue, so gold must be 1/2 as thick as blue.

Producing really light solid color film is not easy but is certainly worth it when you hear the nice comments from your competitors about the good looking film. And it probably is lighter.

**STORING THE FINISHED FILM:** If you have made microfilm previously you probably already have a favorite way to store the finished frames of microfilm.

If you do not have a favorite storage system -- here's mine.

From a wholesale florist I purchased about 8 or 9 large cardboard cartons with shallow top lids. The boxes measure 44 1/2" long, 12" deep and 22" wide. The lid or top fits over the box with 3" overlapping sides. The florist charged me \$4 to \$7 each. I had to build my own 50" long box to store the 48" long sheets. For storage the sheets are laid into the box flat with 3/8 x 18 x 14" balsa spacers, 2 per sheet. Stacked thusly each box will hold about a dozen frames.

Each box is vented to allow free air circulation around the film, but not much. Just under the top lid on each side cut a vent strip about 3/4 "x8" and cut the same size strips near the bottom on each end, for a total of 4 vents per storage box.

The cardboard boxes can then be stacked ceiling high in one corner of your model workshop, but preferable in another room free of sawdust, etc.

Issue 84 1995

## F1D Motorstick Construction by Steve Brown

The motorstick may be the most important single component of an F1D. You can change the wing, even prop, but it seems that motorstick determines the way the model flies. The stick is also the single heaviest part of the model and is a logical candidate for weight savings

**Wood Selection:** Wood that is suitable is rare and stringent selection is required. Examine each sheet by laying it on a flat surface. If the sheet isn't perfectly flat remove it from consideration. The grain should be parallel to the edges. Hold the sheet up to a light and look for density variations or heavy streaks. Compare all the sheets to each other to find the stiffest sheets. The most significant variable in the weight of a completed stick is the weight of the raw wood that forms the tube. I eliminate all sheets that weigh more than .0098 oz for a .013' x 1 1/8' x 18" sheet. The density of a sheet of wood can be misleading since it tells nothing of the uniformity of the grain and resistance to bending. The "density" of the sheet is actually an average of the variations (hopefully few) in density along the length of the sheet. It is rare to find wood less than 3.8 lb. density that is useful.

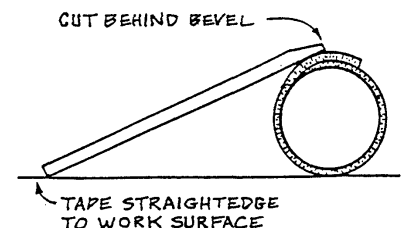
Use a dial thickness gauge and measure the thickness of the wood. I usually check 7-8 spots at random along the sheet. Take care not to compress the wood as you check it. Look for thin spots in the middle. Boron will not prevent uneven bending if there are thin spots in the middle of the tube.

**Rolling the Tube:** I use a .250" o.d. rod to form the motorstick. I've tried rod diameters as small as .210" for F1D and, while the weight savings can be significant, I have never had any success with smaller diameter. The resistance of the wood to the twisting force of the rubber torque varies with the density and character of the wood and the diameter of the tube. Small diameter tubes allow tail tilt and wing wash adjustments to change excessively under high torque. Aluminum arrow shafts (available from archery suppliers) make good forming rods as they are available in 1/64" size increments, have thick walls and are light and easy to handle. Hobby shop tubing, or steel drill rod will also work.

Don't cut the balsa sheet to size before rolling. Trim one edge of the sheet perfectly straight. Position the sheet edge along the edge of your work surface and sand a bevel into the straight edge along the entire 18" length. The bevel should extend about .10" onto the sheet and feather at the edge. Use a waterproof pen (such as a Sharpie) to identify which edge of the sheet has been beveled. Mark both ends.

Soak the sheet in cool water for 15 - 20 minutes. While the wood is soaking cut a 3" X 19" piece of white Japanese tissue. Lay the tissue on the working surface (I use plate glass) and wet the tissue with a soft 1" wide brush. Use the brush to smooth the wrinkles. Place the forming rod along the edge of the tissue and attach it to the rod. Roll the rod about 2/3 revolution so that the paper is evenly attached. Place the wood on the tissue adjacent to, and almost touching the rod with the waterproof ink marks facing down. Do not attempt to force the sheet into a perfectly parallel position against the rod. The wood will do whatever its internal stresses dictate when it is baked and it isn't possible to force it to be straight. Roll the tube and bake at 200 degrees F for 30 minutes. Remove the rod from the oven after baking and allow to cool to room temperature. Do not unwrap the rod at this time.

**Cutting the Joint:** Secure both ends of the rod to the work surface with masking tape to prevent roiling. The ink mark at the overlap should be up. Position a wide metal straightedge as shown. Tape the rear edge of the straightedge down to the work surface. Smoothly cut a clean joint using a new, sharp razor blade edge, while applying light pressure to the straightedge with the other hand. Make 2 or 3 passes with the blade to be sure that all the layers of paper and wood have been cut through. About the only thing that can go wrong with this



method is failing to cut through all the layers.

Carefully unwrap the outer layers of tissue until the wood is exposed. Using a very fine felt-tipped marker (Sakura Pigma .005 or similar) make 4 or 5 small marks across the seam down the length of the tube. These marks can later be aligned and will assist in gluing a straight seam. Remove the wood and the rest of the paper from the rod. Weigh and record the weight of the tube before putting it back on the rod.

Gluing the Seam: I use Ambroid glue thinned 50/50 with acetone for all construction. I plasticize the glue to be used for stick and boom seams with 3-4 drops of TOF plasticizer per ounce of thinned glue. Apply the glue using a 26 gauge needle with the sharp point removed and smoothed, on a plastic syringe. It is most important that glue be applied only the edges of the wood. Use eye magnification. Non prescription magnifying eyeglasses work well. The glue seam can vary in weight as much as 100% depending on the thickness and amount of glue applied.

Clamp the end of the metal rod in a vise so that both hands are free. Beginning in the middle of the tube, with the small ink marks aligned, lightly preglue about 1/2" of both edges of the wood at a time. After about 10 seconds apply a second light coat to one side and press the joint together. Minimize pressure from your finger's to the wood, since it is easy to skew the seam or warp the wood from the moisture on your hands. Allow the glue to dry completely, usually 1-2 hours depending on the temperature and humidity, before removing the tube from the rod. Weigh the glued tube and record the weight. Subtract the weight of the unglued tube from the weight of the glued tube and you will know the glue seam weight. Look for a seam weight of about .00035 oz. for an 18" length.

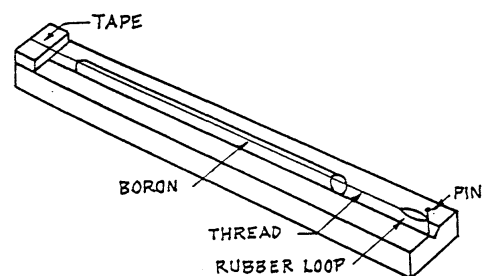
Thrust Bearing, Webs, Rear Hook: I use a Ray Harlan F ID thrust bearing modified to remove excess metal. The stock bearing weighs .00077 oz. Remove metal with a file from the sides and notch the edges of the top of the bearing until it weighs about .0006 oz. Roughen the top of the bearing where it will contact the motorstick. Be careful not to remove too much metal or break off the pigtails. The aluminum cannot be bent more than once without reducing strength.

I use 4.5 lb. C-grain wood, .018-.020" thick for webbing. Orient the grain vertically. A .013" music wire hook will handle torque up to .50 in./oz, without deformation. Whatever hook shape you choose, remember that it is most important that the rubber motor O-ring be easily attached and removed. I reinforce the joint between the rear hook wire and the wood web with one layer of Japanese tissue, but I don't use any CyA because of its weight.

Front End: The glued tube will probably have a slight curve. The location of the seam doesn't matter, just look at the actual curvature. The tube should be oriented to arc "down", that is, to pull against the bracing wire. Mark the top and bottom of the tube 180 degrees apart. Place the tube back on the forming rod and tape both down to your work surface with one of the marks "up". Cut .015" X .750" slots on the top and bottom of the tube, about .25" from the front end. This will help keep the tube round as you work on it. Cut the slot narrower than the thickness of the web and widen it to an exact fit by lightly sanding it with a small piece of 600 grit sandpaper. Install the front web and glue in place. When dry, slice the front of the tube off and install a .013" cap.

Attaching Boron Filament: Boron filament should be held in a jig that tensions the filament and frees both hands. It is critical that the filaments be glued along their complete length. I use the same plasticized Ambroid glue as for the stick seam, applied using a 26 gauge needle and plastic syringe. Mark the locations for the boron filaments with small dots of ink along the entire length of the tube.

Placement of the boron at 12, 3, 6 and 9 o'clock produces the straightest sticks. Unfortunately, locating it at 12 and 6 o'clock causes interference with the stick bracing post. I feel the strength and improved straightness of the tube is worth the extra work required to install the post. Cut the wood tube to length and place the

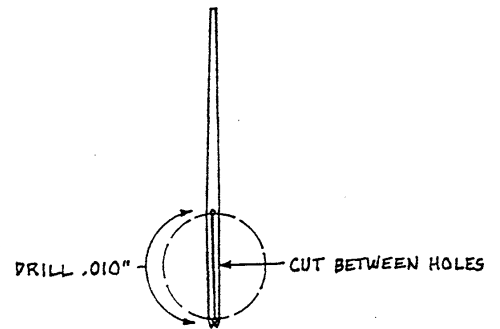


tube on the forming rod into the jig. Glue the boron filaments, alternating the sides of the tube to equalize stress. Four .004" boron fibers glued on a 14.5" stick will add .0011 to .0012 oz.

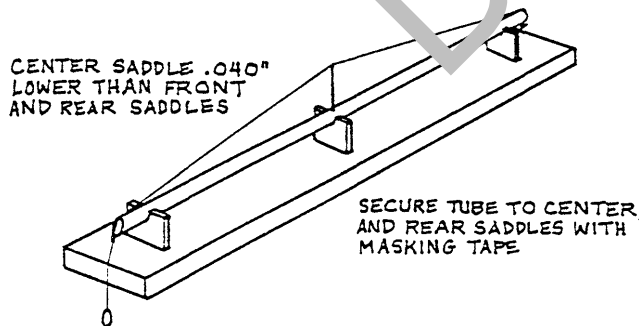
Assembly: Once the boron fibers have been installed lay the tube, on the rod, against a metal straightedge and mark the locations at the rear of the tube that correspond to the top and bottom of the web at the front. Cut, a slots about .015" X .060". Remove the tube from the rod. Using a scrap piece of .015" wood inserted in the slots, adjust the slots using 600 grit sandpaper so that both the front and rear webs ,are in alignment. Cut and insert the previously completed web and hook assembly and glue in place. When the glue is dry slice off the excess wood. Cut the excess .013' wire off so that only about .040" extends above the top of the tube.

Install the thrust bearing with no downthrust ,and 2 degrees of left thrust. I use Ambroid with no plasticizer for this joint. Coat the bottom of the bearing and the location on the wood tube with thin coats of glue and allow to dry for 10-15 seconds. Apply a second coat of glue to one of the surfaces and place the bearing on the wood. Set the thrustline by placing a straight piece of .013" wire about 2.5" long in the bearing using it to adjust the angle of the bearing. This must be done quickly or the joint will be weakened. Once the glue dries apply a second coat in a small "fillet" along the edges of the bearing where it joins the wood.

I use a single 1.75" tall bracing post on all my models. In conjunction with 4 boron filaments it is the strongest bracing method I've tried. Make the center bracing post of 6.5-7.0 lb. "A" grain wood, cut and drilled as shown below. Mark the appropriate locations on the top and bottom of the wood tube and make small holes on either side of the boron with a sharp pin. The holes should be slightly smaller than the bottom diameter of the bracing post. Install the post by lightly "worrying" it into position. The boron filaments will locate themselves in the drilled holes. Be sure that the wood tube stays perfectly round.



Bracing: A bracing jig assures repeatability when tensioning the stick bracing wire. I use .001" tungsten wire from indoor Model Supply and haven't encountered any breakage. I don't see a need for heavier wire or double strands. Don't use wire that will stretch, such as nichrome.



Place the motorstick in the jig and use small pieces of masking tape with tissue pads to secure the tube at the rear and to pull the tube down to touch the center saddle. Tie the tungsten wire around the stub of the rear hook that protrudes through the top of the stick and glue. Weight the

wire with 2 Quarter coins. It is better to have a little too much bow braced into the stick than too little. You can always adjust the tension of the wire at the flying site by lightly sanding the top of the bracing post. The goal is to obtain a bracing tension that allows the stick to be straight (no up or downthrust) at full winds. Don't glue the wire to the top of the post, it is helpful to be able to remove it later.

I use rectangular wing tubes formed by 3 turns of Japanese tissue around a .035" X .064" brass former. I install them by placing the motorstick in a jig that makes round pilot holes at the appropriate angle. The pilot holes are then enlarged with a rectangular toothpick that has been sanded smooth with the comers rounded and the proper width marked.

It isn't possible to cover ail the details in an article this short. If I can answer any questions write me.



Begin with a Moustique!

Design: Dieter Siebenmann (SWI)

Building instruction: Ebele Schouwstra and Thedo Andre (NL)

Choosing a Moustique as your first indoor model is a very good way to start. It is a fairly simple model, it will teach you all the basic techniques an indoor modeler needs and you can already fly it in competitions. It will do two to three minute flights in a gym hall. At competitions flights of more than six minutes are not uncommon. Though we tried to make this building instruction as clear and complete as we could, it will be likely that you will encounter some problems. If something is not clear or when you do not succeed in making something, then do not hesitate to ask an indoor flyer for help. They are very friendly people and will certainly help you. After all, they have been beginners too!

Preparation

When this is your first model airplane you will probably have to learn some new words and terms.

Figure 1 shows the main parts of an indoor model. On the drawing there will be more new words. Enlarge the drawing on a copy machine to size.

We need a building board of 22x60cm from soft board (in which you can easily stick pins in). Tape the plan onto the building board and cover it with clear household foil. This will prevent glue from sticking to the plan. Ensure that everything is flat and wrinkle-free. We need some other accessories. Cut straight strips from a sheet of 2mm balsa of the following dimensions: 10x250mm (4 each), 10x50mm (2 each) and 10x16mm (16 each). Glue four layers of 2mm on top of each other and construct the assembly block of

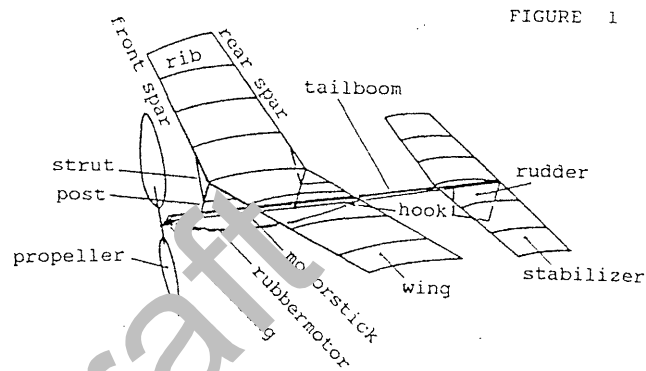


FIGURE 1

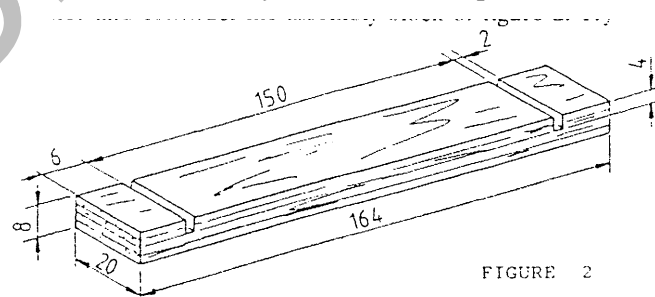
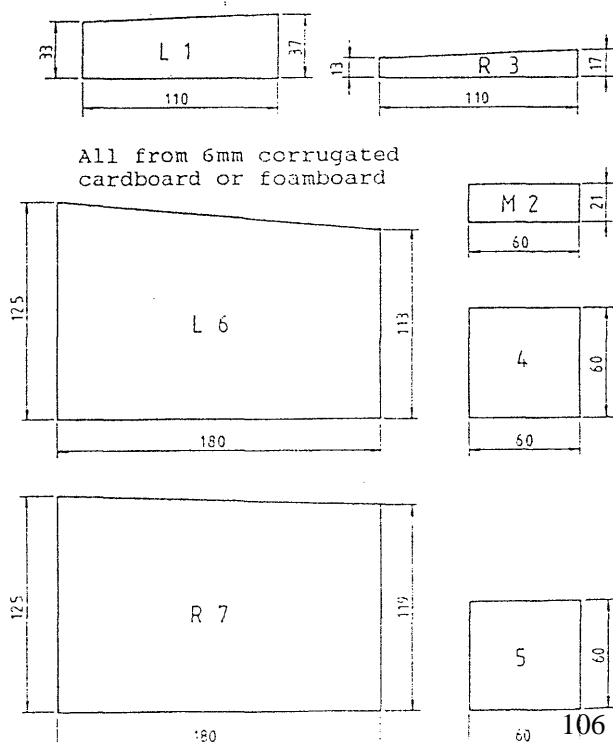


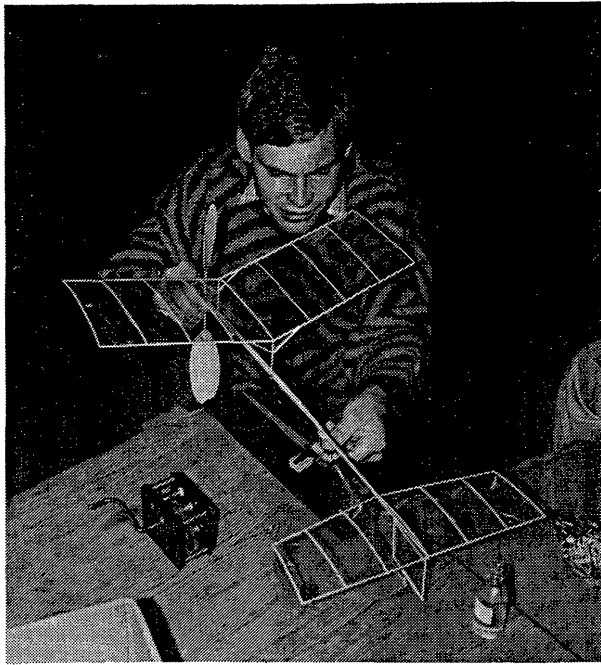
FIGURE 2

FIGURE 3



All from 6mm corrugated cardboard or foamboard

figure 2. Try to get the sides and grooves as square as possible. Figure 3 shows several jigs which you can make from ±6mm thick corrugated cardboard or foam board. As before: cut them as square as you can. Next we make the wing and stabilizer rib templates from thin ply or cardboard (see plan). Finish the curved sides as smooth as possible.



## Two types of glue

We need two different kinds of glue. For joining wooden parts we use cellulose glue (like UHU-Hart). This glue has to be thinned down about 30% with thinner or acetone. The most handy way to apply the glue is by means of a syringe (needle size  $\pm 0,5\text{mm}$ ). Stick a piece of wire in the needle to prevent it from clogging up. Identify the wire with a piece of brightly coloured tape so that you find it quickly in the usual mess on your working table!

The other glue we need is contact cement for adhering the covering to the wing and tail frames. This glue also has to be diluted, ratio glue-thinner 1:2. Usually only thinners of the same brand as the glue will work successfully.

## Required materials

For wing spars and wing ribs we need a sheet of 1,5mm middle hard balsa (weight of a 10x100cm sheet 18-27 gram). For tailplane and rudder 1mm is needed, weight of a sheet 10-18 gram. For the fuselage lighter balsa is required: a 4mm sheet of 40-50 gram or a 10x10x1000mm strip of 10-15 gram. In all cases the grain has to be straight and regular. For the propeller blades we need a soft sheet of 1mm balsa, preferably quarter grain. This type of grain has more bending stiffness in a direction square to the grain. It is recognizable from its speckled look. We further need a piece of dia 0,4 or 0,5mm steel wire for the propeller shaft and rear motorhook, a piece of 0,5-0,8mm hard aluminum (f.i. from a beer can) for the propeller bearing (bearings are also commercially available) and a piece of dia 2mm I.D. aluminum or plastic tubing for the wing sockets. Wing socket tubes can be made yourselves. This is done by rolling a piece of tissue paper over a piece of dia 2mm O.D. wire, f.i. a drill end, and impregnating this with cement or dope (three windings is sufficient). Pull off the tube before it begins sticking to the wire! For the covering we could use lightweight tissue, but only if we cannot obtain one of the many types of lightweight plastic foils that are available. These are called mylar, ultrafilm, microlite, polymicro and the like, and come in weights ranging from 7 to 1,25 grams/m<sup>2</sup>. We further need teflon washers for the propeller bearing and of course rubber to fly on. Addresses of some suppliers are given at the end of the article.

## Building wing and tail frames

We start by cutting the ribs and spars. For cutting we preferably use a razor blade. A thicker blade will distort the tiny strips we cut. Cover the other side of the blade that is not used for cutting with a piece of tape or break the blade overlength into two pieces. The ribs are cut in 1,5mm wide strips along the rib template. Make several extra for reserve. The spars are cut along a steel ruler. Cut them 10 to 20mm overlength. Note that the spars of the left wing are longer than of the right one!

We start by building the stabilizer. Rub the edges of the four longest assembly strips with a candle

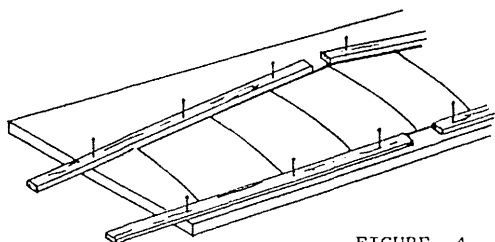


FIGURE 4

wax. This prevents glue from sticking to it. Pin the strips on the building board along the outside of the stabilizer outline (figure 4). Do not cut the strips to length. We need them for the wing also. Position the stabilizer spars along the strips and clamp them against it with the small 10x16mm pieces of balsa (figure 5). The spars rest on the building board with their small side, with the thin tapered ends toward the tip of the stabilizer. Never stick a pin through the

spar!

The spars have to be glued together in the middle. Glueing is always done in the following manner, called "double glueing". Coat each surface with a thin layer of glue, wait a few seconds, apply glue to one of the surfaces and then join the pieces. This gives the strongest bonds. So for glueing the spars we have to remove them from the building board (setting them up was a useful exercise). Coat the end of one spar and replace it between the clamps, coat the end of the other spar, wait a few seconds, coat again, replace and press the spar against the other and reposition the clamps.

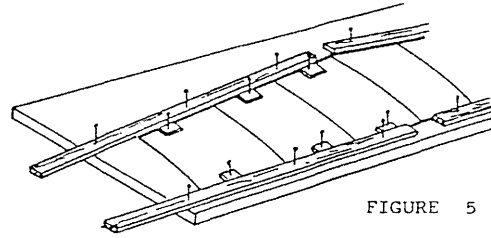


FIGURE 5

Take one of the ribs and hold it in its position over the plan. Carefully mark both ends to the correct length and cut off. The rib should fit in between the spars such that it is not under any bending stress, but still stays upright in position. Now prepare the next rib. If you cut one too short accidentally, do not worry. It can be used at a position closer towards the tip. When all ribs fit accurately they can be glued. Again: doubly glued. Avoid big blobs of glue.

Leave the stabilizer to dry for half an hour, remove the clamping blocks and carefully lift the frame from the board. If it is stuck to the building board at some place, then loosen it by running a pin underneath. Cut off the extending ends of the spars. Inspect every glue joint closely. Add glue when necessary and remove excess glue with a razor blade. A careful and experienced builder will seldom have to do this!

The rudder is assembled in the same way as the stabilizer. Position the strips on the board, cut to length, remove, glue and reapply. Note that one end of the sticks is not cut off (figure 6).

The procedure for building the wing is the same as for the stabilizer. Again note the correct position of the spars. The left wing is intentionally longer than the right wing. The middle rib is glued just left of the center line. You may have noted that the wing tips will be raised to a V-shape. We will do this after covering the wing. So the wing halves are joined in the middle temporarily.

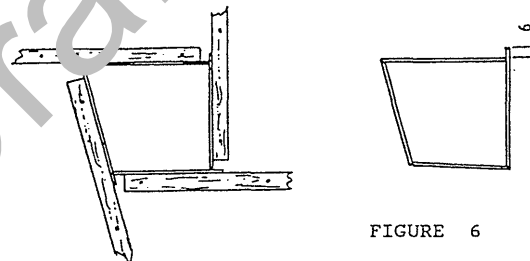


FIGURE 6

### Fuselage

The wood for the fuselage has to be of very good quality. Straight grain and no weak, hard or brittle spots. The motorstick can be tapered towards the ends from 6x4 to 5x3 mm to save some weight. Do the sanding in one direction only. A to-and-fro movement may easily break your carefully selected piece of wood.

