READ THROUGH THE INSTRUCTIONS FIRST IF YOUR GOAL IS TO HAVE OPTIMUM FLYING PERFORMANCE!

The scope of this kit is to introduce students to the precision techniques needed for competition flying. These include primary construction, final assembly, trim flying and optional re-design concepts. **We recommend building the first model as shown on the plan.** The design included is a proven performer for national competition and should be considered as a *benchmark*. We invite students to consider building the second model using sample modifications for even higher performance. Please review these options before starting the first model. In doing so, you may see a technique or design modification that appeals to you.

Notes:

1) All instruction steps read from left to right.
2) The basic design plan may be reduced or expanded in dimensions to conform with current national event requirements. Either use a photocopy machine to change the scale size or simply re-draw the plan on graph paper in scaled up or scaled down versions.
3) Some material dimensions are given in inches (industrial stock sizes) while some other dimensions on the plans or instructions may include both imperial and metric dimensions.
4) Though we suggest different types of adhesives for specific applications, a premium wood glue (Midwest Tacky Formula #362) may be substituted if used sparingly to minimize the added mass.

Kit Inventory

Part No.	Quantity	Description
M409	1	Section of Music Wire, .025" x 12"
W535	2	Formed landing gear wire
W531	1	1/16" x 12" Aluminum Tube
P595	1	Plan
P596	1	Instruction booklet (3 sheets)
34565	1	Laser cut parts sheet (wing ribs,gussets, wheels)
34566	8	Balsa sticks, 3/32" x 3/32" x 24", motorstick, tail