For joining the motorstick and tailboom we need the large assembly block. Put cellotape over one of the small sides. Do not fold over the unsticked part, it may be cut off (figure 7).

Pin the block on the building board along the top side of the fuselage at the stick-to-boom joint. Position motorstick and tailboom on the plan and check whether the joining faces fit accurately (figure 8). Take time to make this fit as good as you can. This joint is a vital one! Glue the pieces together (doubly glued!) and clamp them between the small balsa blocks.

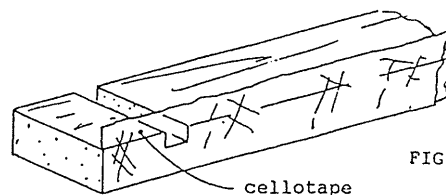


FIGURE 7

When the glue has dried remove the fuselage from the building board and lay it upside down. Prick a hole with

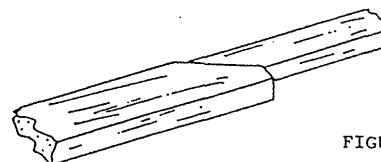


FIGURE 8

a pin between the motorstick and the tailboom along the glue joint for the rear motor hook. Put glue onto the hook and insert it into the hole. Lay a half knot in a piece of thread, slide the knot over the hook, pull tight and glue each end of the thread downwards along the sides of the motorstick (figure 9). Add a couple of winds after drying, put on extra glue and cut the ends off after drying.

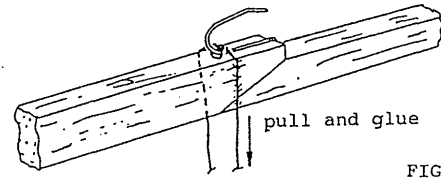


FIGURE 9

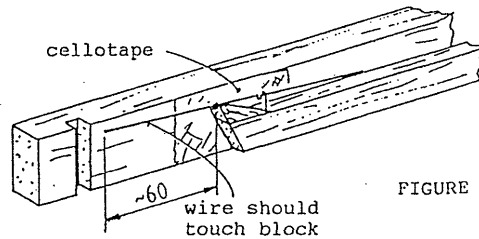


FIGURE 10

The propeller bearing is tack-glued with cellulose glue. With a piece of wire we adjust the bearing such that it is positioned with 1 to 2° of side-thrust to the left. That is to the right when viewed from the bottom as in figure 10! Let the glue dry thoroughly. It is then secured with thread in the same manner as the rear hook, add several extra winds at the front and the rear of the bearing and glue with a generous amount of glue. You can also use instant glue or

epoxy for this purpose. The last thing to add is the little vertical piece of balsa at the end of the tailboom. This piece raises the trailing edge of the stabilizer a little. Practice has shown that the tailboom usually tends to droop downwards instead of upwards. The wing sockets are added later.

#### Propeller

The propeller spar is sanded from middlehard balsa, 12cm long and tapered from dia 3 to dia 2mm towards the ends. The center section is reinforced with a few windings of tissue paper glued onto it. Next the propeller hook is bent and glued squarely in the spar. First bend the rounded hook end, prick a hole fore and aft through the tissue with a pin, push the hook through and bend the end squarely twice. Pull the hook backwards so that the rearward bent wire end sticks into the spar. Check alignment carefully and secure the hook with glue on the front and rear side.

The outline of the propeller blades is transferred to the balsa with carbon paper. It is perhaps better to make a cardboard or ply template of the blade shape and cut the blades along this template. This assures that both blades will be of the same shape. The blade can be sanded thinner towards the edges. Forming the blades into the correct pitch and camber is done in a simple way. For this we need a cylindrical shape, f.i. a paint tin, with a diameter of  $\pm 12$ cm. The blades are wetted in warm water for half an hour. They are then strapped to the cylinder with bandage under an angle as indicated on the plan. By putting both blades on top of each other they will get exactly the same twist. Be sure you have got the direction of the angle right, the propeller will turn to the right (when viewed in flying direction). Let dry thoroughly, a day in the open or 15 minutes in an oven (be careful, lowest temperature setting and leave the lid open).

The blades have to be glued to the spar in the correct angle. For this we make a simple jig as in figure 11.

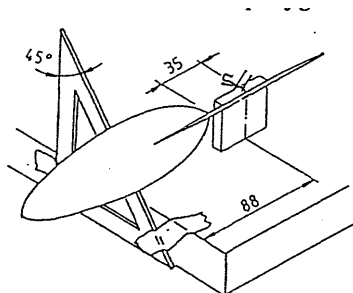


FIGURE 11

There is no need to cut a groove in the blade. You can glue it to the rear of the spar. Use a non-shrinking glue such as PVA or cellulose glue with some drops of castor oil in it. If you decide to make a groove then take care that the blade fits without distortion. On the other hand avoid any gaps. These take up too much glue which can lead to distortion of the blade. The last thing to do is to slide two teflon washers over the hook and finished is your propeller!

## Covering

On an indoor model only the top side of the surfaces is covered. We start with the stabilizer and practice the procedure before we use any glue. Clean up your work table and spread out a sheet of newspaper. Onto this we lay the sheet of covering material. It can be spread easily by gently blowing it downwards. Pick up the stabilizer in the middle with one hand, curved side downwards, hold it about 2cm above the foil, check that there is at least 2cm of excess foil all around and drop the frame. It is of great importance that this procedure goes successfully at the first try. Because we will use contact cement there is no second try! Practice until you feel confident.

Now for the wet run! Lay the stabilizer - curved side upwards - onto another sheet of newspaper. A glue drop on the covering newspaper sheet will lead to disaster! We can apply the glue with a little stick with a piece of velvet (figure 12). You can also use fine brush.

It is better to have the glue thinned down a bit too much than too little. You can always apply a second layer of glue. The glue is applied only to the top side of the spars and the end ribs. It is not really necessary to do the ribs as well. The glue may hardly be visible, but it should feel tacky when you touch it. If in doubt add a second run. Pick up the frame, turn it over, hold in position over the foil, check that there is excess foil all around, lower the frame and drop it from  $\pm 2$ cm height. Press the middle of the spar nearest to you down onto the film. Press down the left end of this spar, then the right end. Be sure to make vertical movements only. Tap the spar downwards at some places in between. Now press down the middle of the other spar and its ends. Because of the curvature of the ribs the fixed spar will lift a little from the board and the ribs will bend, but the structure is sufficiently flexible to do this without risk of breakage. Now the frame is fixed and there is no danger anymore of shifting. Next go all around the outline cm by cm and press down firmly.

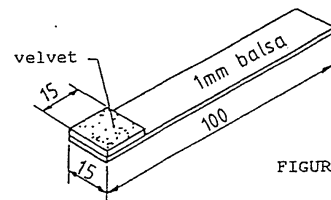


FIGURE 12

With a bit of experience this method will result in relatively little wrinkling. Do not bother about wrinkles, they hardly have any effect on performance. When you use paper as a covering material these wrinkles are even beneficial. Changes in humidity will less likely cause warping of the structure. Never dope a paper covered indoor model! Instead of contact cement you can also use thinned white glue or a glue stick (like Pritt). The wing and rudder are covered in the same way as the stabilizer.

## Removing the excess foil

Take a new sharp razor blade. Lay the stabilizer on the building board curved side upwards, with one spar just outside the edge of the board. Take one corner of the foil between thumb and forefinger, insert the razor blade and move it to the right (figure 13).

It is as if you try to pull the framework off the able with your left hand and are resisting that with the knife. Go all along the outline of wing, stabilizer and rudder. Take care not to cut into the wood. Do not bother too much when you cannot remove the foil close enough to the spar.

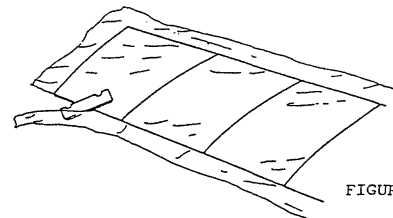


FIGURE 13

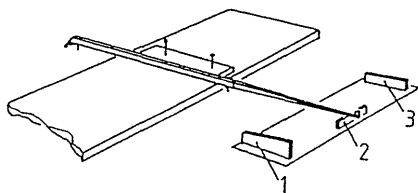


FIGURE 14

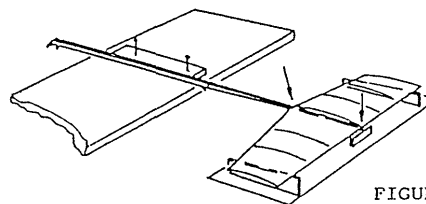


FIGURE 15

### Mounting the stabilizer

Assemble the cardboard jigs L1, M2 and R3 on the working table as in figure 14. The big assembly block is pinned to the building board. Place the fuselage against the block and clamp it between the little balsa blocks. Check that the fuselage is aligned squarely with regard to the stabilizer. If the end of the tailboom does not touch jig 2 put something under the jigs to raise them. Place the stabilizer in position (figure 15). When all is properly aligned glue the stabilizer at the indicated spots. Let it dry for at least 15 minutes. From now on you will have to handle your model with extra care: a sudden movement can easily lead to damage. The best way to hold the model is at the nose between thumb and forefinger.

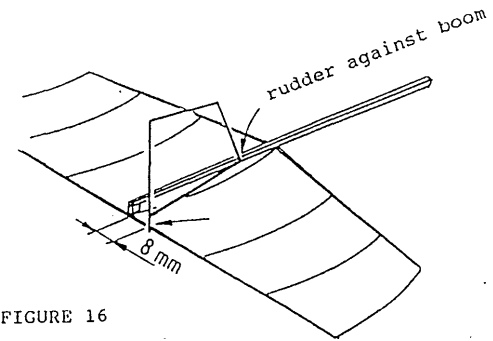


FIGURE 16

### Mounting the rudder

Lay the fuselage with stabilizer upside down. Hold the rudder in its correct position. Note that that the rear is offset to the left 8mm (figure 16). Put glue on the rudder as indicated, hold it in position and keep it there for a few seconds. It will stay upright. Leave it to dry further.

### Tying the rubbermotor

First we exercise in making a half-knot (figure 17). Take both ends of the rubber (1), cross the ends (2), pass one end underneath the other (3) and pull lightly (4).

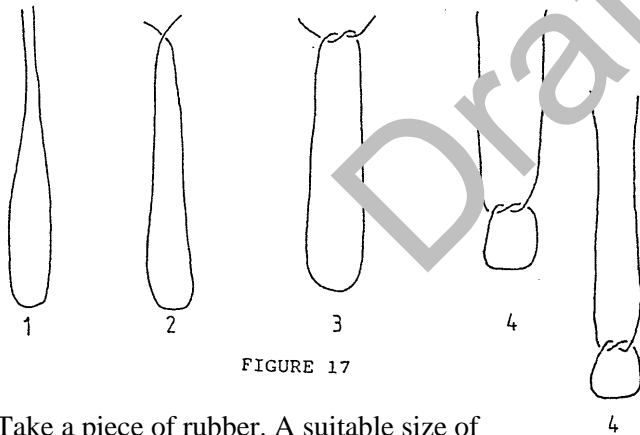


FIGURE 17

Now we make a complete motor (figure 18):

- Take a piece of rubber. A suitable size of rubber motor for this model is a loop of 35cm length and a cross section of 1x2 to 3 mm.

- Slide two small O-rings over the strand and slide them towards the middle. These rings can be cut from dia 3mm hard plastic tubing.

- Make a half-knot and slide it halfway downwards (4).

- Lay the ends on top of each other and tie a double knot (5). Do not yet pull the knot tight.

- Wet the rubber at the knot (f.i. with saliva). The moisture serves as a lubricant and prevents tearing of the rubber. Pull the knot tight and try to move the knot towards the end to within. Pull it really tight!

- Now move the earlier made half-knot towards the double knot and pull tight (6). Remoisture if necessary. - Slide one of the rings towards the knot and leave the other at the middle of the strand. Cut off the loose ends of rubber to about 5mm of the knot. The rubber motor is ready.

It is possible that the knot gets loose when you tied it too loosely. When the motor is lubricated (later more about that) then remove the lubricant as far as possible, tie again with the same type knot but

now an extra half knot is put on top of that (7). This knot usually holds. If not then a small drop of instant glue between the loose ends will help.

### Balancing

The wing posts are cut from relatively hard balsa. The ends are sanded round such that they fit precisely in the wing sockets. The fit must be such that no real force is required to insert them, but on the other hand they may not slide too easily. The front post is 60mm long, the rear 55mm. The exact position of the sockets on the fuselage is determined as follows: hook the propeller into the bearing. Slide one of the rings of the rubber motor over the propeller hook and the other ring over the rear hook. Support the motorstick with a little stick and shift the fuselage till it balances horizontally (figure 19).

Mark this position on the motorstick with a fine pencil. Set other marks at 105mm forward and 45mm aft of this mark. These indicate the positions of the front and rear wing post.

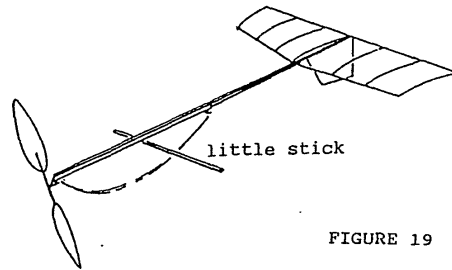


FIGURE 19

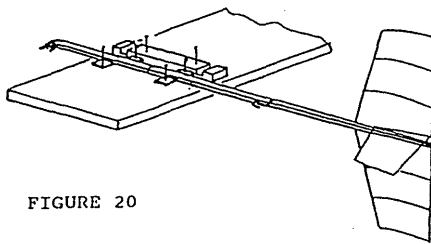


FIGURE 20

Take the building

board with the big assembly block and pin it down as indicated in figure 20. Lay the fuselage parallel to but not against the block. Leave about 1,5cm between so that the fuselage can be clamped with the little blocks. The lengthwise position should be such that the front and rear wing post marks align with the grooves in the

assembly block. Slide a socket over each of the wing posts and lay them in the grooves (figure 21).

Let the sockets stick out over the motorstick equally at both sides. View the posts along the fuselage direction to be sure that they are aligned in the same plane. Glue the sockets to the motorstick sparsely. Do not let any glue get onto the posts themselves! Let dry for 15 minutes. Add an extra layer of glue.

Only after every-thing has dried completely you can pull out the posts from the sockets.

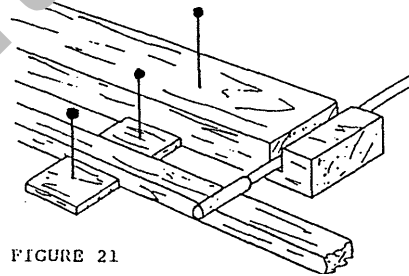


FIGURE 21

### Dihedral

The next step is to make dihedral in the wing and mount it to the wing posts. For this we have to set up a jig as in figure 22. Pin the cardboard jigs 4 and 5 vertically on the building board and jigs L6 and R7 against them with the 125mm side forward. Note that L6 and R7 are not exactly equal. The rear side of L6 is shorter than the rear side of R7. This guarantees that

the wing halves will be glued together with the right warps built in. The left wing gets a positive warp of 6mm. Pin the large assembly block on the building board with two pieces of balsa underneath to raise it about 2mm.

Insert the longest wing post in the front wing socket and the shortest in the rear socket. Clamp the fuselage against the assembly block as in figure 23. The tail of the model will stick out beside the table, so be careful not to hit it or the building board accidentally. Take the

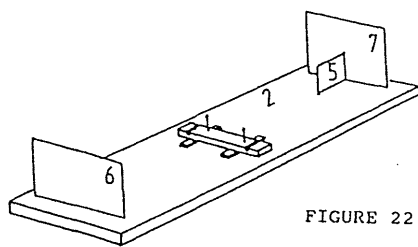


FIGURE 22

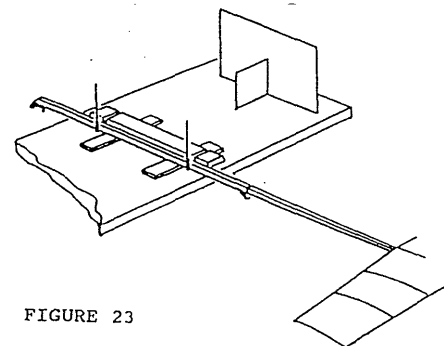


FIGURE 23

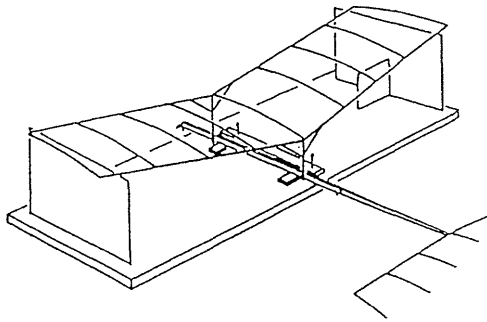


FIGURE 24

wing and lay it upside down. Make a half cut where you joined the wing spars. Gently break the joint further till you get the required dihedral amount. Handle the wing with care to prevent tearing of the covering and lay it on the jig (figure 24). Be sure that the leading edge is forward. The left wing is longer than the right. Position the wing break on top of or just between the wing posts and glue firmly.

You will notice that a big wrinkle has developed in the middle of the wing. It may not look nice but it will not influence the flying capabilities of your model. Add the four struts and let dry for half an

hour. Remove the model from the jig and admire your model for a moment. It is finished!

#### Accessories

Find a box in which you can store and carry your model. The dimensions should be 56x34x14cm minimum. Construct the flaps of the box such that they cannot fall into the box and damage your model (figure 25). The fuselage is fixed with the motorstick slid into two foam rubber blocks. Cut a slit in each block and glue to the bottom of the box. The wing is mounted in the same way as it is fixed to the fuselage. Glue wing socket tubes to a piece of balsa and glue this in the box. Also in this case the sockets have to be aligned properly to prevent warps from developing in the wing.

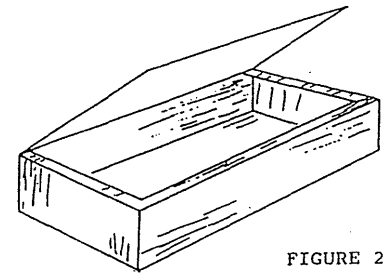


FIGURE 25

For winding the rubber motor we need a winder with a gear ratio of about 1:10. You can make one yourselves from an old hand drill, alarm-clock or Meccano gears. They are also commercially available.

#### Flying

For our first trim flight we need a draft-free space with a floor space of trim flight minimum (a gym hall, cantine, hangar, church). Because an indoor model always flies powered by its propeller and not as a glider we will trim it directly as a powered airplane. Remember that the safest way to hold your model is at the nose between thumb and forefinger. This way you also hold the propeller. Force yourself to slow down, make gentle movements. When you run with the model in your hand all that will be left is the motorstick and remnants of wing and tail will flutter behind you.

Insert the propeller into the bearing and attach the rubber motor (knot at the rear!). Check that:

1. the longest wing post sits in the front socket.
2. the underside of each wing post is exactly equal with the underside of the socket.
3. the left wing has the correct positive warp and the right wing is flat (figure 26).
4. the stabilizer is flat.
5. the stabilizer is tilted to the right (figure 26).
6. the rudder is flat.

Small deviations are acceptable.

Take the model at the nose with your left hand and turn the propeller with your right hand 200 turns to the right.

Now switch over the model such that you hold it with your left hand from the front at the bearing also keeping the propeller from rotating. Take the model with your right hand at the motorstick under the wing and release the propeller. Let the propeller turn for a few seconds and release the model with a gentle movement. Do not throw it! The model will turn to the left if everything is right. Do not panic when it hits the wall. Just let it happen and pick it up when it has slid down. Also when it risks to collide with a person say to him to stand still, freeze

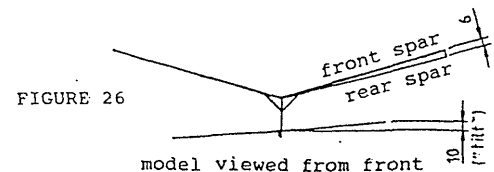
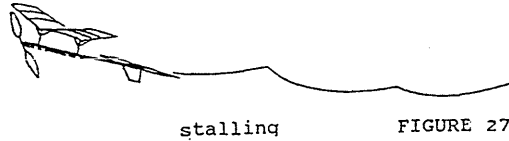


FIGURE 26



and let the model hit and slide down. The model flies so slowly and is so flexible that hardly, any damage will result.

The model should not dive nor climb. When it tries to climb you will notice that it loses velocity, stalls and dives to pick up speed again (figure 27). When it stalls the front wing post has to be lowered in the socket. Do this in small steps of  $\pm 1$ mm. When it dives the rear post has to be lowered. When the model flies a neat and level left turn you can increase the number of turns. From now on we do not do this by hand any more as you can easily damage your model. We use the winder. The motor now



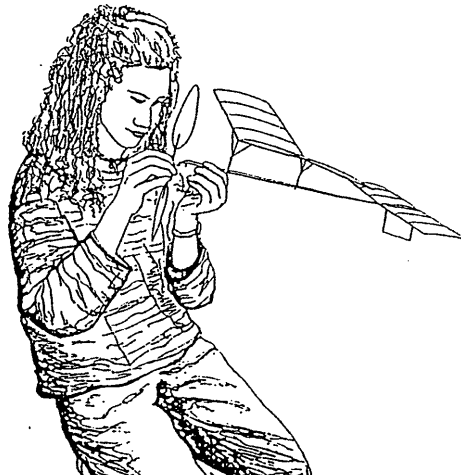
always has to be lubricated with castor oil or another type of lubricant. Only then will the motor unwind smoothly and have a longer life. Hold the model between thumb and forefinger at the front so that you also hold the propeller. The rubber is hooked up at the propeller (knot at the rear!). Ask a friend to wind  $\pm 500$  turns in the motor. Take off the motor from the winder grabbing it firmly just before the O-ring and hook it up to the rear hook. The winding is best done by stretching the rubber about 4 times its original length. In this position wind in about half the number of turns. The other turns are wound while gradually approaching the model till it matches the length of the motorstick. With this procedure, which can be refined a lot, you will get much more turns in the motor and it will last longer!

When the model flies level cut off the end of the wing post that extends below the wing socket. This ensures that you will always mount the wing onto the fuselage with the correct incidence angle. Always slide the wing posts into the sockets till they are aligned with the underside of the sockets.

You can now further increase turns till the model approaches the ceiling. When the ceiling is flat and smooth you can even allow it to hit the ceiling. When your winding technique has become optimum you can get up to 1600 turns into the motor. In large halls times of almost 10 minutes can be flown! But in a gym hall flights 5 minutes are very well possible. It is all a matter of clever experimenting with longer, shorter, thicker or thinner rubber, a larger propeller, more pitch, other blade shape or whatever design change you can think of!

How to continue?

That depends on you. Building or flying this model may not have been as satisfying as you expected or you have had some bad luck. We do not think that that is too bad. You have tried something and gained new experience. But you also may have become curious to what this model really can, and that is quite a bit. It requires further experimenting with rubber sizes. A lot can be told about winding technique. There are many, many other more challenging designs. Remember this: when you fail at something, or have something to ask, call or write one of the other indoor fliers. They will be glad to help you!

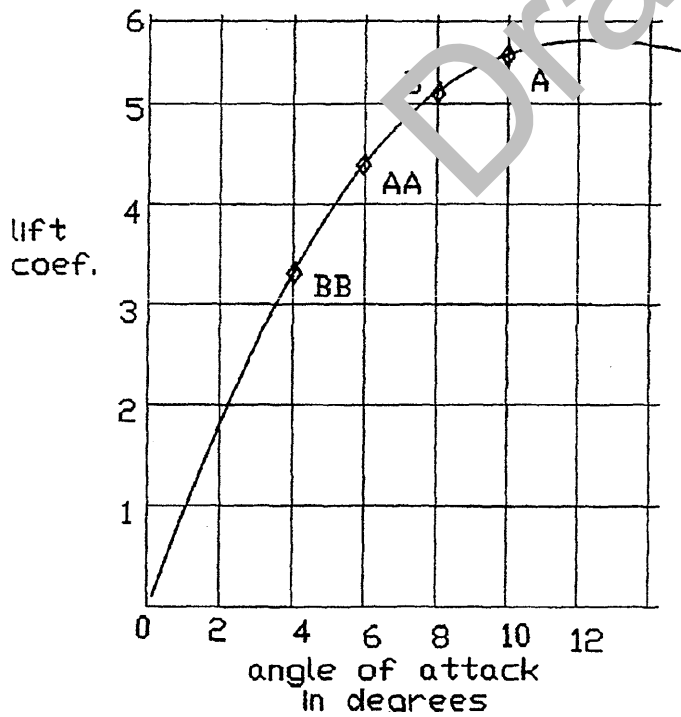
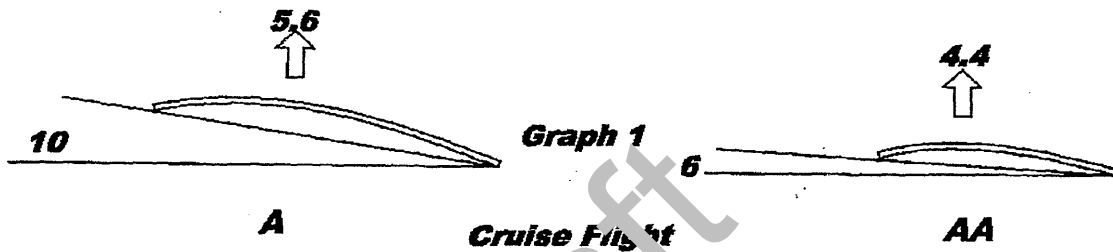


Pitch Stability in Indoor Models

By Steve Gardner

Your model is up there near the rafters doing great! All you need is another two minutes and it is still all the way up there. You can't miss. You are still watching it very closely though, because it is not the best model for bouncing around in the clutter up there. You enter the last minute that you need to win, and the model bumps something. It is slowed a bit too much and this lets the nose down ten or fifteen degrees. The model speeds up as it dives and it loses the nice tight turn that has kept it in the center of the building all this time. One of two horrible things happens now. The model flies straight for too long before it starts to circle again and it gets into a wall, or it continues the dive until the wing starts to twist which increases the dive angle and spirals the model to the floor. Fifteen seconds too early. Rats!

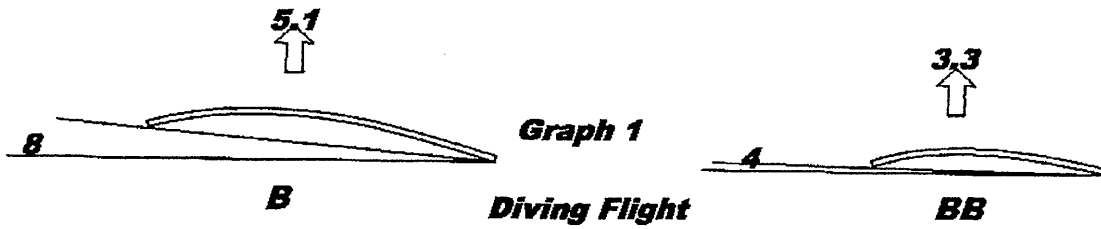
What went wrong? It was just a bump. It got away from whatever it hit cleanly with the nose down only a little. You own and have seen other models that would pop right back into their flight pattern without any problem after such a bump, but this model has a real problem with recovering from disturbed flight. Why doesn't it behave like the other ones? Can it be fixed?



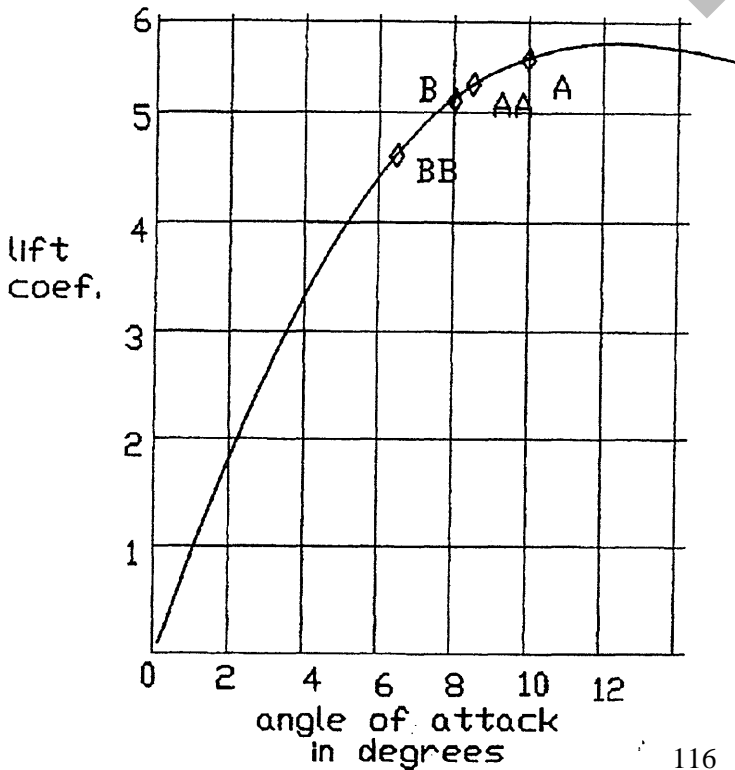
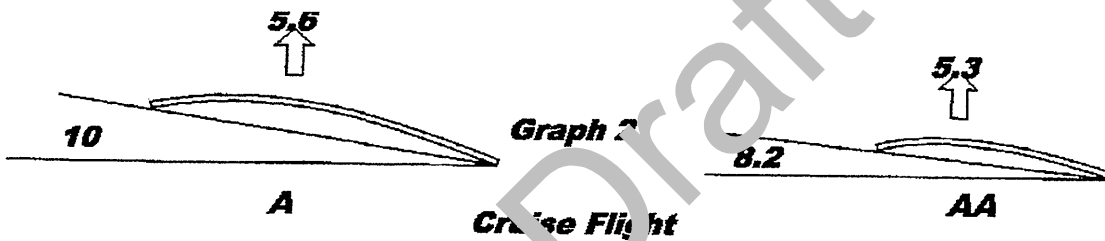
To start with we need to understand what went wrong. Why do some models pop their nose right back up after being disturbed and some do not? What makes a model "stable"? Look at the simple force diagram above. Imagine the balance point, or center of gravity as simply being the model's weight. The wings have to hold this up for the model to fly. From the drawing you can see that the stab also helps hold up the weight, so there is lift from both the wing and the stab. When the model is in steady flight the lift from the wing and from the stab are balanced so that the weight is just supported and there is no tendency to raise or lower the model's nose. The numbers indicating the lift of each surface are simply used to compare the proportions of lift from the wing and stab, and are not related to any real lift values. In this example the balanced lift

condition happens when the wing's lift value is 1.27 times the stab's lift value. (the wing carries more of the weight than the stab). If this number goes up, the wing is then lifting more than its share of the weight and so the nose comes up. The larger the number, the faster the model pitches up. Looking at

the second set of points on the chart marked B, BB we can see the lift numbers for the same model just after it has been disturbed and is diving as shown here:

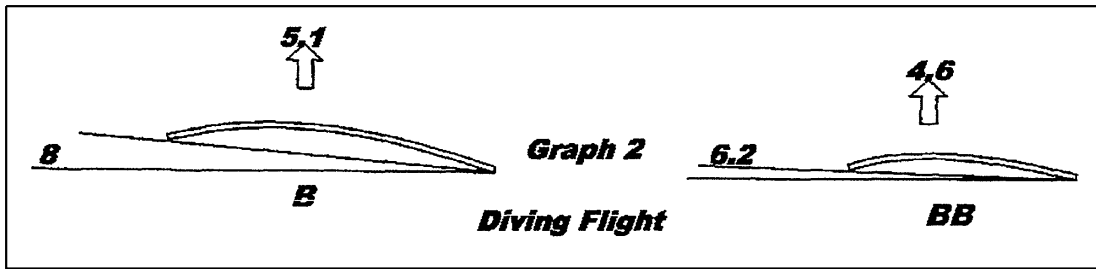


The wing is now lifting 1.55 times the stab and this will pretty quickly raise the nose of this model. From the lift chart you we can see that the lower the angle the model is flying at, the larger the nose up tendency. This lower angle is not the dive angle itself, but a diving model will have a much lower angle of flight, it can get close to zero in very steep dives. This chart, Chart 1, is for a model with 4 degrees of decalage. Decalage is the angular difference between the wing and stab. It has nothing to do with the angle of incidence, which is simply the surface angles compared to the models centerline. When you trim your model out you adjust the wing or stab incidence to get the model flying nice and nose high. Once you have the model trimmed out there will be a certain angle of decalage between the wing and the stab. In the next set of diagrams we show what happens when the decalage angle is too small.



The model in these diagrams has a decalage angle of 1.8 degrees, which is very small. This model will fly, well as long as it doesn't get too far from its trimmed speed and angle. In steady flight it has a wing to stab lift number ratio of 1.04. Watch what happens when the nose gets down for any reason.

The lift ratio now goes to 1.11, only .07 from the steady flight. The 4-degree decalage model had .28 difference between steady and diving flight, four times as much. This model may or may not get its nose up before its wings begin to warp from the speed. In any case it will end up much lower than the model with more decalage.



So, all we have to do is make our models with more decalage. Right? Mostly, but we have to figure out how to do this, and how much more we need, too. There is a drawback to decalage. The more you use, the less work the stab does. A model with none will fly with the wing and the stab at the most efficient angle for the most lift, and this will maximize endurance. This model will also have to be launched perfectly, and must not run into anything at all that might disturb it. It has no margin of stability at all and a gnat's wake will send it crashing. It will just not work at all. On the other hand a model with say, six degrees of decalage will be stable even outdoors in the wind, but it will just be dragging the stab along for the ride. An indoor endurance model can not afford to give this much efficiency way. To make matters a little more complicated yet we must remember that the tail boom of many indoor models is not perfectly rigid and so the decalage can change in flight.

Part of the problem with this "solution" is that we can not just make the decalage any amount we like. We test fly our models and move the surfaces so as to make the model fly at what our experience says is the best speed. Once the model is flying the way we feel it should then the decalage has been determined. If we mess with the angles now it will make the model fly too fast or stall the model. Now we just fly the model into the rafters to see if it will behave well or not. Let's say this one does poorly, are we really stuck with a lemon? Not necessarily, here are some things to try.

1. Move the wing back just a bit on the motor stick. This will effectively shift the center of gravity forward and so the model will need a bit more decalage. Make this change in small amounts so that you do not over do it.
2. Add a bit of down thrust to the model's nose bearing. This will also result in the model needing more decalage at a small performance cost. A possible advantage is that the down thrust will help prevent the model stalling during the initial climb phase, yet allow the decalage to be set so as to get the model nice and nose high during the cruise portion of the flight.
3. Use a stiffer tail boom, If the tail boom of your model is a bit too flexible it will actually let some of the decalage bend out of the model. Look at the model in cruise flight and make note of the upward bend of the boom caused by the lift coming from the stab. Now watch the model just after it has bumped something and is starting to dive a bit. If the bend in the boom stays much the same and the model gets its nose up right away, fine. If on the other hand the bend relaxes a great deal and the model dives for an extended period, or even speeds up and spirals in, you need a stiffer boom.
4. Make the tail boom longer. I like this one. The longer tail boom gives any difference in the lift between the wing and stab a greater lever arm to act through. A smaller amount of decalage will work well enough if the tail boom is long enough. Remember number three though when you do this.
5. Make the stab area larger. This lets the stab carry its share of the weight at a lower angle which means less decalage. This fix is not too practical because most flyers are using the largest stab the rules allow anyway. Just another reason to do so.

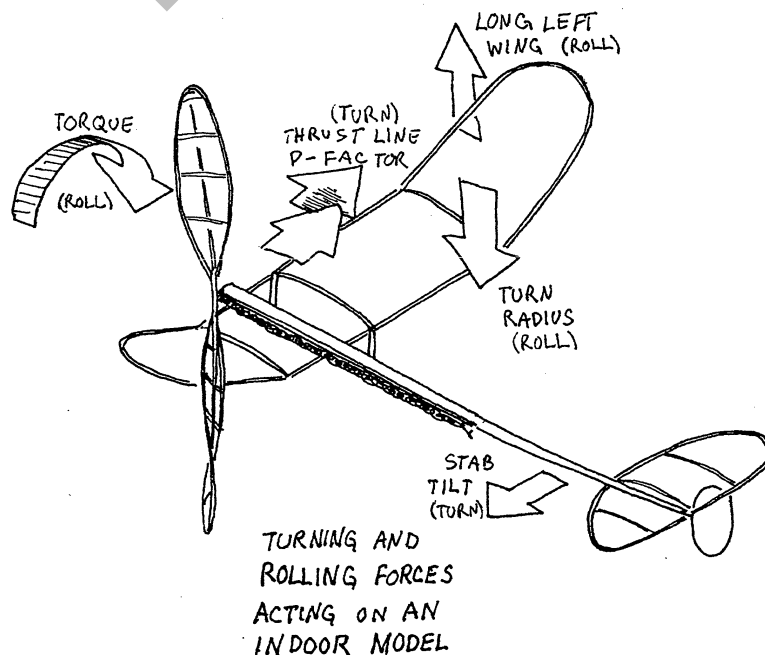
#### *Why the model goes for the wall when it dives from a girder bump*

One of the most aggravating things about bumping the ceiling is the model taking off for the wall. It will hit the girder or whatever and the nose will get down a bit and the speed will pick up some, then it will proceed to quit circling and fly straight for an extended time. If you are flying in a small area this will make it necessary to steer the model if you can. If you are way up there in a large site you may just have to watch while your model leaves the sweet spot you launched it into and heads for trouble. What is happening here? Why does a model that flies happily with a circle of 40 or 50 feet

decide to open up the turn when the speed gets up a bit? Can you stop it, or at least minimize the effect?

We are kind of in a fix with this one. The reason our models do this is related to how we must trim them to get the best duration while staying within the confines of a building. We need a fairly tight turning circle without a great deal of bank angle while flying very, very slowly. The adjustments we must use to get this work well only when the model is at or very near the trimmed speed. When the speed gets up above this certain level the adjustments we use start to work against us. Imagine a hang glider flying along in level flight. The pilot decides to turn to the right. How does he do this? He pushes his weight to the right to get that wing down. Our models fly with the left wing longer than the right. This is exactly like the hang glider pilot pushing his weight to the right. He gets a right turn for his action. What do we get? If the model is flying fairly slowly we get a nice left turn. What is the difference? We have the added complication of torque, the "P"-factor, thrust line effects, stab tilt effects, and turn radius effects. The torque tends to lower the left wing and if you think it is a small force you do not fly mini-sticks! The "P"-factor tends to yaw the model to the left and its strength is directly related to the amount the prop disk is tilted up when the model is flying. The thrust line also yaws the model to the left because that is the direction we point it. The same is true of the tilt of the stab. The last factor comes from the fact that a model with a turn radius of 20 feet and a span of 18" has a right wing flying about 7.5% faster than the left wing. This makes the right wing lift about 15.5% more per unit area than the left, causing a roll effect to the left. Whew! Complicated!

So what is going on with our model? The torque that is applied to the model is fairly constant, causing a left roll tendency. When the model is flying at the proper slow speed the nose is up and so the "P"-factor is helping turn the model left. The slower the flight the harder the prop pulls, so the effect of the thrust line is greatest then giving use more left turn. The effect of stab tilt is related to the lift the stab is giving, and from the previous diagrams that is highest when the model is flying at high angles of attack (slowly), this effect is to turn the model left. The turn radius effect is to roll the model to the left. No wonder we need a longer left wing to hold that wing up! All that left stuff going on! So what happens to the model to make it dive straight or to the right? Imagine the model with the nose down and the speed up. The angle of attack is very low, so that the "P"-factor disappears. The stab tilt is also at its weakest point. The model is now flying faster than the prop is pitched to go, so the thrust is way down and so is the effect of the thrust line. All this begins to open the turn up, and this removes the turn radius effect. What remains is the torque and the long left wing. If the wing were the only factor we would turn right just as the hang glider does, but torque helps us out now and we end up with sort of straight flight, unless the speed gets up any higher. If it does then look out! If we have done what we can to get the model to pop the nose back up then this set of effects will quickly return the model to the nice left turn. If we have a model that takes its time getting the nose up then the model will go wandering whenever it bumps anything. It will almost never wander into a better spot than you started in, so see if any of this stuff helps you get a better flying, more consistent model.

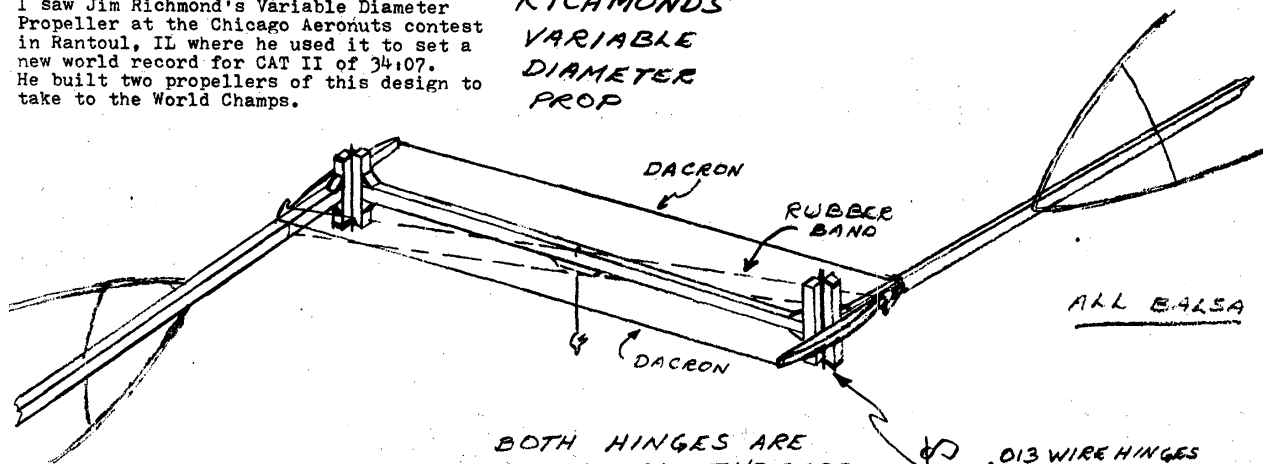


Issue 16 1984

# Jim Richmond's Variable Diameter Propeller by Richard Doig

I saw Jim Richmond's Variable Diameter Propeller at the Chicago Aeronauts contest in Rantoul, IL where he used it to set a new world record for CAT II of 34.07. He built two propellers of this design to take to the World Champs.

## RICHMOND'S VARIABLE DIAMETER PROP



BOTH HINGES ARE IDENTICAL. THE DACRON TENSION "WIRES" PULL BOTH BLADES IN EVENLY  
22 INCH EXTENDED DIAMETER  
18 INCH FOLDED DIAMETER

.013 WIRE HINGES

DRAWN BY: R. DOIG

Draft

Issue 17 1985

## Variable Diameter & Pitch Propellers likely by Richard Doig

When I saw Jim Richmond's Variable Diameter Propeller last September in Rantoul, IL I asked him why he was using it and his reply was that it was a more reliable way to change the pitch than changing the blade angle. Which brings us to the heart of the matter, when this type of propeller folds you get a dramatic reduction in pitch.

### BACKGROUND

Variable Diameter Propellers are nothing new, as Hewitt Phillips and Jim Clem have been experimenting with them for many years. (See accompanying articles.) Up until very recently, however, no one had succeeded with a variable diameter prop without incurring a severe weight penalty. That all changed last September 29, when Jim Richmond broke the CAT II World Record using one. (34:07 under 44 feet) This flight had an interesting flight pattern in that the model climbed to 20 feet or so and cruised for 10 minutes. Then over the next 2-3 minutes the prop folded and the model climbed to a peak altitude of 40 feet. This was advantageous as the ceiling height was 44 feet with lights which hung down 2 feet and there was noticeable drift close to the ceiling. Richmond succeeded in staying below the drift. At the World Champs in October, Richmond was able to fly top times without touching the ceiling and without risk of hanging up, while everyone else bashed the girders. His prop was clearly the hit of the World Champs.

### DOIG VARIABLE DIAMETER PROPELLER

Richmond's prop made extensive use of bent wire hinges and other parts - which he is very good at making. I took a different approach, using Micro-X teflon washers as hinge bearing surfaces around straight pieces of wire. As originally built this prop would not completely open but stopped 15° short. However it still flew well enough to win the Balsa Bug's MI State Championships in October - 23:43 at 60 feet in 50 F air.

The propeller has since been modified to reduce the distance that the rubber has to stretch for full opening and this corrected the problem. (see figure 1)

This mechanism added about .0040 ounce to the weight of the prop (mostly in Hot Stuff required to repair the many breaks caused by my clumsiness during building). Properly done, this mechanism should add about .0015 - .0020 ounce.

Opinion seems to be very strong concerning Variable Diameter & Pitch Propellers. Those who oppose them are adamant that the extra work involved will reduce participation even further. Those who favor them can see their value at making models last longer because you stay out of the girders. It does take less time to build one of these props than a replacement model. Most flyers don't see any benefit from Variable Diameter & Pitch Propellers in high ceilings (CAT IV) at this point. However in lower ceilings, especially those with cluttered girders, lights, sprinkler- systems the advantage of staying several feet below these obstacles are great.

Please note that this type of propeller is specifically outlawed in the A.M.A. Rulebook for Novice Pennyplane and Manhattan Cabin.

### HOW THE CHANGE IN PITCH WORKS

In Jim Jones' accompanying article he discusses pitch change as the blades are folded inward. However he presumes that the pitch was helical when the prop was fully extended. This is not necessarily the case. When I asked Richmond where he placed the blades, he was non specific except to say that helical pitch occurred part way through the fold. In the case of my own prop I set true helical pitch to occur when the prop was halfway through the fold. That is, I glued the blades onto the spars with the hinge pin at the point on the pitch block where I normally put the hook, see figure 2. (Actually this is the only way it would fit.) This creates a situation where, when the prop is fully extended the pitch is very high at the hub and decreases toward the tip and the average pitch is higher than the prop block. The higher pitch at the hubs slows the R.P.M. way down while keeping the tip at

a shallower pitch so the tips don't stall. When the prop is fully folded the opposite is true. The pitch is low at the hub and increases toward the tip and the average pitch is much lower. The R.P.M. increases dramatically due to reduced drag and if you are high enough on the rubber's torque curve the model will begin to climb again. This prop construction gradually folds to approximately 90° over a long period of time. 2-3 minutes or more. When the mechanism gets to 90° and goes over center, the next 90° of travel happens very quickly and abruptly taking 2-3 seconds. If properly done, the fold will not be in until 10-12 minutes into the flight (or even longer).

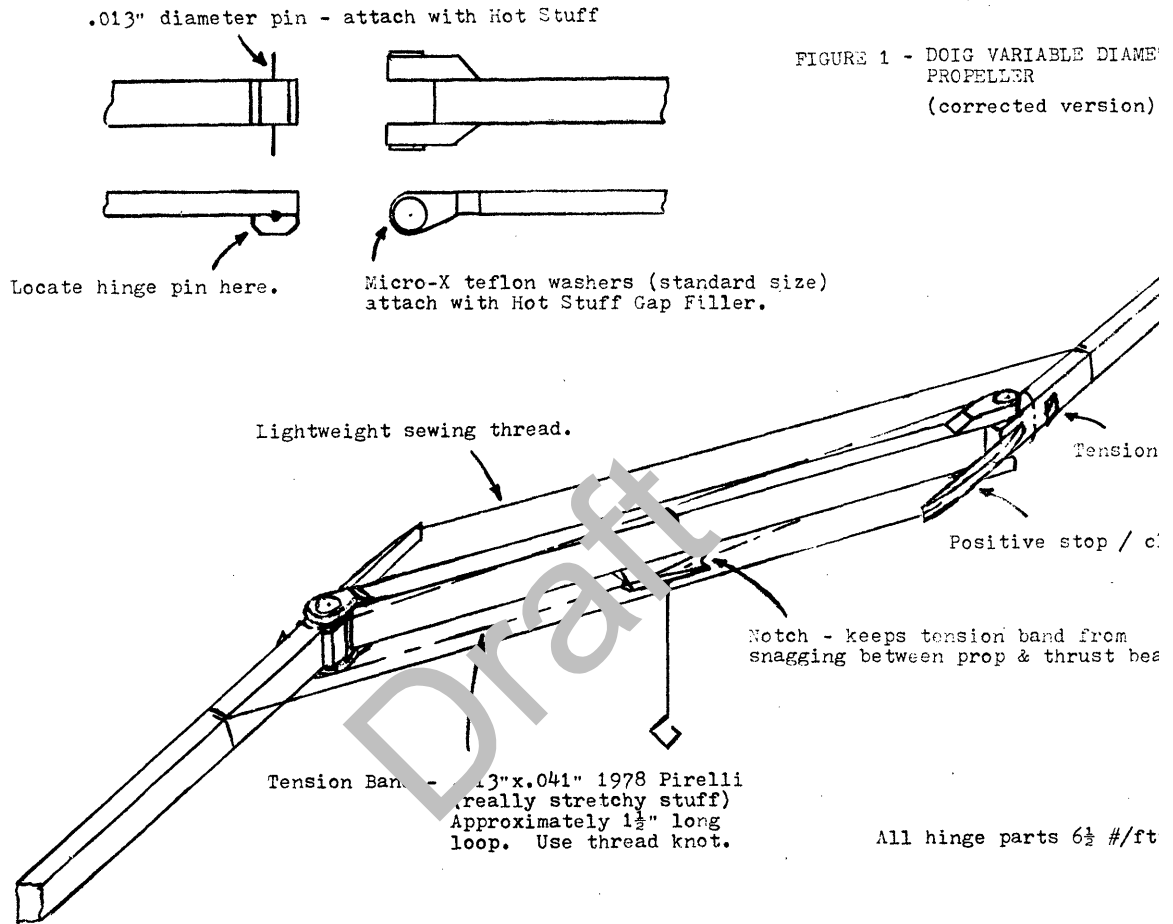
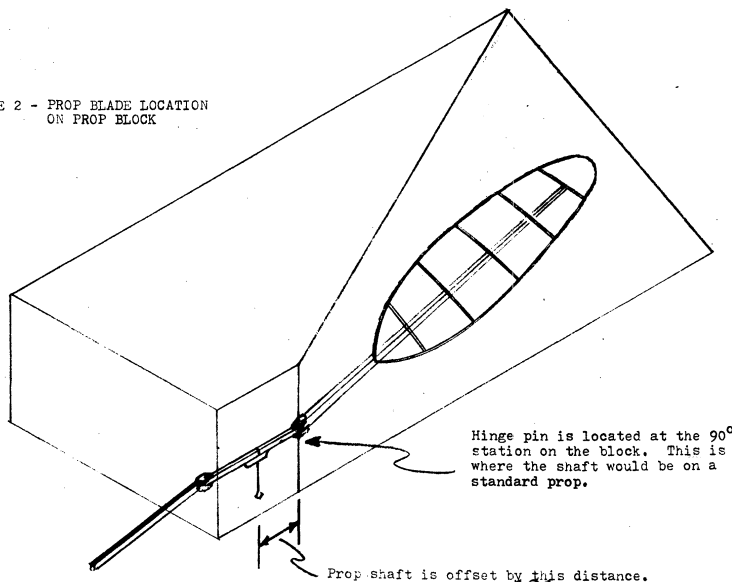


FIGURE 1 - DOIG VARIABLE DIAMETER PROPELLER (corrected version)

FIGURE 2 - PROP BLADE LOCATION ON PROP BLOCK



### WHAT DOES THIS ALL MEAN?

Only experimentation by several modelers under a variety of flying conditions will provide the answers along with discussion amongst modelers, especially if we are to come up with mechanisms which are easy to build and lightweight.



Reprinted from Indoor News & Views, April 1966.

The Variable Diameter Prop  
by Hewitt Phillips

Look at what it has taken us nineteen years to learn

I have built two or three of the variable diameter props, and they really work. However, the additional weight and drag of the mechanism would be more of a penalty on today's models than it was in the old days. The principle of operation is shown on the attached sketches. The two blades are kept in the same relative position by a parallelogram linkage (absolutely essential, as discovered on the first trial when one blade would stay full out and the other full in). The blades wind out against the tension of a fine rubber band wrapped around a small pulley. The rate of climb or descent of the model depends solely on the tension in this rubber band and is independent of the winds or torque of the rubber motor. Thus, the model may be adjusted to fly level throughout the flight by carefully adjusting the tension in this fine rubber band.

Variations in the characteristics may be obtained by changing the pulley from circular to elliptical or cam-shaped. Usually, it is desirable to obtain some climb at the start followed by a long level cruise. Otherwise, the drafts near the floor will eventually bring the model down. Also, blade angle change may be obtained simultaneously with diameter by canting the hinges. This may be used to compensate for twist of the blades under high torque at the start of the flight. It is perfectly easy to obtain peculiar effects, such as a descent at the start under full power, with the prop stretched out to maximum diameter, followed by a climb near the end of the flight with the blades pulled in and the propeller buzzing around like a beginner's ROG. This condition obviously should be avoided for endurance.

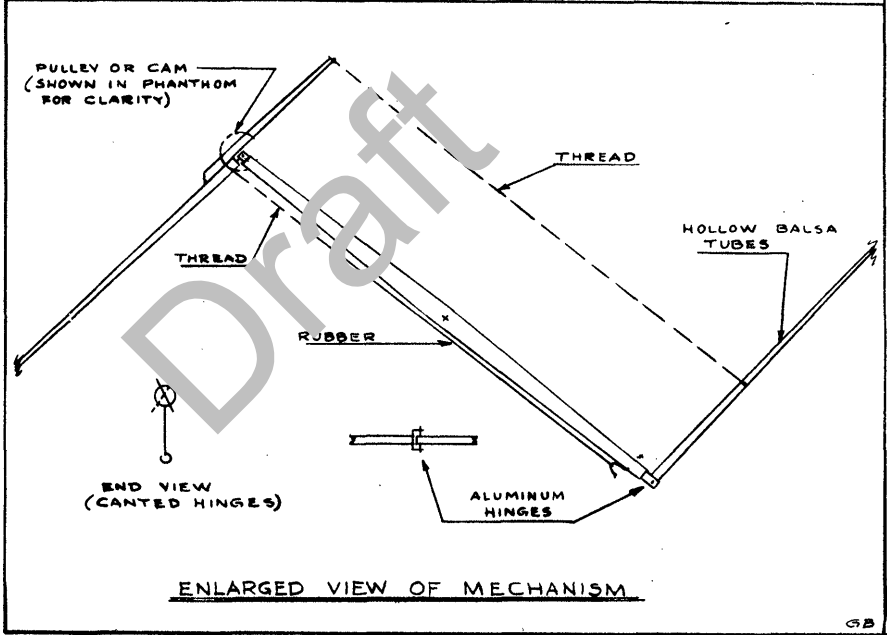
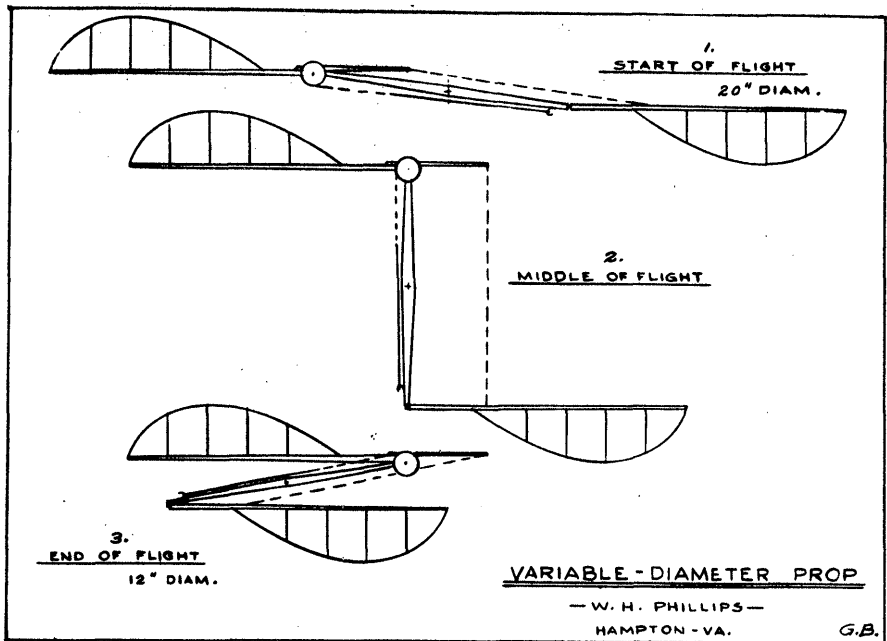
In Boston, we flew in the old Irvington Street Armory which had a 55' ceiling. The variable diameter prop was really advantageous under these conditions. I don't think it would compete with fixed diameter props in ceilings above about 80 feet.

F.Y.I. (FOR YOUR INFORMATION) by Jim Jones

Since Jim Richmond won the Indoor World Championships in Japan, I have seen two published drawings of his winning model. One in N.I.M.A.S.'s INAV & the other in my latest edition of "Bat Sheet" both articles mention the variable pitch prop but they refer to it only as a variable diameter. When the diameter changes, the pitch also changes, & it happens like this.

For the sake of explaining this condition. I will assign a pitch of 36 inches to the fully extended 22 inch position. The 45° section of a true helical pitch prop exists at 11.5 inches. When the blades are retracted to the 18" diameter minimum, the 45° sections also retract. These 45° sections now exist at a diameter of 7.5 inches. The pitch now is only 23.4 inches, but it is no longer a true helical pitch. To illustrate, the tip angle of a 36" prop at a diameter of 22 inches is 27.5°. When this prop retracts to its 18" diameter minimum, this tip angle remains the same. When you figure the pitch of a blade with a diameter of 18 inches, & a tip angle of 27.5° it calculates out to a pitch of 29.5 inches. This prop now has a pitch of 23.4 inches at the 45° section and a pitch of 29.5° inches at the tip.

These calculations are based on the premise that the blade extends & retracts in a straight line without rotating on its axis. It also is figured without taking into account any of the flexing that an indoor prop has to endure. To summaries, from the center of the hub to the 45° section the angles will be less than they would be if it were a true helical pitch, & from the 45° section outboard the angles are just a bit higher than they should be. But the change is great enough to allow the prop to pick up a few R.P.M.s & extend the cruise. When the conventional fixed pitch & diameter prop would be slowing down too much to maintain lift.



Issue?

## INDOOR PROPS - VARIABLE PITCH AND VARIABLE DIAMETER

by Hewitt Phillips

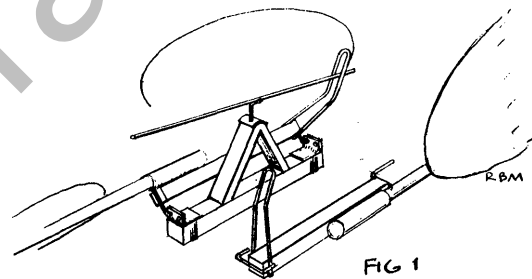
Reprinted from May, 1976 NFFS Free Flight Digest

Ever since the days of hand-carved balsa indoor props, attempts have been made to build in a distribution of area and structural stiffness which would allow the blade to "flare" at the start of the flight to slow down the climb and prop R.P.M. during the initial kick of the rubber motor. The slower climb was especially beneficial in low ceilings, but as performance of indoor models improved, it was found that under good conditions, models without a flaring prop would climb too high for even the tallest dirigible hangers. Thus, most all modern microfilm props are designed to increase pitch at the start of the flight.

The conventional prop with flexible spars is definitely limited in the amount of flare that can be provided. If the spars are made too flexible or the prop area is centered too far forward, a disastrous type of instability sets in under full power. One blade will diverge to a full high pitch condition but this will slow the R.P.M. to a point that the other blade will twist to low pitch. The resulting unbalance will usually shake the model out of the air.

Several prop designs have been suggested and tried in past years which allow much greater pitch change without the instability. These systems usually added some weight, which, for models without a minimum weight rule, almost always outweighed any advantage that might be obtained from the device. In the case of FAI models, Pennyplane, etc., in which the minimum weight is specified in the rules, a device weighing a few thousandths of an ounce can frequently be accommodated without exceeding the specified weight. In fact, a weight at the nose may often be beneficial from the stability standpoint. The interest in variable-pitch propellers is therefore growing.

A variable-pitch propeller was described in an article by Jeff Annis in the 1975 Symposium volume of the NFFS. The feature of this propeller which allows a greater pitch change than that of a conventional flaring prop is that the change in pitch of the two blades is kept equal through a linkage. Another prop design increasing this principle has been proposed by Bob Meuser (figure 1). Both these prop designs should prove very beneficial whenever the ceiling height is less than that of the very biggest hangers.



Theoretically, more efficiency could be obtained by increasing the prop diameter rather than the pitch at the start of the flight. A larger diameter prop acts on a larger volume of air, thereby losing less energy in slipstream velocity. Also, a blade stall may occur if the pitch increases excessively. A method of increasing prop diameter was proposed many years ago by John P. Glass, and was tried by the author in several different versions.

The method of varying prop diameter is shown in figure 2. The propeller blades are synchronized through a parallelogram linkage, and the blade position is determined by balancing the torque against the tension of a thin rubber band wrapped around a pulley. By changing the shape of the pulley from a circle to an arbitrary cam shape, most any climb profile for the model may be obtained. For example, the model may climb rapidly to 20 feet altitude, then cruise at this altitude for the rest of the flight until the propeller reaches its minimum diameter. So long as the propeller is

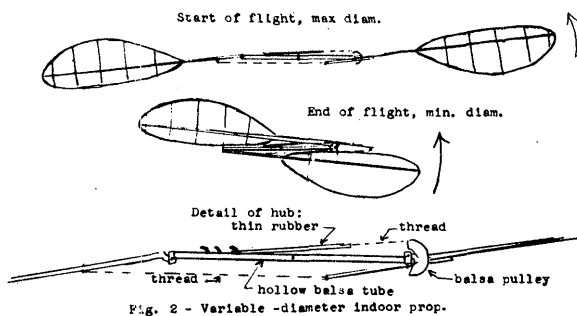
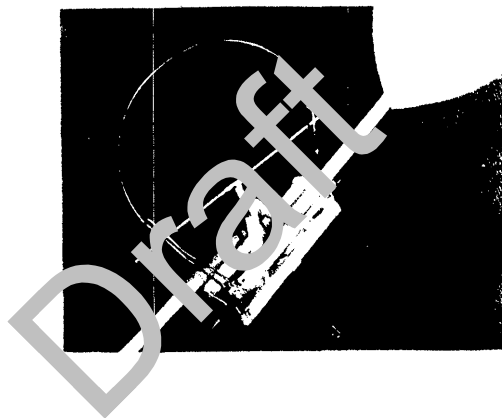
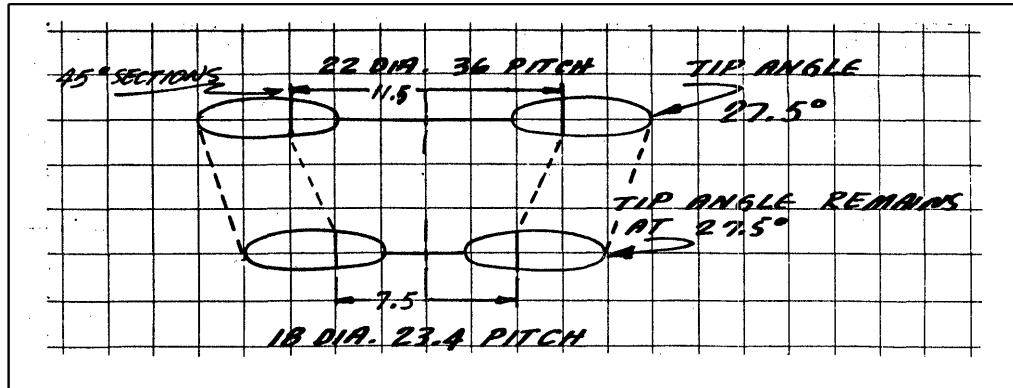


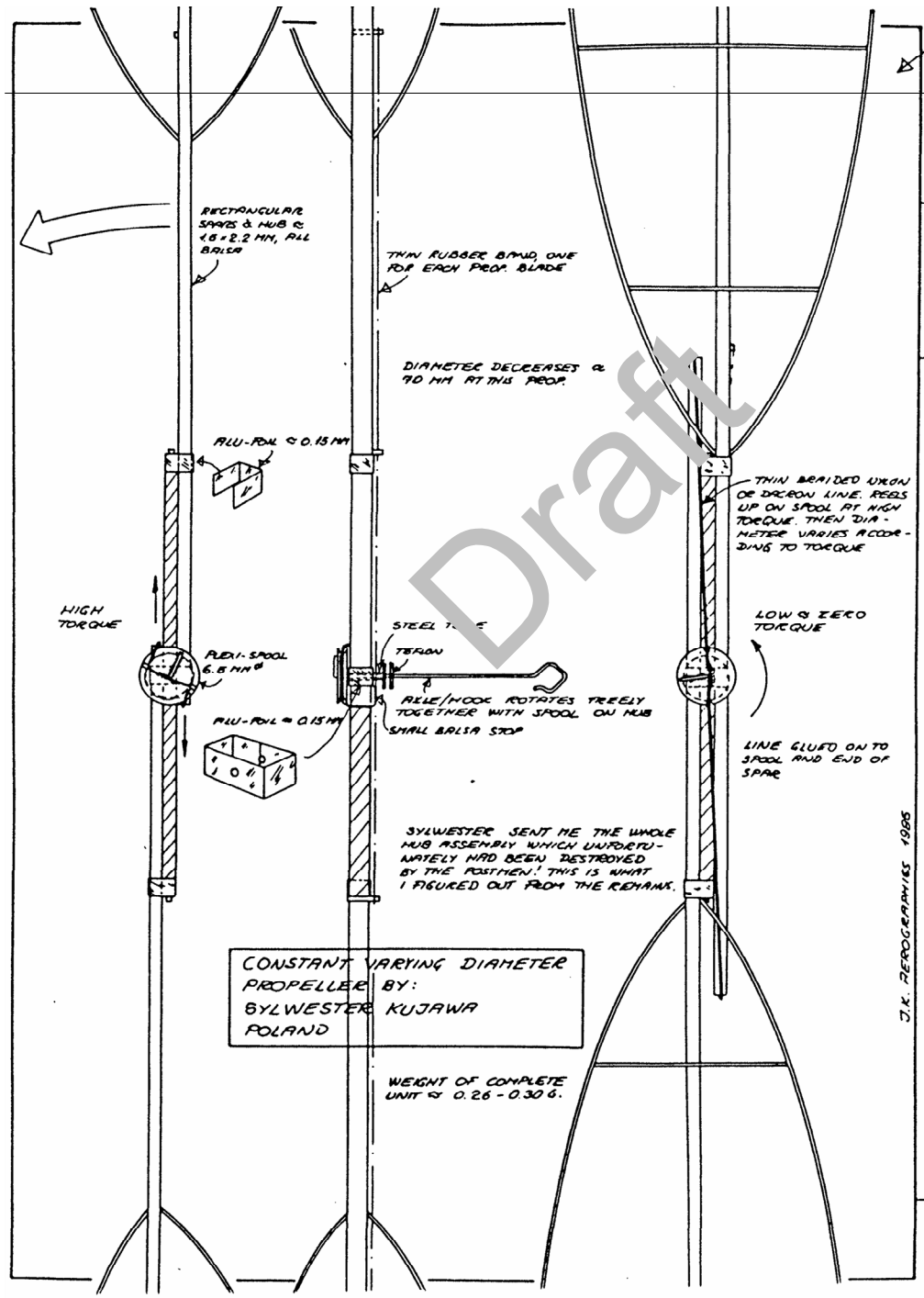
Fig. 2 - Variable-diameter indoor prop.

in this "regulating" condition the climb of the model is not affected by changes in motor torque. The effect of reduced torque due to breaking in the rubber is therefore eliminated. To offset these advantages, however, the propeller spars have high drag and the overall efficiency is generally less than that of a conventional prop. A final possibility that may be mentioned is to change both pitch and diameter simultaneously by skewing the hinges of the blades.



### A Propeller With Constantly Varying Diameter from Sylwester Kujawa by Jorgen Korsgaard

In September I got a letter from Sylwester containing the hub and some part of the blades of his newly developed C.V.D. prop. Unfortunately the postal services had been rather brutal to the envelope, so quite a lot of bits and pieces fell out, when I opened it. I tried to put the prop together again, and on the drawing you can see, what I figured out. Editor's Note: Bud Romak was in Romania this autumn and saw Kujawa's props up close. He says that Korsgaard's drawing is correct. This prop appears to be much easier to build than the hinged versions by Richmond or Doig.



Issue 71-72-73 1993

Partial Motor Test Flights  
by Lt. Col. Bob Randolph

I have to credit the former World Champ and microfilm supplier Erv Rodemsky for getting me interested in partial motor testing in about 1983. I use this technique extensively and make very few non-official full motor flights. This saves time, rubber, and models. In my opinion, it is the "Royal Road" to successful FAI and other indoor model flying. I also use it when I fly Cabin and Mini-stick very successfully.

The basic concept is quite simple. For example, a quarter-sized test motor requires a test stick that is exactly three-fourths of the distance between hooks and that is weighted to exactly three times the lubed weight of the quarter motor. Since only one-fourth of the full motor turns can be put in, the model should climb to one-fourth of the full motor altitude and one-fourth of the full flight time.

The good news is that four times as many test flights can be made. The bad news is that any errors you induce through inaccurate procedure or faulty estimation of altitude will be compounded.

Make a 1/4 motor test stick that is 3/4 of the distance between the hooks of your model. I suggest you also make a balance with moment arms in a 3 to 1 ratio to be able to quickly add the right amount of clay to the 1/4 test stick to match each 1/4 motor you fly. Incidentally use lubed test motors for the balance and always center the clay on the mid point of the test stick and mold it evenly around. Failure to do this will affect the model balance or worse, crush your motor stick.

We are trying to determine the optimum motor that will result in the most time for the existing temperature and conditions. After you find the optimum motor, back off turns and launch torque, you can expect that a full motor of 4 times the length and weight will fly close to 4 times the altitude and duration achieved. Since Cat 1 & 2 require ceiling scrubbing and beam tapping for competitive flight times, I will cover my modified test stick procedures in a future article.

The following is how I flight test a new ship. I make up 8-10 1/4 test motors (use one o-ring) close to the best guess as to the right length and thickness. Let's say this is 4" loop of .070 Tan. I would also make a 4" .068" and .072" plus a 3.5" and 4.5" of these same thicknesses. Balance the test stick for the motor to be used and put in 100 turns. Adjust wing incidence under this cruise power. Adjust circle size if required and check on the ships cruise attitude. If not enough nose up, adjust more negative incidence in the stab. This will mean readjusting wing Incidence. You are looking for a floating cruise where the nose stays up to load the prop and reduce its RPM. Too much will produce a mush requiring more cruise power.

Peak 1/4 motor flying time will require a fully broken in motor but I must admit I break in these little motors by my flight tests. You do not want to out climb the site so start out with all the turns it will take but back off so that the launch torque is 25 units. If this is still too much power, use your steering pole to prevent out climbing your site. Better to only climb 1/2 way up and then keep increasing launch torque slowly. You can't really tell if the motor is the right size until you reach full height. Upon landing, the turns remaining will indicate if you have too much or too little power. A non-VP prop should have about 1/3 row of knots left. A good VP prop will have very few turns left. For either type of prop going deadstick before reaching the floor means the motor is too powerful. Whether to correct this by reducing the thickness or by increasing the loop length depends on the flight time you achieved.

Keep in mind that we are seeking flight repeatability, so you must be precise in your winding and test stick technique. I like to use several motors of the same size as they can rest and recover more fully between flights. The three most important factors for FAI flying are practice, practice, and practice.

The next article will probably cover VP prop adjustment and my low ceiling technique.

Issue 18 1985

## Plug-In Tail Booms

Likely by Richard Doig

The first time I saw a plug-in tail boom was on Al Rohrbaugh's "Big D" model at the 1972 NATS. The model had such a large stab that it would not fit in his car unless the stab was turned 90 on the back seat. I didn't think much more of plug-in tail booms until the 1980 World Champs. The Swiss had model boxes that were 27" x 19" x 13" and held five models apiece that when assembled were 35" long. The high density packing spurred me into plug-in tails.

### ADVANTAGES OF PLUG-IN TAIL BOOMS

1. Ease of packing - a smaller model box is possible or you can get more models in the box you are currently using.
2. Allows adjustment of the stab tilt - just by pulling the tail off it can be slid on at a different angle, no glue joints to melt.
3. Allows swapping of stabs with different motorsticks this can be especially useful towards the end of a contest where several models have suffered damage if you have an undamaged motorstick, stab, wing and propeller, you can assemble a complete model.

### DISADVANTAGES OF PLUG-IN TAIL BOOMS

1. An increase in weight - the extra wood of the plug and the Jap tissue wrap do add some weight, however using other weight saving techniques in the stab (fewer ribs, etc.) and rudder can result in a tail assembly of the same weight.

Below are four versions of plug-in tail booms that work and winning flights have been made with all four. Most important I have never had a tail boom come off during flight, even when I missed during steering and snagged the stab so hard it noticeably moved, and not even when a model has blown up, the plug has remained intact.

FIGURE #1 shows the construction technique used by the Swiss at the 1980 World Champs. (see INAV #5 - Bacillus by D. Siebenmann) I built many models using this construction starting in late 1980 up until mid-1984. It had one drawback in the relatively large diameter joint tended to get mushy as the model aged. As it mushed the boom slid on further and further until it butted against the motorstick without being tight. However, it still worked extremely well. Total weight penalty was .0010 ounces for the plug and a Jap tissue wrap of negligible weight. Advantage of this version is the tail has a long handle with the full length of the boom available for packing. Its disadvantage is that the large diameter of the plug requires more wood and incurs a larger weight penalty. Also if the same thickness of wood is used in all versions this one will mush out sooner because of the large diameter to wall thickness ratio. The smaller the diameter for a given thickness, more force (side load) is needed to crush the tube. Ask an engineer-type to explain radial stresses sometime if you are interested.

FIGURE #2 is the arrangement I used on a model built in 1984 to repair a tail where the boom kinked and broke directly under the X in the stab bracing pattern. The stab bracing wire glues to the boom about 5" ahead of the stab leading edge. I made the plug arrangement to reinforce this area because the plug slides inside the section of boom that had kinked. The advantage of this version is that reinforcement is provided in the area of the boom bracing wires (stab bracing in future INAV). This version is made by rolling a full length tail boom and the joint is made by slicing out a 1/8" long section of boom and then inserting a separately rolled plug. The 1/8" gap allows space for the rear section of the boom to tighten as it is slid over the plug.

A disadvantage occurs in that as the joint wears, the rear part of the boom may butt up against the front section of the boom without the plug being a tight fit. If this happens the rear section of the boom may have to be trimmed and a new wrap applied. This version uses less wood than #1 because the plug is a smaller diameter.

FIGURE #3 shows a version similar to #2, except instead of a stepped front section it uses a telescoping section of boom. This is the same construction as Al Rohrbaugh used minus the stiffeners. The first one I built was from two scrap and broken tail booms and it came out slightly lighter in weight (.0004 oz.) than #2 but required reinforcing strips on top and bottom as it proved to be too flexible. This is the lightest of the three versions which I have built, with no noticeable difference in strength as compared to #2. As the joint wears the stab pushes on further to maintain the fit as long as it clears the stiffeners. It has a disadvantage in that it requires two separate booms to be made and the stiffening strips (.010" x .020") are tricky to handle. Also assembly #2 and #3 are harder to mount in a box than #1 because there is not much boom clear of the bracing wires.

FIGURE #4 shows the construction used by Jim Richmond on his Film Flam. It uses a straight tube front end and tapered rear section which slid inside. I believe he originally did this to lengthen an existing motorstick and boom combination. Since I have not built this version I have no experience with it, however I see a problem with the fit if the rear half of the boom is tapered because the tapered piece can move sideways within the straight section of the tube. It also does not provide any reinforcement around the bracing as in #2 and #3. However Richmond won the 1984 World Champs with it so it does work.

FIGURE #1

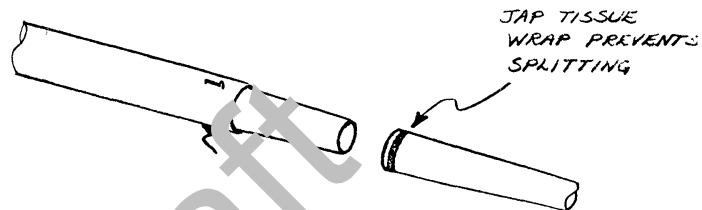


FIGURE #2

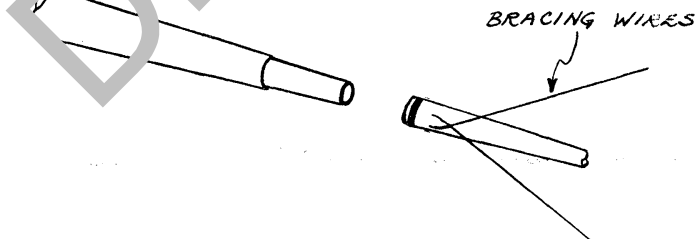


FIGURE #3

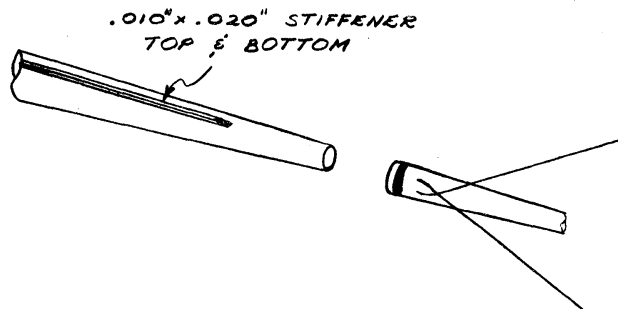
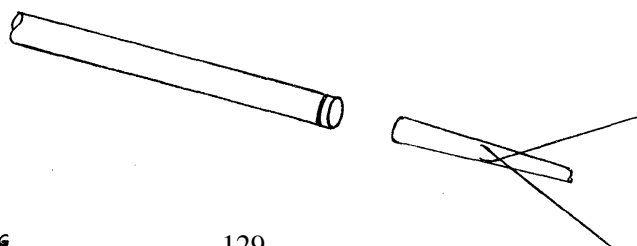
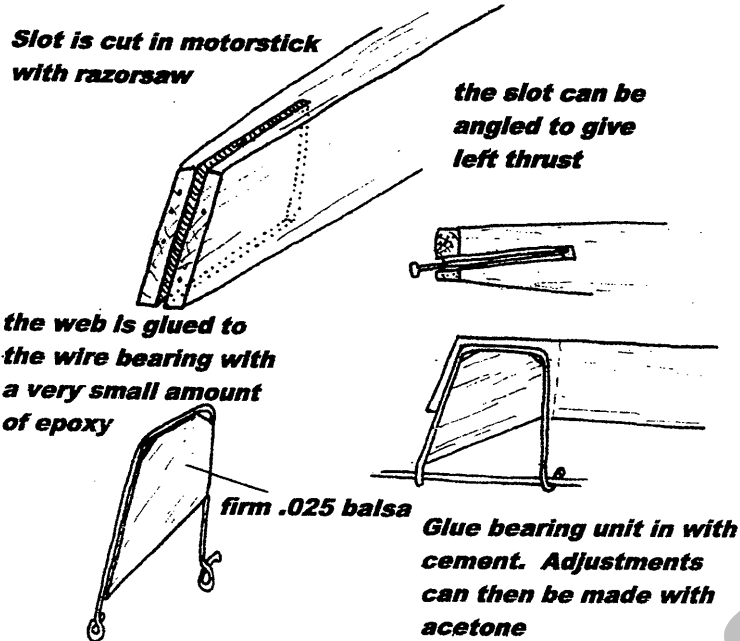


FIGURE #4







**EZB/Pennyplane adjustable bearing**

Draft

## Some Thoughts On Indoor Model Airplane Propellers

Jim Grant

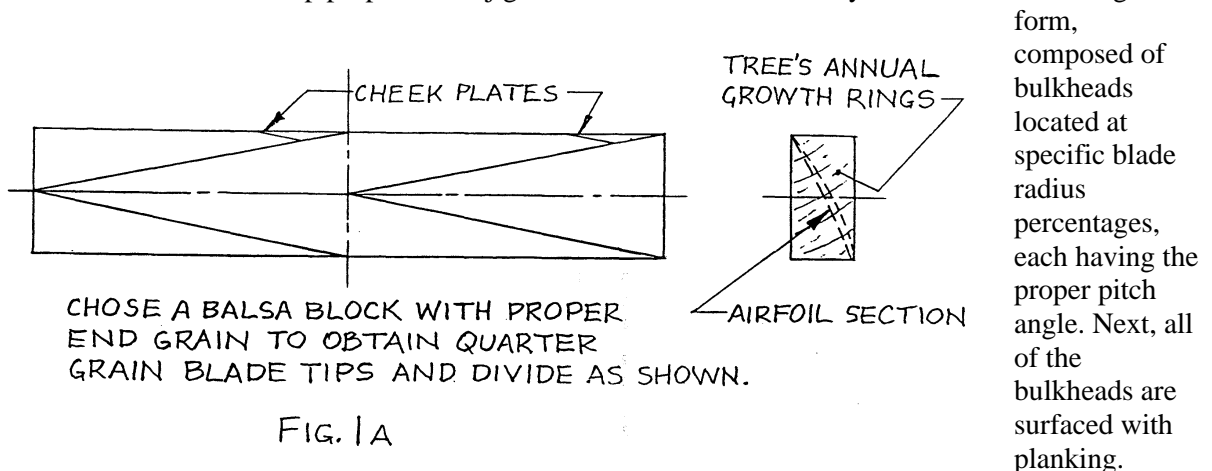
This article is written in response to a request which apparently assumes that my experience with full scale propeller blade design fifty plus years ago qualifies me as a model airplane propeller expert. The fundamental geometry and function are the same, but differences in scale effect and construction methods are apparent. Even longer ago I was fortunate to have learned about model propellers of all types from such modelers as John Tyskewicz, Herb Greenberg, Pete Andrews, and others. The request for this article also specified that it include "no math," so with that limitation let us begin.

First, a foreword is in order. I would emphasize that the propeller is the most important part of the model. A model may be accurately built, finished and rigged but if it has a poorly made, inefficient propeller, the flight results will be quite disappointing- - Conversely a good prop can haul an ugly crate through the air! Pay attention to accuracy and suitability when making the propeller.

A propeller blade is a rotating airfoil which transforms horse power, through torque and revolutions rate into thrust, which propels the aircraft, just as a wing is an airfoil which provides lift to support the aircraft. They differ in that the wing moves on a flat plane through the air, whereas a propeller blade moves-along a helical path, and is itself a helical surface modified by thickness in the form of airfoil sections and bulk in the hub region. This intriguing shape, the helix, is a surface which is generated by a radius rotating about and translating along an axis at uniform rates of motion. Let us consider the elements of blade geometry: pitch, blade planform or shape, and airfoil section.

**PITCH:** The pitch of a propeller is the distance it moves forward in one revolution. It determines the pitch angle progression of the blade airfoil sections from hub to tip. These angles are measured with respect to the plane of rotation which is perpendicular to the thrust line. The progression of these airfoil pitch angles is called "basic pitch angle distribution." For some full scale aircraft, custom designed propeller blades will have slight variations from the basic distribution to accommodate changes in air flow caused by the shape of the forward nacelle or fuselage. However, for model airplanes, basic pitch angles without modification in the form of "wash in" or "wash out" is probably the best choice. Although there is a slight relative increase in inflow velocity where the airstream passes through the tip area of the propeller disc, it may be advantageous not to "wash in" the tip to compensate, but rather to take advantage of the induced "wash out" which this slight inflow velocity increase causes, just as we "wash out" wing tips to minimize vortex drag and to delay stalling. The pitch angle in the shank or inboard area near the hub is also best left unchanged since this part of the blade provides very little thrust. For carved propellers it should be streamlined as best as possible.

The propeller block shape which will provide perfect helical pitch is shown in figures 1-A, 1-B, and 1-C. A geometric shape such as this may be used either to carve a wooden propeller or as a form on which to construct built up propellers. A jig mounted on a flat board may be constructed having this



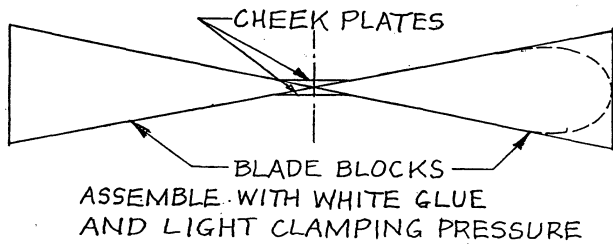


FIG. 1B

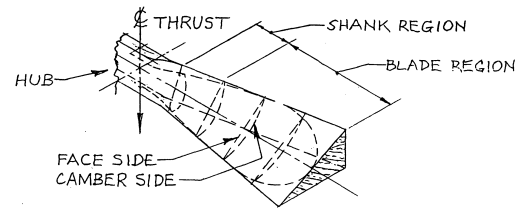


FIG. 1C

The pitch we have been discussing is geometric or theoretical pitch. The actual pitch is less because, like any lifting airfoil the blade assumes an angle of attack to create its thrust. This angle will vary from as high as 6-8 degrees in a power climb to as little as 1 degree during the cruise regime. For a graphic idea of the two pitches see figure 2.

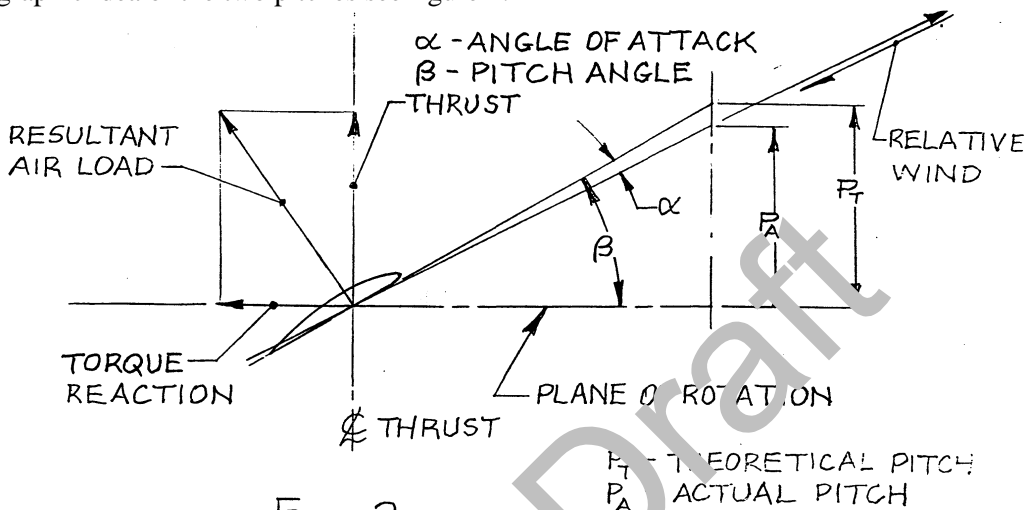


FIG. 2

**BLADE PLAN FORM.**- Depending upon limiting factors, such as diameter and function, blade shape may vary from a graceful willow-leaf pattern to a rather unattractive, but quite utilitarian rectangular paddle. The built up blades used on ultra-light models have no restrictions against diameter, pitch, or blade width, and may be shaped for high efficiency. For some other models, such as "Limited Penny Plane" or "Bostonian" the diameter is limited and yet these propellers must absorb the power of much heavier motors. The only answer is the use of wide paddle blades and higher pitch ratios (the ratio of the pitch to the diameter). Blade area distribution fore and aft of the spar may be varied to create blades of differing flaring capability. Several blade plan form shapes are shown in figures 3-A, 3-B, and 3-C.

**AIRFOIL SECTIONS:** The section shape currently in use for ultra-lights, AMA Stick, FID, ROG, etc. is a truncated ellipse with a camber height which may vary from 3-6 percent. Propellers whose blades are formed from sheet wood have a simple arc for an airfoil shape. Carved propellers for flying scale, etc. have airfoil sections similar to the "Clark Y."

I hope that this article will provide some help to young modelers of all ages!!

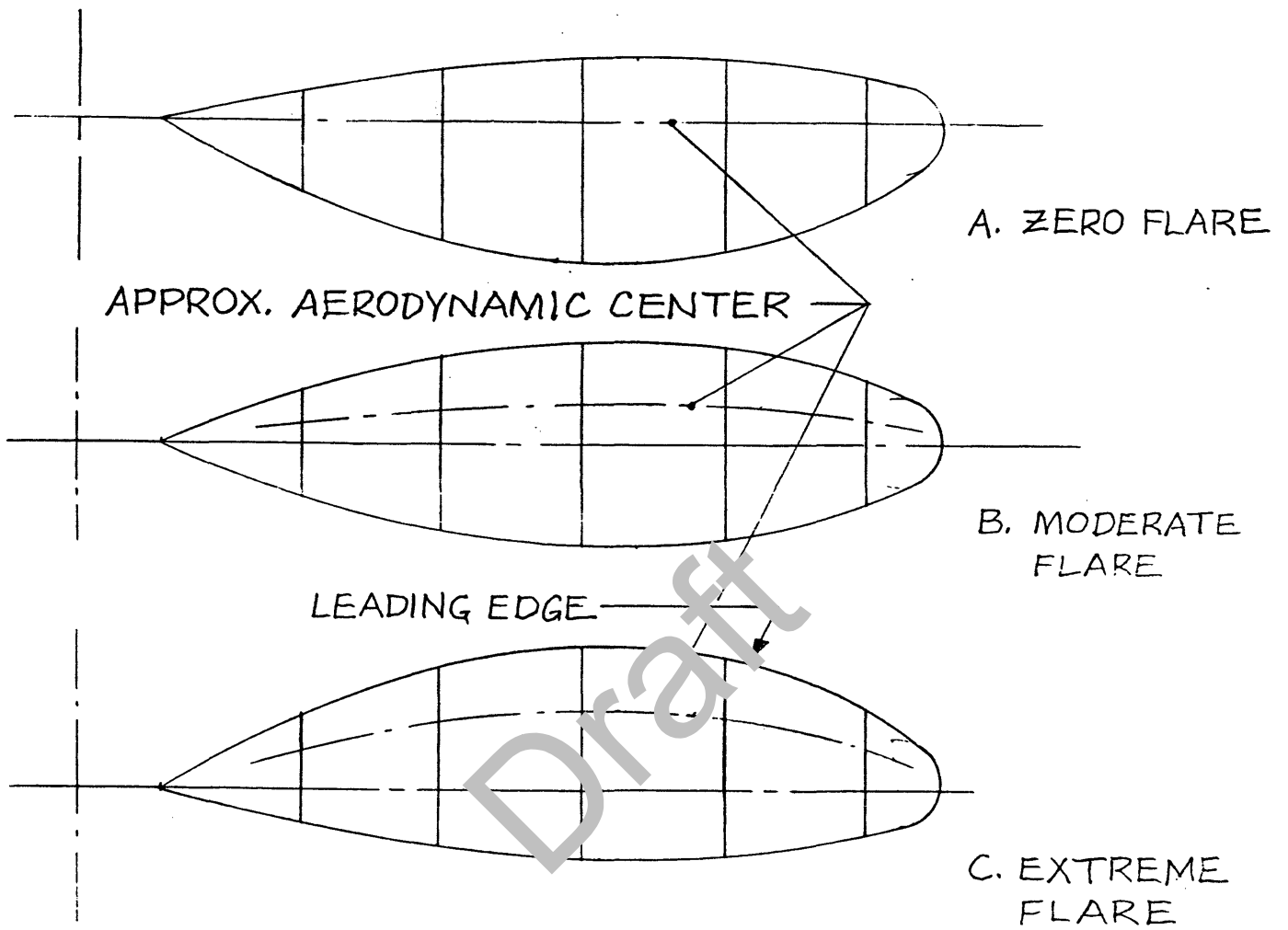


FIG. 3<sup>5</sup>

## Applying Ultrafilm With Spray Cements by Ray Harlan

With proper care, spray cements can provide a lighter, more uniform adhesive for Ultrafilm (and other plastics and condenser paper) than any brushed on coating. Brushed-on adhesives are difficult to control and take much longer to apply. A light spray adhesive will add less than .00012 oz. per sq. in., or less than .0002 oz. for an Easy B wing. One of the best features of spray cement is that it allows repositioning of the film if a mistake is made while covering.

The first step is to choose the right product. Many spray cements (such as 3M Sprayment) produce a cream-colored lacy pattern that is too heavy and is not uniform. Much more suitable are 3M Super 77 and 75, and Grumbacher 548 with fine, transparent sprays. The Super 77 is a high-tack adhesive that now comes with an extra fan-spray nozzle ideal for indoor models. For the lightest covering, Number 75 is best. It has a lower, but more than adequate tack, and is formulated for temporary bonds. The air loads on indoor models are so low that this adhesive is essentially permanent. Grumbacher 548 sprays uniformly, has moderate tack, but is heavier than No. 75. It has an orange tint that makes it easier to see.

When setting up to cover a model, two essential items must not be overlooked. First, be sure the room is well ventilated. This means open windows and fresh air. Second, cover the floor where you will spray with lots of newspapers, at least three feet beyond each edge of the largest frame you will spray. You don't want gummy furniture. Spraying in a large, open-top box will help contain the overspray. To help see where you are spraying, try this shine a flashlight horizontally across the spray zone a few inches above the floor. Turn out all other lights when you spray. The aerosol droplets will reflect light from the flashlight so you can see them more easily. This is a good way to estimate how much cement you are applying, and where. A black plastic background also helps you see the droplets and can be cleaned with paint thinner.

Use just one pass on a narrow wing, and no more than two on a wider wing (one each for the leading and trailing edges). For No. 75 and 548, hold the can 12 to 24 inches above the frame. For No. 77, use 24 to 36 inches, Spray at about one foot per second. You will be surprised how little adhesive is required. Remember, less is lighter.

The best covering method is to borrow a microfilm technique: cover the wing flat and add dihedral later. If the sprayed frame is put over a traced outline on the board, it can be adjusted to eliminate skew and wiggly outlines. You may need to tack glue it to the board if it doesn't want to stay in place. There is no rush; the spray adhesive will stay tacky enough for several hours.

Ultrafilm can be applied either from a light balsa hoop larger than the frame to be covered, or two people can hold it with a hand at each corner. A little practice will get smooth coverings without crushing curved ribs. If you make a mistake, carefully peel back the covering and rework it. Tightly press on the outline to secure the Ultrafilm. Then cut it out with a pencil soldering iron ( a 23 to 47 watt iron with a thin chisel tip is good). Not only is this much easier than trying to use a razor blade, it seals the film edge and prevents rips that might propagate readily. After cutting off the excess film, turn the frame over and press the ribs to secure the film to them.

Dihedral in wings can be added at this stage. The film near dihedral ribs will loosen. To draw it tighter, wet a small brush in spray cement (from a spot sprayed on paper) and lightly coat the film on top of the rib. You may want to thin the cement with some toluene (Elmer's contact cement solvent) to make it brush easier. When the coat gets tacky, gently nudge the loose film against it with a thin flat (but dull) tool, or balsa sliver, from below the wing. Be careful not to push too much film onto the cement strip or the dihedral rib will bow excessively. If this happens, pull the film apart and rework it. This technique requires some practice. But remember, loose film is not too detrimental to long flights.

These covering suggestions should get you well on your way to indoor modeling without the frustrations encountered with paper and other plastic covering materials. Soon you will be devising your own special techniques to further simplify the job.

Draft

Ultra-Film Covering Tips  
by Roger Schroeder

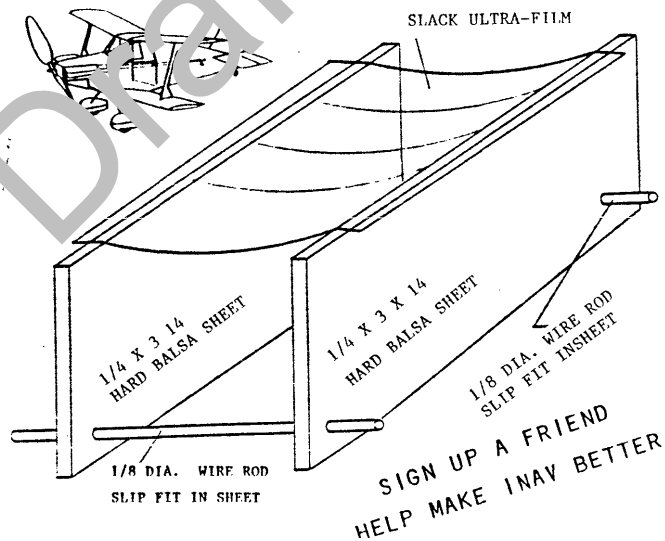
I have recently completed a Pieces Easy B according to the 1992 design update by Earl Van Gorder and it provided an opportunity to improve my covering technique. In general, I try not to touch the micro-lite, but either handle it between sheets of newspaper or on a frame. In this respect, micro-lite is treated like micro-film.

To start a covering job, I lay down a flat sheet of newspaper that has been cut to a width about 1/16 to 1/8 in. wider than the roll of micro-lite film. The length is about 12 in. I unroll micro-lite on the paper trying to keep it straight and flat. Wrinkles can be smoothed by lightly blowing on the film, or as last resort, working the film with fingers.

As soon as the micro-lite is smoothed out, lay another similar sized sheet of newspaper on top of the film. Now the film is captive between the two sheets of newspaper. The film, and paper, can be cut to the length desired with a straight edge and razor blade. It can be picked up and carried around without worry.

I use a simple frame for covering which is illustrated in the drawing. It is made from a sheet of hard 1/4 x 3 x 36 balsa. Cut the balsa sheet in half, square the ends and sand the long edges smooth. You end up with two similar sheets about 14 to 18 in. long. Drill two undersize 1/8 in. holes in a lower corner of each sheet (about where shown on the drawing). Cut two 1/8 dia. steel wires to a length of about 10 in. Slip the wires through the sheets as shown. I found that reinforcing around the holes helps. The wires need to be a snug fit so that the position of the sheets along the wires can be adjusted, but the sheets stay put when the frame is handled.

The film needs to be transferred to the frame. Adjust the wires of the frame so the frame width is about 1/2 in. less than the length of the cut film/newspaper laminate. 3M contact spray is the best for sticking film to the frame. Lightly spray the top edges of the frame, remove the top sheet of newspaper and invert the frame onto the exposed film. Press down to be sure the film is attached to the frame. Lift the frame. Some newspaper will stick, but can usually be peeled away easily. Set the frame down with the film up. Adjust the frame along the wires so the film is straight and slightly slack. The slack will be greater if you are covering a wing with a curved airfoil.



At this point I formerly misted some 3M spray onto the wing, or whatever I was covering, and then laid the wing onto the slack film. Four things invariably happened. They are:

1. The film jumped toward the wing as I laid the wing on the film.
2. The film never ended up flat on the wing.
3. The slack varied when the film jumped and messed up the airfoil shape.
4. I got into a foul mood.

For the 92 Pieces, I changed my technique. The wing was laid on the film dry without any adhesive. The frame could then be adjusted to straighten out any wrinkles and have the slack match the airfoil shape. After adjusting, I sprayed some 3M into a cup and added thinner to it until it was mostly thinner and a little adhesive. I used a very small brush to paint the thin adhesive on all the outlines

and ribs where the film was supposed to stick to the wood. I had to let it dry for some minutes. Acetone may be a quicker drying solvent, but I didn't know if it would cloud the film. Once the adhesive was dry, the film was cut along the wood outlines with a hot wire cutter (Dr. Bates wonder cutter). I was very pleased with the resulting covering job.

Note that there are no ends to my frame. The end of the film is not supported by the frame. This is an advantage because I can build the dihedral into a wing and then cover it, one panel at a time, by using film lengths just a little longer than the panel to be covered. The lack of ends on the frame allows me to (carefully) lay a tip panel on the film, attach it with liquid adhesive, and then cut it away from the frame. When doing this, the rest of the wing must be supported correctly to get the tip panel to lay flat onto the film.

Draft

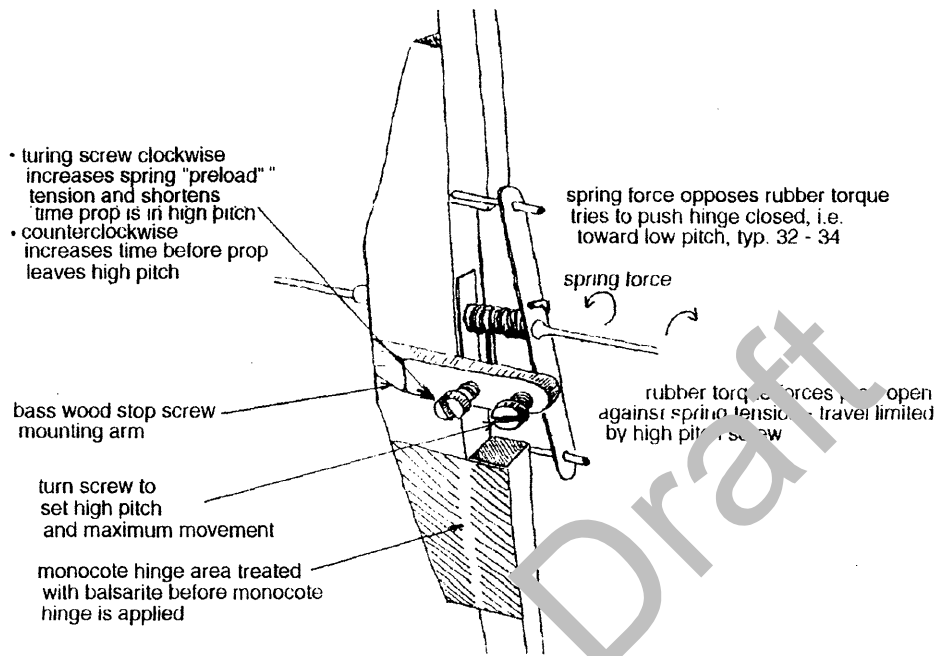


Construction Of Variable Pitch Props For Indoor Models  
 by Steve Brown, illustrations by Steve Gardner

Variable pitch propellers, or "VP" props, have become common place in F1d indoor flying. The performance improvement they offer is important to the competition flyer looking for really good times, and the modeler responsible for the prop detailed here can really talk about good times. His unlimited stick just did 63:54, breaking the magic hour barrier in a big way.

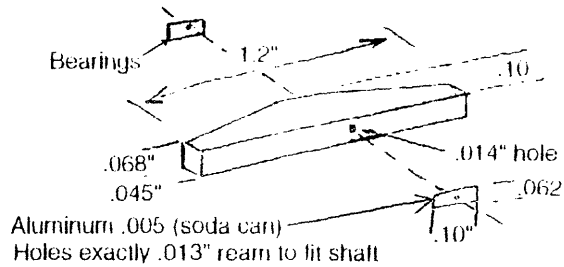
**CURRENT F1d VP PROP CONSTRUCTION**

low pitch built into prop when hinge is fully closed. adjustments are high pitch position and torque load at high pitch



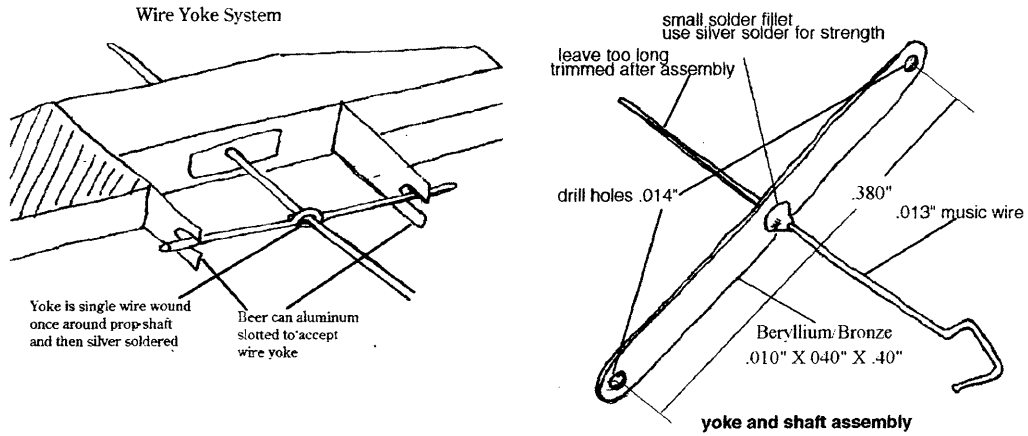
Great care has been taken to retain the original information supplied by Steve Brown while getting his art and text into this format. Any mistakes are probably due to the transference and not to the original design.

1. The first step is to make the hub, or center spar, to the dimensions given in fig 1. Don't omit the aluminum bearings. The holes should be just large enough for the prop shaft to rotate freely without any wobble. The bearings are attached with Ambroid or Duco cement.



**FIG.1**

2. Make the prop shaft and yoke assembly next. The dimensions are given in FIG.2. Make certain that the solder joint is very strong. Use a silver solder such as sta-brite and build up a small fillet to reinforce the joint. Use a jig to insure proper alignment. After soldering place the assembly in warm, soapy water and scrub off all of the flux. Rinse thoroughly and inspect to make certain all the flux is gone. Flux will cause corrosion that will fail this important joint.



3. Tack glue the prop spars to the hub using a jig block as shown in fig. 3. The jig is used to space the first spar then it is swung around to space the other spar the same distance from the shaft hole. The spars should be to finished dimensions and matched for flexibility before they are tacked to the hub.

4. Install Monocote hinges. The area under the hinge is primed with balsa-rite from the Coverite company to insure a very good bond with the spar and hub. Japanese tissue strips were originally used to reinforce the hinge

5. The actuator arms are added to the spars now. Use the shaft / yoke assembly to space the actuator arms. They go on opposite sides of the hinges as shown in fig. 5.

6. At this point the complete assembly is placed on the prop jig and the outlines are added. This is to avoid interfering with the adjuster screw arm that will be installed later.

7. Make the adjuster arm from 3/32 X 3/32 model railroad basswood or the wood from a tongue depressor. The bass wood is both lighter and easier to work with. Drill two holes .037" in diameter in the basswood stick a distance from the end that will preclude splitting. These holes should be the same distance apart as the length of the spring plus a .010" to slightly spread the spring when it is in place on the prop. These hole are now tapped with a 00-90 tap, reinforced with a drop of thin CyA glue,

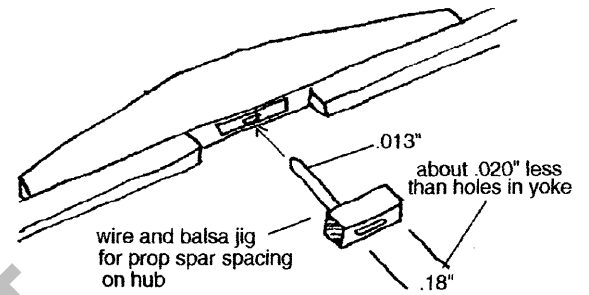
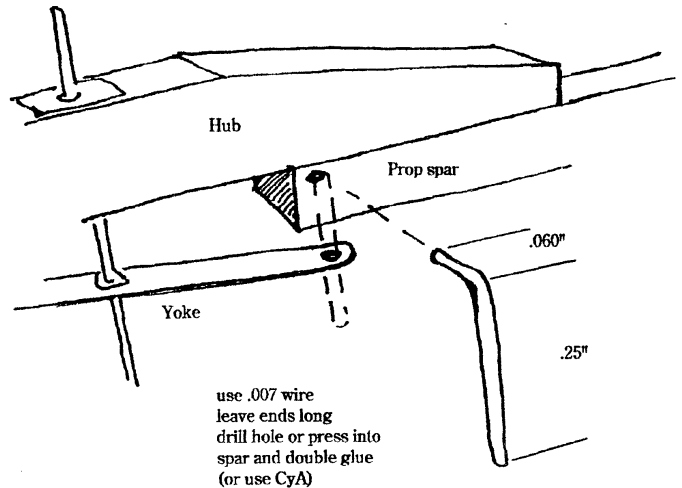
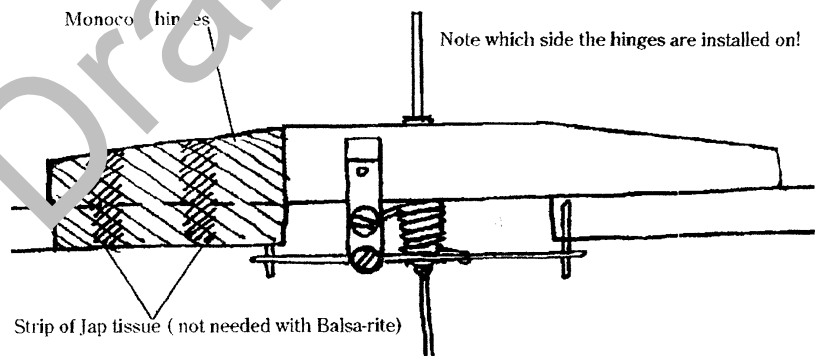


FIG.3



Actuator arm detail

then tapped again to get clean strong threads for the stop screws. Make certain that the glue is hard and dry before tapping the holes the second time.

Once the holes are properly tapped the end of the arm is rounded off close to the hole so as to save weight. To prevent splitting add a bit more CyA to the end of the arm where it has been rounded, then trim the thickness down to .055" and cut the notch .020" deep as shown in FIG.6. Once the actuator arm is shaped it is placed against the hub to determine the proper length and then it is cut to size. Assemble the shaft/yoke and spring onto the hub and arrange everything in the proper position, then add the adjuster arm using Titebond. Once this is dry drill a .025" hole and add a hard balsa peg through the arm and the hub to strengthen this joint. See FIG. 7

8. Now remove the shaft /yoke assembly and carefully soak the tack glued spars loose so that the hinges can operate. Be very careful not to soften any other glue joints and let things dry for 4-6 hours.

9. Drill a .037" hole in a piece of Plexiglas or metal about 1/16 or so thick and tap to 00-90. Screw a 00-90 nylon screw through until it is just sticking out of the back side of the piece. The idea is to slice and sand off the conical point of the screw so that the end of the screw is nice and flat. Repeat for the second screw, but after you have flattened the end drill a .010" hole into the end of the screw while it is still in place. Use good magnification to insure that the hole is in the

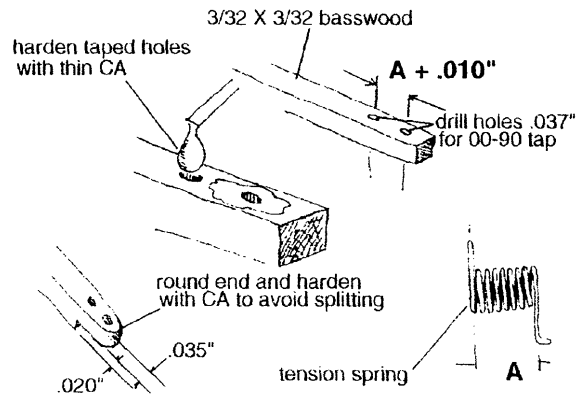


FIG.6

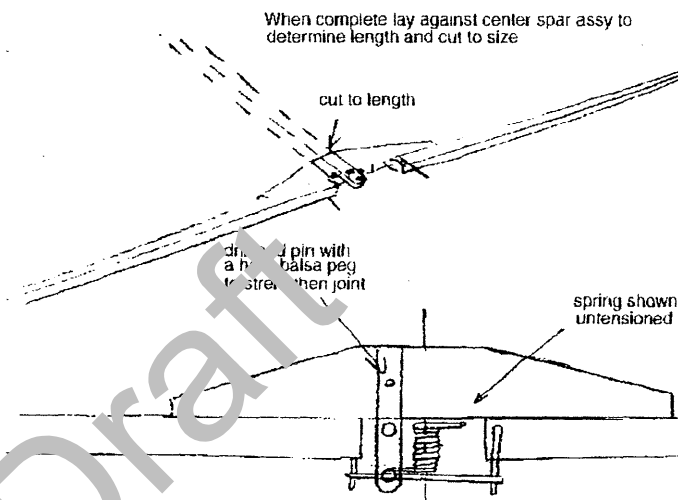


FIG.7

screws turned into tapped holes in 1/16 or 3/32 plexiglass or metal until just the very end protrudes

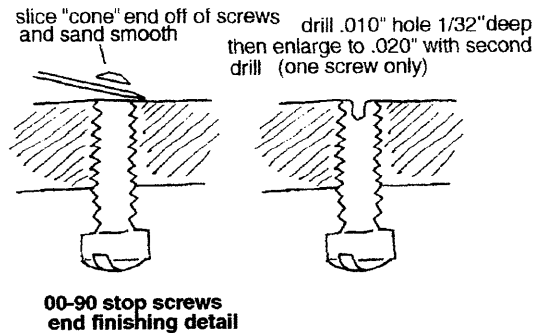


FIG.8

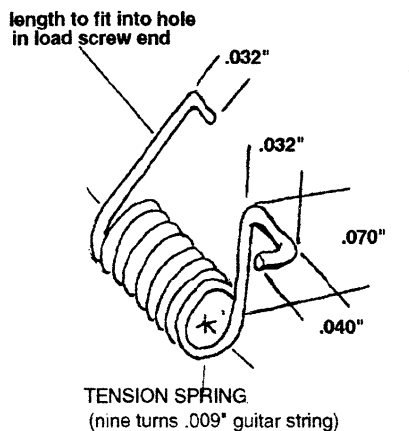
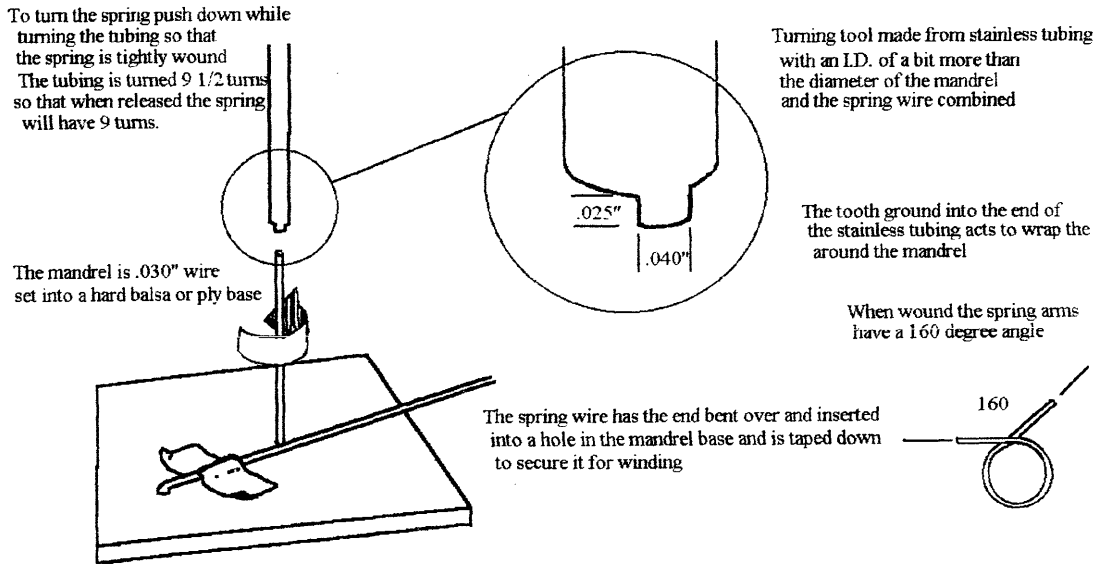


FIG.9A

center of the end of the screw. Enlarge the hole to .020" about .032" deep and nice and clean as shown in FIG. 8.

10. Wind the spring around a .030" mandrel using a driver made from a piece of stainless steel tubing

with a .040" wide by .025" tall tooth ground into the end of it. The I.D. of the tubing should be a bit more than the O.D. of the mandrel and the spring wire combined. The spring is wound 9 1/2 turns so that it relaxes to about 9 turns total with an angle of 160 degrees between the arms. See FIG.9.



11. Carefully assemble the prop in the following manner. Add a piece of .035" O.D. X .013" I.D. Teflon tubing to the shaft to center the spring around the shaft and prevent binding. This tubing will ride inside the spring so it has to be shorter than the spring a by a bit. Add the stop screws with the drilled one in the front hole nearest the hub. Place the spring onto the shaft and push the whole assembly together until you can get the front end of the spring into the hole in the screw. At the same time hook the rear arm of the spring onto the yoke and twist, opening the spring and sliding the yoke, onto the actuation arms of each prop spar. You may need needle nosed pliers to walk the front arm of the spring into the hole in the front screw.

When it is all together the mechanism will be under tension with the spring holding the prop closed, (the hinges fully shut and the prop in low pitch). Add a small Teflon washer or a .030" long bit of Teflon tubing to the shaft to retain the hub. This washer should be a very snug fit and it is further retained by gluing with ambroid to just the shaft in front of the washer. The shaft and actuating arms are now trimmed to length. See FIG. 10

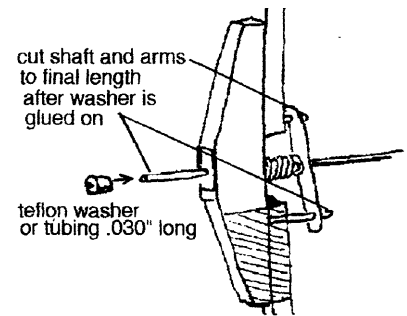


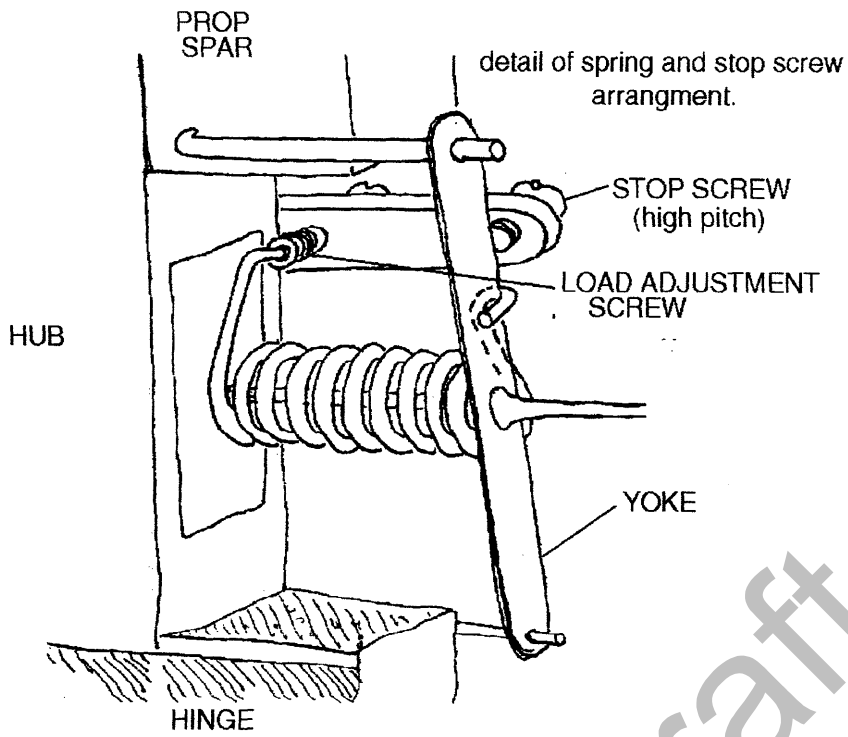
FIG.10

12. To adjust the propeller for flight start with the front screw, the one with the hole in it. Screw this in about half way to start with. Steve Brown made a small torque meter to help set the pretension to where the prop blades just start to open (viewing the hinge line under magnification) at about .14 -.17 in/oz of torque. This is just a starting point and will most probably need to be adjusted further. Screw the rear screw (high pitch limit screw) about 2/3 to 3/4 the way in to start with a fairly low setting for the highest pitch. Install prop and test fly the model. First use the rear screw to set the high pitch - high torque setting to get the altitude needed, then use the front screw to set the tension and so vary the point when the prop starts to switch over to lower pitch. In some cases you will have to take the prop apart to adjust the spring tension by "tweaking" the spring if you run out of travel on the front screw adjustment.

**WARNING.**

Watch the shaft/yoke solder joint! When it starts to fail (and it will!) the shaft will start to rotate slightly in relation to the yoke. This will cause the prop to tend to remain in high pitch too long and so spoil the flight. This is a sign that the joint is failing. If a prop that flew fine suddenly needs the high

pitch reduced a great deal, and the adjustment has little effect, check to see if this joint has shifted and so is about to fail. Stop flying and repair immediately!



Draft

Tom Vallee And Jim Clem V.P. Props

Tom Vallee and Jim Clem sent drawings of v.p. propellers based on the design by Cezar Banks. Each added a screw adjustment to preload the spring that reacts to the torque load to change the pitch. So both has screw control of high pitch, low pitch and start of change from high to lower pitch. The drawing of Tom's hub did not reproduce well enough for printing but as it is somewhat different from the Clem hub those who anticipate making a v.p. hub would do well the write to Tom (SASE of course) and ask for a drawing of his hub.

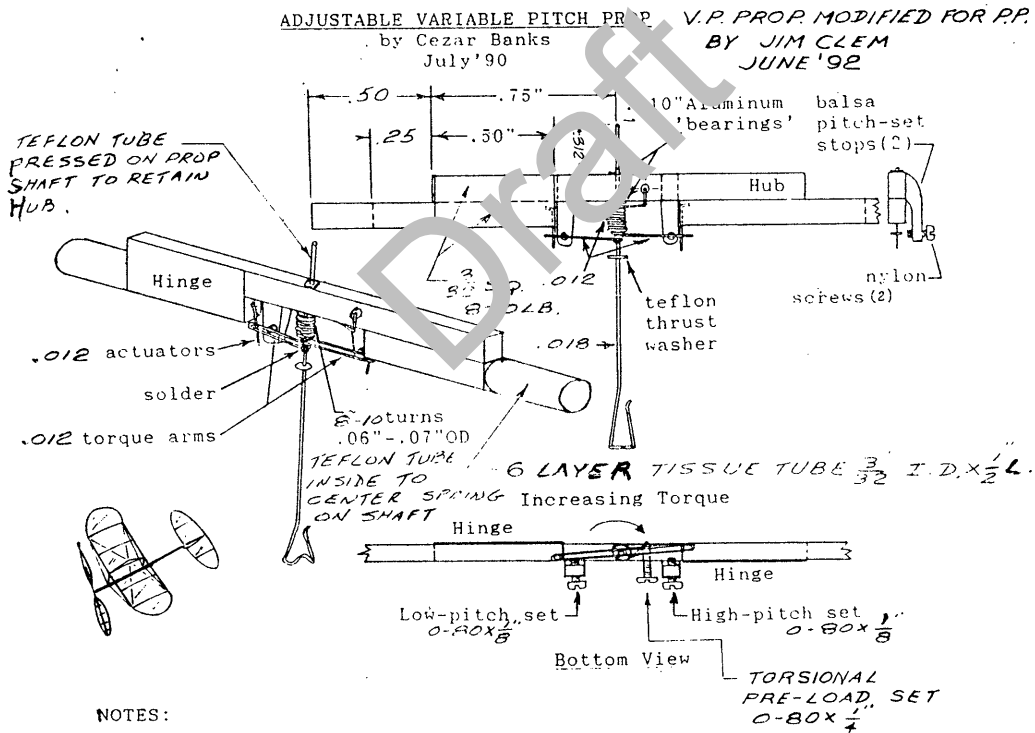
NOTES:

Hinges are iron-on Monokote or Micafilm Ends of nylon screws act as adjustable stops to rotation of torque arms.

0-80 Nylon screws are available from: Small Parts Incorporated

Threads in balsa stops are 'cast' out of cyano using 0-80 steel machine screw as a mold. Force screw out when cyano has 'set'.

Torsional pre-load on spring determines when switchover starts. I try for 2-1/2 - 4 minute mark. To adjust, bend free end of spring or add shims where spring end is glued to hub. Transition time to reach low pitch stop is determined by number of coils and coil diameter.



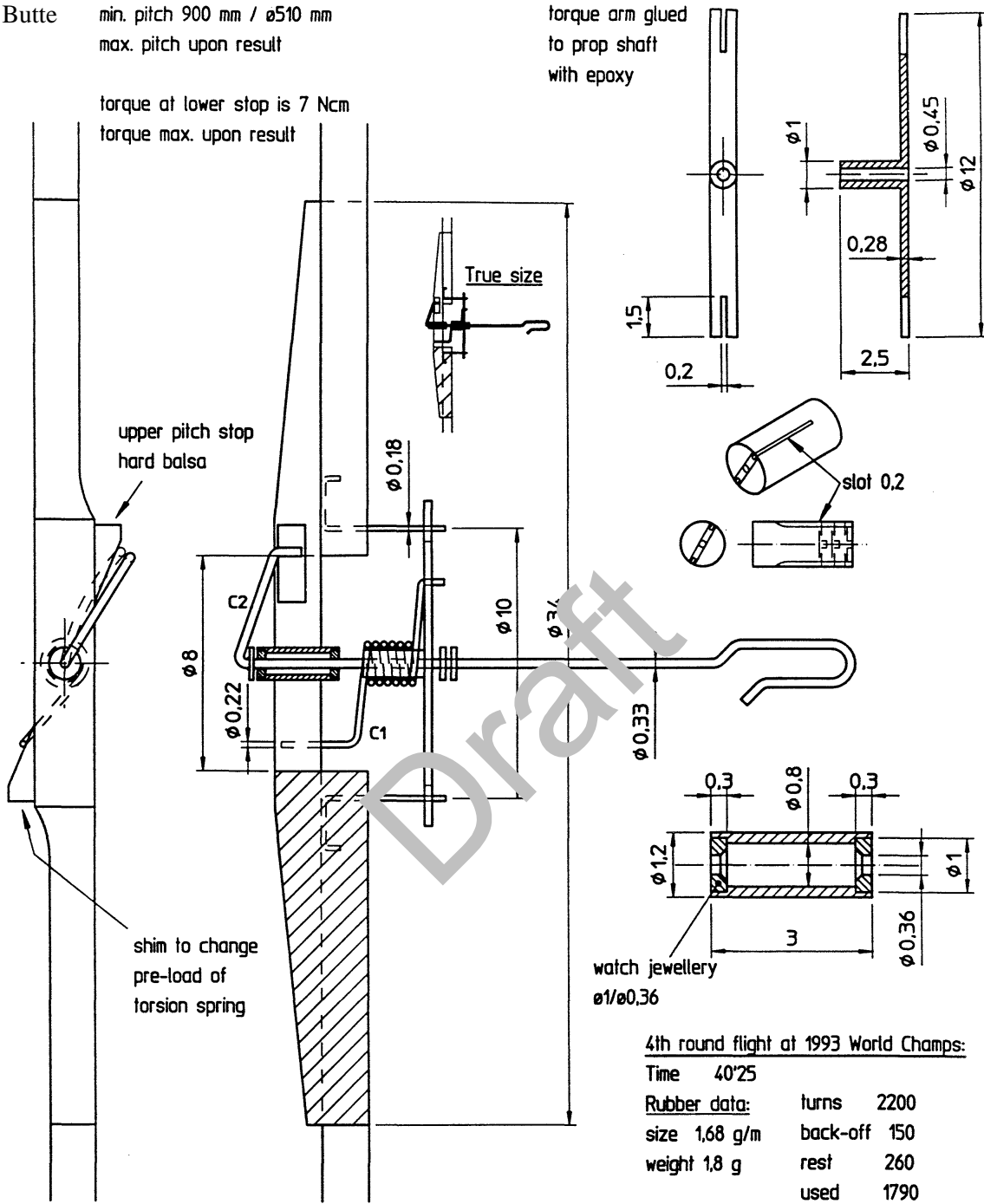
Variable Pitch F1D Prop

by Rene Butte

min. pitch 900 mm /  $\phi 510$  mm  
 max. pitch upon result

torque at lower stop is 7 Ncm  
 torque max. upon result

torque arm glued  
 to prop shaft  
 with epoxy

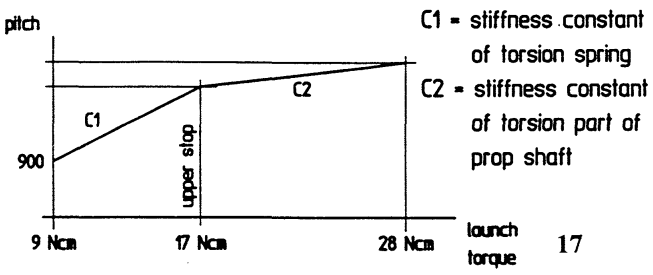


4th round flight at 1993 World Champs:

Time	40'25
Rubber data:	turns 2200
size 1,68 g/m	back-off 150
weight 1,8 g	rest 260
	used 1790

RPM 44,3/min.

Weight of prop: 0,19 g



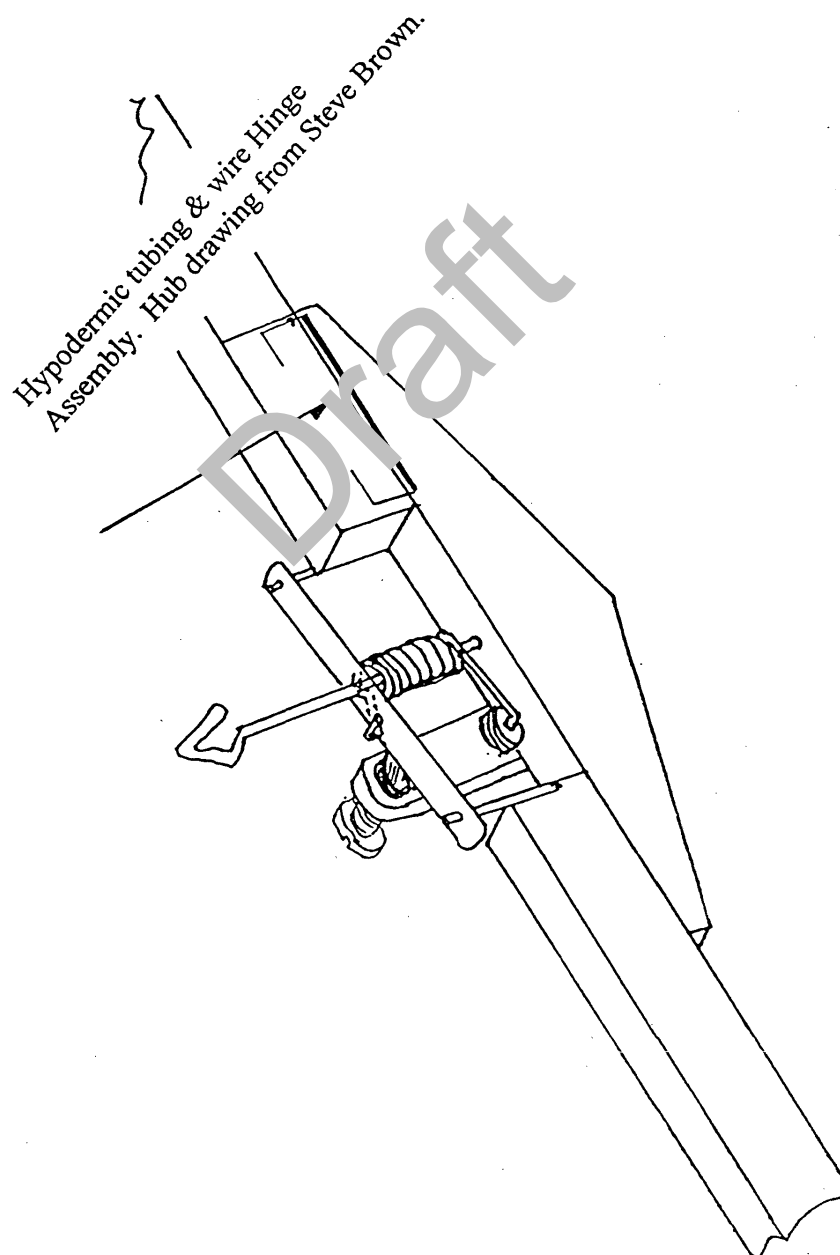
**F1D Variable Pitch Prop**

by René Butty (SWI)  
 F1D European Champion 1993

Issue 86 1996

Joshu V/P Prop Hinge  
by Larry Coslick

If you use a V/P prop on your Penny Plane and the mono-coat hinges get loose after a few flights, try this idea from Gene Joshu. We are making the hinge assembly from .007 I.D. Hypodermic tubing and .007 music wire from Small Parts. Tack the tubing to a piece of 1/4 inch balsa with hot stuff and cut off two one-half inch lengths with a Dremmel tool. Insert the .007 wire in the tubing and bend as shown on the drawing. I hold the hub and prop shaft in alignment with two insect pins. Long pins can be fashioned using .015 wire. The tubing portion of the hinge has to be positioned .025 inches from hub trailing edge. Pre-glue the balsa with Ambroid. For a little extra security, I put a .007. wire staple 3/32 long and .008 wide where the wire attaches to the prop spar. Only one is needed and place it on the blade side of the hinge. Coat the tubing and wire hinge with three coats of thin Ambroid. My #2 Penny Plane uses .120" wide rubber and is launched with 1.4 inch ounces of torque. The hinges are as tight as the day they were installed.

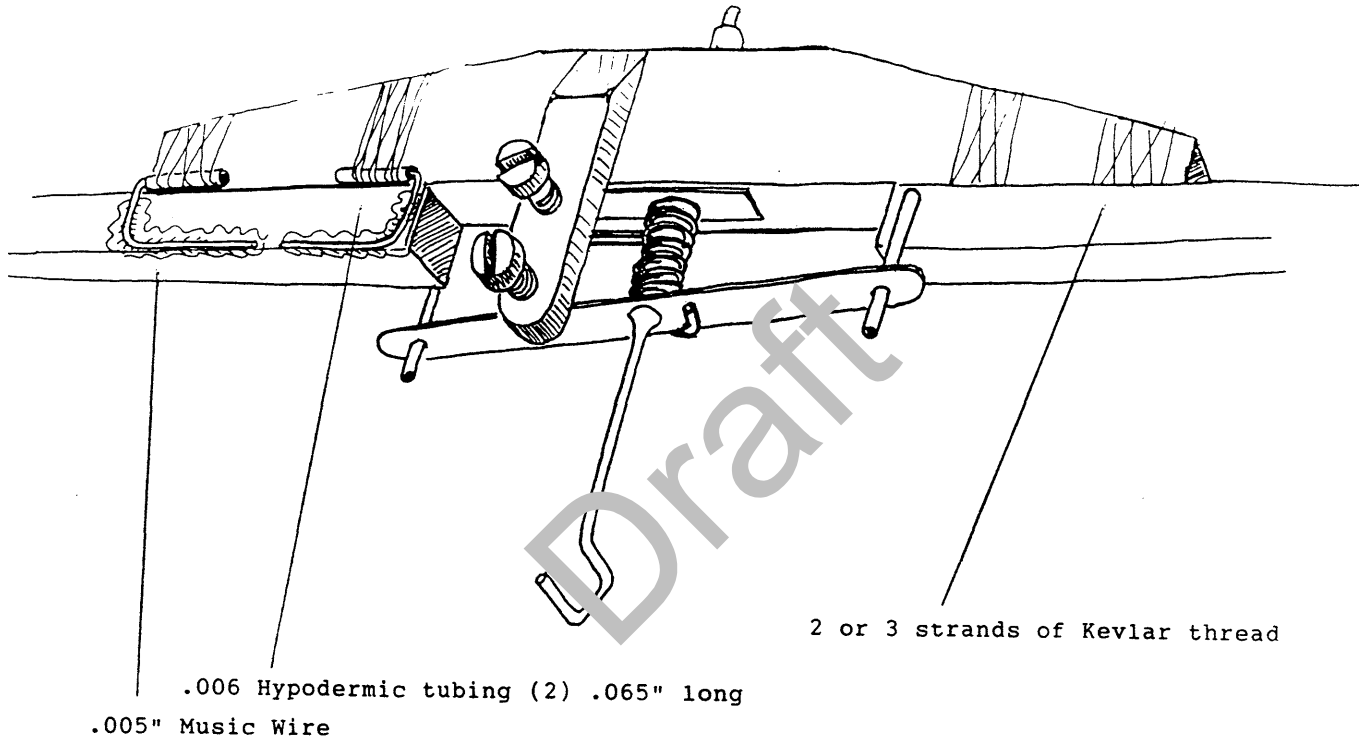




VP Wire Hinges

By: Larry Coslick Drawn: Mike Palrang

Lay a piece of .006" Hypodermic tubing on a sheet of 1/4" balsa and cover with clear tape. Cut off 4, .080" long pieces of tubing with a cut off wheel. Hold each piece in a forceps and hone the ends flat until each piece is about .065" long. Clean out the hole with a sharpened piece of .005" wire. Thread 2 of the hinges on a 1 inch piece of straight .005 music wire. Position the tubing on the hub as shown on the drawing. Tack glue each hinge in place and then remove the wire. Wrap each hinge with 2 or three strands of Kevlar thread. Apply 2 light coats of Ambroid or Duco to the hinge and thread. Bend the .005" wire parts as shown and glue in place. A .1X.5" patch of Jap tissue can be placed over the wire parts, but it is not necessary. See Steve Browns article on prop construction in INAV Issue 89, 1996.



Rubber Stretch Testing  
by Howard Henderson

Since rubber is the life blood of this hobby; I guess it is natural that we should talk about it a lot. Much has already been written on rubber, but since we now have the new stuff, maybe somebody will be inspired to write about how to get the most from it.

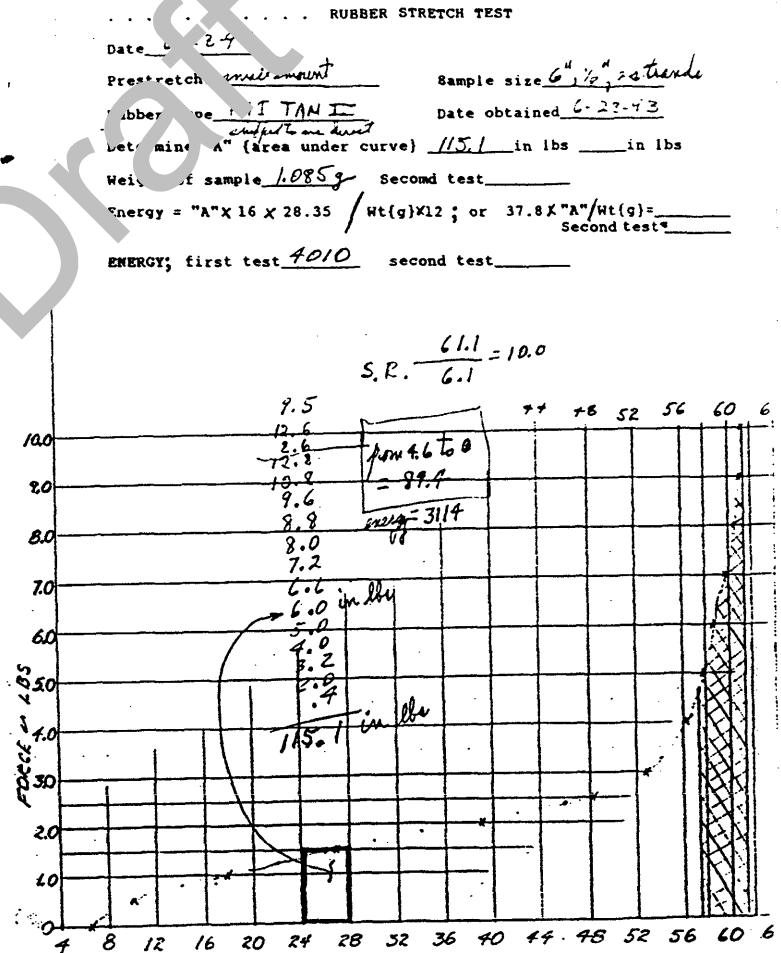
In this issue, we are including one method of testing rubber. Most old-time rubber flyers have developed their own method. However, it is still common for people to hand me a piece of rubber to test. (As if I have the only know-how around here! Hi!) The enclosed sample test sheet, in full size, may be copied and used as-is. The equipment required couldn't be more simple. A 1"x2" board, 6' long, with a large headed nail (protected by fuel line tubing) about 2" from one end is used as an anchor for the test rubber. An old measuring tape is strapped to the board. It would be slightly better, if it read in tenths of an inch, but a standard scale is o.k. Interpolation can be made to tenths. All test pieces are 1/8" wide loops 5 1/2" to 6" long, tied with your favorite knot. Pre-stretch it, if you wish. I'm not sure Tan II benefits a lot from it. There are a variety of opinions on this. My experience with the old TAN I was that it got better each time it was used, if it got a 1/2 to 1 hour rest.

We have a 10 lb. fishscale by "Normark", which has worked fine to do the stretching. They are inexpensive at the discount fishing departments. It has a guaranteed accuracy of about 2 oz. giving a little over 1% full scale, but we have found them to be better than that. The digital read-out helps. If you are in doubt, you can get a couple of calibration points by taking a couple cans of bolts to your friend with an "Ohaus" or a digital scale at the post office.

How far do you pull this sample? To what percent of the average breaking point should it be pulled? TAN II gets pretty hard at 10 lbs. and if you want to know how much total energy there is in the stuff, go to 10 lbs.. We used to take TAN I to 8 lbs. and quit. Relatively speaking, that is good enough to tell you how good the rubber really is.

Hold the test board in a good vise. Set a tape recorder up and pull the rubber to your max load and call out the deflection every pound as you relax the tension (After 4 lbs, every 1 lb, 8 oz.)

Plot this on the sample graph. If you do not want to test this sample again later, cut off the knot with a razor, while the rubber is in tension, and weigh it. It should be close to 1 gram. The area under the curve is determined by adding a succession of elements as



shown by the example.  $[28-24] \times 1.5 = 6.0$  in lbs. / by the weight in grams will give you the energy in ft. lbs. per lb.

Many indoor models can't use the last portion, an example being the cross-hatched area shown. If you start comparing the energy without that portion, it could be more meaningful for indoor use. What do you think? Chris Matsuno tells me they use everything they can get for FIB. However, I've heard some old-time outdoor modelers don't torture the rubber that much, particularly in the SAM events. Incidentally, a piece of very creamy Tan II given to me a J.C. tested over 4200 ft. lbs/lb. Nothing I've seen has been as good.

What portion of the curve you might cross hatch, when comparing data is subject to debate, I suppose. All rubber testing here is done in the basement at a pretty uniform temperature year round.

Draft

Rubber Testing  
Bob Gibbs

One of the important characteristics of all rubber is the energy (E) contained in a given batch in ft-lbs. per unit weight. Another characteristic is that E is not constant between batches (as we all know) and unfortunately E is quite variable within the same batch. A single one pound box may vary as much as 250 ft-lbs throughout its length. An average of at least ten test loops taken from different boxes from the same batch will provide a reasonable "talking" value for the energy for that batch. Rubber is also quite sensitive to temperature and since all tests are not run at the same room temperature adjustments must be made to the energy test results ( $E_T$ ) to a base temperature. I have used 70 degrees Fahrenheit as a base for some 20 years ( $E_{70}$ ). Any (E) estimate without knowing the temperature is of doubtful value.

The variations discussed above may be traced to the vulcanization process including the growing season of the crude rubber utilized. Like wine, some years are better than others for rubber.

Other characteristics of "good" rubber besides its (E) value includes the turns per inch a motor will take before it breaks and any tendency for motors to break in mid-flight. The final test of course is the performance of the model, its propeller, the flying techniques used and the rubber batch being used. When you get good results (high times) stick with that combination. Your best performance may not be achieved by the highest (E) value rubber you have but it probably will, all else being equal.

Many different test techniques have been utilized by different people to determine the energy content of various batches of rubber. The procedure described herein is time consuming and in my opinion is reasonably accurate and repeatable. The procedure provides the information used to calculate the area under a curve of force (in pounds) vs stretch (in inches) for the weight of the test loop from which data the test loops energy may be obtained. Since the rubber in a one pound box may vary as much as 250 foot pounds, a single test is not sufficient to establish an average energy for an entire batch of Tan II. At least 8 to 10 samples should be tested, preferably from separate boxes of the same batch. The average of these readings will approach the correct value of energy in ft lbs/pound of rubber for a given batch. Each test loop must be adjusted to 70 degrees Fahrenheit before averaging.

Terms used and the procedures involved are:

$L_0$  = the length of the test loop to the nearest .01 inches in length. This should be in the range of 6.5 to 7.0 inches in length. The rubber should be unused and unstretched except for tying the knot.

W = the loop weight minus the knot weight (we are not testing for the energy of the knot). The cross section of the test loop should be such that  $W = .020$  to  $.022$  oz. Knot weights are in the range of .0005 to .0009 oz.

$F_1 = 1,278.28 (W/L_0)$  a force in pounds.

$L_1$  = the test loop stretch in inches (to two decimal places) required to reach the reaction for force  $F_1$ . Return the test loop to zero load.

$F_2 = 12,214.69 (W/L_1)$  a force in pounds.

T = temperature in degrees Fahrenheit at the same level above the floor as the test loop. By this point you have achieved a means of measuring stretch and force (reference  $L_1$ ). It must also be capable of providing force readings at three-inch increments in the following procedure. For manual recording purposes I use a two-column "form" for length and force entries. My test setup will be briefly described later (you may have a better technique).

$L_2$  = the loop length (stretch) required to reach a force equal to  $F_2$ . These two values ( $L_2$  and  $F_2$ ) are recorded on the first line of the "form" above. Proceed to relax the force until  $L_2$  minus three inches is reached. Record both the length and force values on line two of the "form". Continue to relax the loop tension at three-inch intervals recording each length and force value pair until zero force is reached.

$Z = \text{sum of the } F\text{'s minus } F_2 \text{ (Add all of the numbers in the "form" column for force and subtract } F_2)$

$Y = (2x + F_2) / 2 \text{ (lbs)}$

$E_T = (4y / W) \text{ (ft-lbs of energy per lb of rubber at the test temperature)}$

$E_{70}$  = the test loop energy at 70 degrees Fahrenheit in ft-lbs/lb. Temperature effects on energy are assumed to vary with the square with the square of the ratio of the two temperatures in degrees Kelvin. For example, at a test temperature of 75 degrees F assume that  $E_T = 4000$ . The conversion to  $E_{70} = E_{75} \times .98138 = 3925.5$  ft-lbs/lb. If  $E_{70} = 4000$  the energy at 75 degrees =  $4000 \times 1.01898 = 4075.9$  ft-lbs/lb. This is a gain of 1.9 percent in energy for a 5 degree Fahrenheit increase in temperature over the  $E_{70}$  value base temperature. An energy estimate not associated with a temperature is close to meaningless.

$S$  = the ratio of the maximum stretch required to perform the test ( $L_2$ ) divided by ( $L_0$ ). The test device used by the author is mounted on a piece of wood, one inch x 4 inches x 8 feet long. A 16 foot power tape is used for length measurements. A coil spring about 2.0 inches long, 0.36 inches OD and wire size diameter of .035 inches is used for force measurements. This spring is close wound with about 55 turns. It provides for a maximum force measurement of 5 lbs at 1.25 inch travel per pound of force (linear). The test loop is mounted on one end of a traveler (#1) made of rigid plastic pieces which rides on a piece of aluminum angle. The other end of traveler (#1) is attached to an end of the coil spring. A second traveler (#2) rides along the board surface as the rope pulls it away from and later toward the no force position. The rope of course is positioned by "hands on". The end of the test loop and the 16 foot tape are attached to this traveler (#2). The rigid plastic traveler (#1) also provides markers to permit reading length and force values for the three inch increments at which readings are required and recorded for each position.

Photos are included of the test device for information. The device may be modified from the above so long as the same results are achieved. The constants used for calculating  $F_1$  and  $F_2$  will accommodate variations in loop length ( $L_0$ ) and loop weight ( $W$ ). If the loop is too long you may need a 10 or 12 foot long board and if its weight is too great you may need a different scale. If two adjacent loops from a batch are tested the results should be within 10 or 15 ft-lbs of each other at 70 degrees F.

For Tan II (5/99) my estimate is:  $E_{70} = 4,110$  ft-lbs per pound of rubber. This is the average of 19 test loops and is slightly higher than Tan II (7/97) with an  $E_{70} = 4,093$  which is the average of 37 test loops. If you test a single loop from a one pound box and arrive at a low figure do not give up. I recently tested an end-of-box loop from (5/99) and had a result of  $E_{70} = 3950$ . A second test loop from about 125 feet into the box yielded an  $E_{70} = 4,225$  ft-lbs per pound result. By coincidence, these two locations from the same one pound box must be close to the high and low limits for the (5/99) batch. None of the other 17 samples tested exceeded these values.

If you have any suggestions, corrections or questions please contact the author (especially if you have a simpler way of achieving the same  $E_{70}$  results!).

## Clean Motor Stick Repair

By Tom Vallee

One of the most annoying things which can happen is to have a motor break at a major contest, crushing the motor stick of your best FAI stick or Intermediate stick, usually just behind the bearing or just in front of the rear hook.

My method of emergency repairs works pretty well for me. First of all, the idea is to repair the model so it is as good as new, assuming its original shape so that your adjustment is not changed.

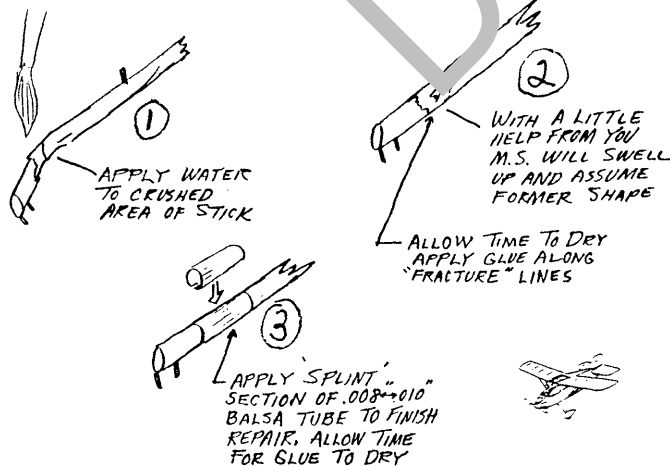
My system is as follows. First to be prepared for such an emergency, I always carry a small plastic box containing short sections of balsa tube about the same diameter as a typical motor stick. Use thin motor stick stock or better yet, make the tubes from tail boom stock.

To start a repair, you take a water brush and apply some to the crushed area of the motor stick. The motor stick will absorb the water and try to assume its original shape. It won't do this completely by itself, but with a little help from you, it should be possible to restore the original shape.

While the motor stick is drying (about 8 to 10 minutes) cut a short "splint", usually about an inch long to cover the crushed area of the motor stick. When the motor stick is dry, apply cement to the "fracture line" in the crushed area of the stick. Apply a coating of thinned cement to the surface of the crushed area. Open the seam of the splint so you can apply the splint over crushed area of the motor stick.

Use a brush dipped in acetone to insure that splint is attached properly (glue bond over whole surface) to the motor stick. Apply glue to front and rear of splint as well as to the seam.

Once you learn the technique, you can have a badly damaged stick, good as new in a half hours time. The model will retain its original trim for your final all out flights. Also you will have a neat, permanent, high quality repair, with little increase in weight.



Issue 83 1995

Rubber Measurement By Weight  
by Wally Miller

Most indoor modelers spend a great deal of time and effort selecting the proper wood, weighing every piece, keeping records and building as light as they dare. Then, at the flying site, quite often an eyeball evaluation of the power requirement is made and from a container that has the desired size marked on it, you remove a length of rubber. Well, I can almost guarantee that, if certified mechanically, the size will be in error.

A while back, I was stripping rubber for an upcoming contest. (I use both Harlan & Oppgard strippers.) After a pass on a 20' length, a check of the profile revealed that I had once again created a trapezoid, not extreme, but enough to raise my pressure a few points. Now I know this rubber is perfectly usable, but what size is it? After thinking about it considerably, I produced a formula for finding the average size of any profile configuration. With a slight deviation, it will enable the calculation of the weight of any known size to length.

The inconsistency of the rubber we use dictates that a "Base" must be established from a sample of the proposed length to be stripped. This is the key to our formula. Start by inspecting approx. 22' of rubber with a 10X scope. If all looks good, cut it off 21' long, then remove some exact amount from each end. 6" seems right. Their combined lengths are the "L" of our formula. Weigh each piece and total it for "WT". Next, measure for "W" This is best done with a dial vernier caliper, set it to .253 (for 1/4 Stk) and let the jaws hang over the edge of your bench. Now, check all four ends of the sample, adjust the setting until the rubber just hangs on its own. With the above information, just follow the instructions on the left side of the chart and you will soon have a "Base" to suit your needs.

Now - Sizing rubber.

From a strip, cut off a length as if to make up a motor

Measure and record its length. Weigh it to a 4-place decimal. Follow the "Unknown Size" instructions on the right side of the chart.

Cut the remainder of the 20' strip into usable lengths. Weigh, calculate and store it in marked containers.

While researching this project, 2 dozen 20' lengths were stripped. Each usable length within a strip was recorded for weight and size variation. From six to seven motors per strip, the average variation in weight was .0015 and .002 for size. Considering that both stock and cut size were simultaneously averaged, the results seem quite remarkable. Other batches may be different. Only time will tell.

In conjunction, and of equal importance, it was found that by reversing our formula, we are able to calculate the weight of any given size to length. This has been produced in a chart form as a "Visual Scale" or field use, and should prove to be a valuable tool for maximizing various flying conditions.

One final note: in Lew Gitlow's new book, on page 73, is a chart for the optimum motor weight as a percentage of the model weight. Combine the two charts and perhaps your watch will tick a little longer.

RUBBER SIZE

RUBBER SIZE

	.025	.028	.030	.032	.034	.036	.038	.040	.042	.044	.046	.048	.050	.052	.054	.056	.058	.060	.062	.064	.066	.068	.070	.072	.074	.076	.078	.080
6.0	.007	.008	.009	.009	.010	.010	.011	.012																				
6.5	.008	.008	.009	.010	.011	.011	.012	.012																				
7.0	.008	.010	.010	.011	.011	.012	.013	.013	.014																			
7.5	.009	.010	.011	.011	.012	.013	.014	.014	.015																			
8.0	.010	.011	.011	.012	.013	.014	.015	.015	.016	.017																		
8.5	.010	.011	.012	.013	.014	.015	.016	.016	.017	.018																		
9.0	.011	.012	.013	.014	.015	.016	.016	.017	.018	.019	.020																	
9.5	.011	.013	.014	.014	.016	.016	.017	.018	.019	.020	.021																	
10.0	.012	.013	.014	.015	.016	.017	.018	.019	.020	.021	.022	.023																
10.5	.013	.014	.015	.016	.017	.018	.019	.020	.021	.022	.023	.024																
11.0	.013	.015	.016	.017	.018	.019	.020	.021	.022	.023	.024	.025	.026															
11.5	.014	.015	.017	.018	.019	.020	.021	.022	.023	.024	.025	.026	.028															
12.0	.014	.016	.017	.018	.020	.021	.022	.023	.024	.025	.026	.028	.029	.030	.031	.032	.033	.035										
12.5	.015	.017	.018	.019	.020	.022	.023	.024	.025	.026	.028	.029	.030	.031	.032	.034	.035	.036	.037	.037	.039	.040	.041	.042	.044			
13.0	.016	.017	.019	.020	.021	.022	.024	.025	.026	.027	.029	.030	.031	.032	.034	.035	.036	.037	.039	.040	.041	.043	.044	.045	.047			
13.5		.018	.019	.021	.022	.023	.025	.026	.027	.029	.030	.031	.032	.034	.035	.036	.038	.039	.040	.041	.043	.044	.045	.047	.048			
14.0			.020	.022	.023	.024	.026	.027	.028	.030	.031	.032	.034	.035	.036	.038	.039	.040	.042	.043	.045	.046	.047	.048	.050	.051	.052	.054
14.5				.023	.025	.026	.028	.029	.031	.032	.033	.035	.036	.038	.039	.040	.042	.043	.045	.046	.048	.049	.050	.052	.053	.055	.056	.058
15.0					.026	.027	.029	.030	.032	.033	.034	.036	.037	.039	.040	.042	.043	.045	.046	.048	.049	.051	.052	.054	.055	.057	.058	.060
15.5						.028	.030	.031	.033	.034	.036	.037	.039	.040	.042	.043	.045	.046	.048	.049	.051	.052	.054	.055	.057	.058	.060	.061
16.0							.031	.032	.034	.035	.037	.038	.040	.041	.043	.045	.046	.048	.049	.051	.052	.054	.055	.057	.058	.060	.061	.063
16.5								.033	.035	.036	.038	.040	.041	.043	.045	.046	.048	.049	.051	.052	.054	.055	.057	.058	.060	.062	.063	.065
17.0									.036	.038	.039	.041	.042	.044	.046	.047	.049	.051	.052	.054	.055	.057	.058	.060	.062	.064	.065	.067
17.5										.039	.040	.042	.044	.045	.047	.049	.050	.052	.054	.055	.057	.059	.060	.062	.064	.066	.067	.069
18.0											.041	.043	.045	.047	.049	.050	.052	.054	.055	.057	.059	.060	.062	.064	.066	.067	.069	.071

"VISUAL SCALE"

WEIGHT ROUNDED TO NEAREST .001

WALLY MILLER 1994

TO ADD TO THIS CHART

(BLS) = WT

EXAMPLE, 14.0 LOOP/.048 SIZE

.0240 X 28.0 X .048 = .0322  
(B) (L) (S) = (WT)

4

TO FIND UNKNOWN SIZE

(Have weight & length)

(WT/L/B) = S

EXAMPLE WT = .0310 LOOP = 14.0

.0310/28.0/.0240 = .0461

(WT) (L) (B) = (S)

LOOP LENGTH

TO FIND "BASE" OF ANY SAMPLE  
WEIGHT & SIZE RUBBER

WT = WEIGHT  
L = LENGTH  
W = WIDTH  
B = BASE

EXAMPLE THIS CHART

WT = .0729 (12.0 X .253 TAN II, 8/93 BATCH)

L = 12.0

W = .253

WT =  $\frac{.0729}{3.0360} = .0240$  BASE



Issue 87 1996

## Winding

by Phii Alvarez

Motors must be broken-in. Always lubricate previously everytime you wind. This prolongs rubber life and lets you get more turns than any other thing. Two of the most successful ways of winding that differ radically in the technique and the amount of stretch are:

A.-Stretching 4-6 times;

B.-Stretching 9 times.

A.-Stretching 4-6 times:

1.-Wind rapidly about 50% of the turns.

2.-Pause to move the rubber to align knots and let it relax for about two minutes.

3.-Next give a slack and return to the previous position; Continue winding slowly, watching your torque. As torque raises, slack so torque drops.

4.-Pull back and watch: if torque remains, give some slack and continue winding.

5.-Repeat and get closer until reach the desired winds/torque.

B.-Stretching 9 times:

1.-It requires checking tension frequently. While pulling, feel it between your thumb and index and stop when you feel that it is tightening up.

2 - Start winding slowly and begin coming in as you continue winding and check frequently that it doesn't tighten up. Pump up about 25% of turns as you get close to the hook.

3.-Checking the slack, stretch again just short of breaking and start winding again, this time about 15% of the turns. Repeat.

4.-This time do it about 5%, and repeat and repeat until you get the 95% of desired turns.

5.-The last 5% is done in two times. Everytime you end at hook-to-hook distance.

In both techniques, back-off the required turns immediately.

Balloons, Poles, and Steering  
by Ray Harlan

Introduction

Since the seventies, when the British introduced it, steering has been the bane of existence for most indoor modelers the world over. This article attempts to describe acknowledged techniques, the equipment needed, and how to put it together. Methods for retrieving hung models also are covered. Since contests are won or lost through steering, it is hoped that this article will encourage you to learn the fundamentals and gain the confidence needed to put you in the winners' circle.

Equipment

Helium displaces air with a buoyancy of about one ounce per cubic foot. For steering in a large facility (one hundred feet high) the net lift should be more than six ounces. This is needed because the balloon acts like a heavily damped, inverted pendulum and will not follow the steerer's moves quickly enough if there is insufficient lift. There is nothing more frustrating than trying to contact a model, rapidly getting into trouble, with a slow balloon.

Ten pound test monofilament nylon is a good choice for the line. 150 feet of it weighs something near an ounce. A 20 foot steering tube made of 3 mil polyethylene (one inch plastic bag stock) also will weigh roughly an ounce. The balloon itself weighs one or more ounces. Therefore, a balloon displacing nine or more cubic feet is required for high ceilings. A seven or eight cubic foot balloon is adequate for lower sites.

A 30 inch diameter spherical balloon will displace about eight cubic feet. A 33 inch sphere gains two more cubic feet. These sizes will provide reliable steering for all conditions. However, balloons don't inflate truly spherical, so it is better to err on the large side. For small sites, a smaller balloon actually may be preferable, in order to get into girder work to dislodge a hung model. The steering response will be good, since the line is short. Inflating a large balloon (4 to 5 feet diameter) to 30 to 35 inches can have the advantage of more resilience and it will be less likely to explode if it touches a sharp object. However, the larger balloons are very expensive.

Attaching steering tubes to lines and to balloons probably is as varied as there are numbers of balloons. For steering tubes, tie an overhand knot at the bottom end to close off the tube. Then tie the line to it with several overhand knots. Monofilament must be tightly knotted to itself or else it can come loose. In all of this try to make a smooth transition from tube to line so that if a model, inadvertently slides down the tube, onto the string, it will not be caught and potentially damaged. At the top end of the tube, a tee fitting (supplied by Harlan) can be used to provide a fill port and to attach a small auxiliary balloon (about 8 - 10 inches in diameter) which serves as a plenum to keep the tube filled even if there are some small leaks. Hold the tee as you would read the letter T and insert the vertical leg into the steering tube. Wrap the tube onto the fitting, above the small hose barb, with carpet thread, sealing the tube well. Do the same at one of the other legs to seal the auxiliary ball.

The main balloon can be sealed in many ways. Several wraps of heavy twine can do it. Leave enough extra after tying a few knots to make a loop in the end for hooking up to the steering tube. Some British fliers fold the nozzle of the balloon over a 1/8" wood dowel and lash them together with a couple of small rubber bands. This method is easy to remove, but still requires some string to connect to the steering tube. A short piece of monofilament or twine tied to the tee fitting on the steering tube and to a small fishing swivel catch makes for easy coupling to the balloon. The reel deserves special attention. Too many modelers use very cheap reels and spend a lot of time untangling line. A good spool type reel (Penn 209 or 210) with level wind mechanisms are worth the cost. Spinning reels are inappropriate because the bail must be cocked to release the line and the line can't be controlled without letting it slip between fingers. Bait casting reels have the same problem and an added one. Because the spool is covered and the handle is stationary when line is released, it is difficult to observe line moving slowly out the reel. This leads to the possibility of cheating by stopping the prop

of a descending model on the tube or line, and, while steering to another position in the flying site, slowly allowing the model to gain altitude. At a meet where I was CD'ing I observed the line near the exit hole wiggling while one flier was steering his model a generous distance from where he engaged the model. Since the monofilament has a permanent coil set to it, the wiggle clearly indicated.

Many fliers use a short rod with its reel. It provides extra control in case the balloon needs to be moved away from the model quickly, by swinging the end of the rod. A stiff, four or five foot collapsing rod is ideal. The rod also adds some weight to the reel; some light reels can be lifted by large balloons.

A latex balloon is porous and will not maintain its lift over night. At a multi-day contest, these balloons require topping off each day. If you leave a balloon inflated for long periods (say a month), most of the helium will leak out. However, just topping it up for the next contest may not be smart. Water vapor has a very small molecular structure and can penetrate the balloon almost as easily as helium. A lot of the gas in that mostly deflated balloon could be water vapor with no lifting power whatsoever.

This brings us to mylar balloons. A few people, myself included, have experimented with mylar balloons. They are fairly difficult to seal because they require the right heat to do so and a sliding hand iron can burn and pull the mylar. Professionals have a hot rolling wheel device to seal edges of special balloons. Standard mylar balloons are stamp sealed. They all are too small for steering. Making mylar balloons by hand is tedious and very time consuming. My six segment balloons take over three hours to construct. The greatest advantage of a mylar balloon is that it will never explode if it hits a sharp projection on a girder, since it is not pressurized. Although exploding balloons are rare, they have taken their toll of models. Another advantage of a well sealed mylar balloon is that it does not need topping each day.

#### Steering with a Balloon

In low ceiling sites, steering is relatively easy because the balloon responds to the steerer's movements quickly and he can see the relationship between the tube and model easily. The real challenge is in high ceiling sites. Therefore, it is important to practice and gain confidence in low ceilings before tackling the job in a blimp hangar! Steering should be initiated when the model is in the part of its circle farthest from impending collision. This takes planning and careful execution. Don't wait until the model is a few feet from disaster; always watch the model and mentally predict where it will be a few circles later. If it clearly is drifting toward the girders, or another model is approaching the circle your model is tracing, get to steering. One caveat, however: it is generally accepted practice for impending model collisions to request that the flier whose model has been in the air the lesser time to steer his model. This is the best solution if that flier is competent, and offers the least risk to the longer flying model. Unfortunately, it is all too common for a flier to hesitate steering because he is inept, and excuse this in action by denying any impending collision. If your model has been in the air longer, press the other flier to steer, but be ready to steer your own model if he balks.

Before attempting to steer, be sure the balloon is high enough that the model will contact some portion of the steering tube. In high sites, you may need help from fellow fliers ten or more yards away from you to judge balloon height.

The best steering technique literally stops the prop and continues to move the model at its normal flying speed, but in a direction different from its flight circle. To execute this maneuver, walk the balloon in a circle that is inside the flight circle and that is tangent to it at the point where you want to begin steering. This means that the steering tube will converge on the motor stick near the left wing leading edge. Never approach the model from the right side. If the prop catches the tube, it will not release. The speed of the model should not change and as the tube is moved forward, the prop is caught and stopped. Then the direction of flight can be changed to avoid the obstruction. Do this slowly, but always keep the model moving at its normal flight speed.

Proper speed is extremely important; you will learn to walk at that speed without hesitating. If the model stops, the tail will drop and the model will begin to rotate about the motor stick if the prop is

caught. Righting the model can be nearly impossible if it has rotated more than 15 or 20 degrees. If the prop has not been caught, and the model stops, it can slide down the tube enough to constitute an illegal steer. Once you have reached the point where the model should be released, the procedure depends on whether the prop is stopped. If it is not, simply walk and/or swing the pole forward and to the left of the flight path to clear the model. If the prop is stopped, a slight downward pull should free it and the same forward left move will clear the model.

So far, steering at altitude has been discussed. But there is one more important use of a balloon. The sixty-second official-flight rule permits stopping the model by any physical means. Therefore, if the model is not climbing correctly after launch, the balloon can be used to stop the flight. Have your timer call out each ten second interval so you can judge when to approach the model if necessary.

#### Steering with a Pole

When models are flying below 15 feet and must be steered away from obstructions on the floor, a telescoping fiberglass pole is the instrument of choice. There are several makes available. Most are called "still water" fishing poles and telescope to 20 feet. The last section is very thin and whippy. It is best not to use this section because it can easily damage the model if you are the least bit unsteady in steering. Because the model most likely not be steered from below, the technique differs from that with a balloon. The model is carefully pushed on the front of the wing, preferably near a dihedral joint where it is strongest from the bracing. This area is pushed backwards, causing the model to pivot in the air. Since some of its forward momentum is lost with this steering motion, the model often stalls, but recovers quickly. Although altitude is lost, the alternative of hitting an obstruction is worse.

#### Retrieving Models with a Balloon

Inevitably, models will hang up on the girders. Getting them back can be fairly easy or a real challenge, depending on how they are lodged. If a model is just hanging from a girder by one prop blade, a balloon can be brought under the girder beside the model. If the model is rotating from motor torque, wait until its bottom faces the balloon, then gently contact it with the balloon. Move the balloon out and up to level the model, then raise it from its perch. If you are fortunate enough to sit the model on the balloon, slowly lower it to the floor to retrieve the model. Most often, the model slips off after being freed from the girder and doesn't lose much altitude, provoking the opportunity to hang up again after a few more circles. If this occurs, catch the model on the steering tube, stop the prop and slowly wind the line in. Don't let the model slide down the tube or line; damage can occur if the model assumes a bad attitude. When a model sits on top of a girder, how it is retrieved depends on how much of the model is visible and how the prop is caught. Also, how much room there is above the girder plays a role, for if the front of the model is clear and there is room for a balloon above, the prop can be snared on the steering tube and the model can be lifted off. This is a rare circumstance. Occasionally the tail is visible and the prop is past the other side of the girder with one tip snagged. A careful push with the balloon on the bottom of the stabilizer can move the model off and limit damage to a broken rudder.

If very little of the model shows past the girder, a balloon by itself is useless and will only serve to damage the visible parts of the model when the flier gets frustrated and bashes a little harder. It is time to add to the ballooning arsenal. Pull the balloon in and attach a stick of 3/32 or 1/8" square balsa, 3 feet long, to the top of the balloon with a small piece of drafting tape about 4 to 6 inches from the end of the stick. This tape is preferred over masking tape because it can be peeled off easier. Support the stick in a horizontal orientation by two diagonal braces to the lower portion of the balloon. All of it can be taped together. Tightly tie a second balloon string (less balloon and steering tube) to the tail of the horizontal stick. This will be used by a second person to orient the stick.

Move the balloon back up near the model. The second reel is released at the same time and the holder moves away from the balloon so that his line makes an angle of about 45 degrees with the floor. A third person acts as an observer and orchestrates each person's moves so that the balsa stick can be maneuvered under the wing in a chordwise direction, near the center of the wing. In high sites 7X50 binoculars and a chair or chaise lounge are mandatory for the observer. Commands to move a few inches at a time are given and the retrieving rig is allowed to settle between them. When the stick is

under the wing, the model is then raised to free it. Some forward motion may be required to free the prop. Although it sounds complicated, this technique can be quite successful and can result in no damage to the model. Naturally the model is reeled to the floor and not released from the stick.

Occasionally, a model will be entangled in a hanging string. This occurs most frequently in gymnasiums where parties are held. Small helium balloons are released, they eventually deflate, and their strings hang over the girders. There is no way to untangle a propeller that has gotten wrapped up in one of these strings. The solution is to return to the retrieving rig described above and super glue two halves of a double edged razor blade to the horizontal stick so that the halves form a vee beside the stick, with the cutting edges inward. When the offending string is snagged in this vee, a slow tug on the orientation line can cut the string and not jerk the model so as to damage it. If the model gets caught in the part of the string where the balloon is attached, cutting it free in this manner may cause the model to plummet to the floor due to the added weight of the balloon. At least you will get the model back.

Retrieving models often calls for ingenuity because the balloon or line can't always reach the model. The techniques described here provide the basis for most successful efforts, but variations may be necessary. If you want to become an expert, always offer to help someone who is timid about retrieving his model. He'll be grateful to get it back, even if slightly damaged, and you'll get some practice without breaking your own model.

Draft

## Straightening Crooked Tail Booms

By Larry Coslick

I have been building intermediate sticks for the past 3 years and it seems that every time I build a tail boom, the last 1/3 of the boom has had a curve in it. I have tried steaming the boom on a tapered form and soaking the boom and form in water. However, these procedures did not work. Some builders tell us to use the curve to obtain a left turn, but I do not like to sight down a motor stick and see a crooked boom. Recently, I glued a boom together and again I had the same curve when it was removed from the tapered form. I set the boom aside and while working on another project, I laid a pair of pliers across the aft section of the boom and crushed it. The damaged area was small, so I decided to cut out the damaged section and butt joint the two together. After the repair was made, I noticed the boom was straightened, yet not straight enough. After three more butt joints, I had a boom that I could live with that only added .004 grams. For the builder who is interested in appearance, the butt joints are hardly noticeable.

The procedure is as follows:

Determine where the curve starts and mark it. Slide the boom over the tapered form and wrap a 1/8' wide strip of Scotch 230 drafting tape (available at office supply stores) around the boom, where the cut is to be made. Drafting tape will not tear .006 C grain balsa. Match the ends of the tape so that a perfect circle can be cut. I use the tape because it is very difficult to make a perfect cut freehand. Hold the tapered form in your right hand and only rotate the form while following the edge of the tape with a new razor blade.

Separate the two sections and check for a good fit. Set the front piece aside and cut the back section in two equal parts. Check again for a tight fit. Apply thinned Duco or Ambroid glue with a plastizer added to each end of the aft section where the last cut was made. Slide the 2 aft sections on the form and align the two. Take a small brush and apply acetone around the joint and rub the joint back and forth. Also, rotate the form so that the glue won't stick to the form. Remove the boom and check for straightness. It might be necessary to reverse the seam on several sections along the boom to get it straight, but normally this is not necessary. When the aft section is straight, slide the forward and aft sections on to the form and reattach the two. On the last 2 booms that I made, one took 6 butt joints, with 2 seam reversals and only added .006 grams. The other boom took 2 joints and added .002 grams. Although I don't use this procedure to straighten bowed motor sticks, I'm sure it would work. After the boom has been straightened, I usually leave it on the tapered form for several days to let the glue cure.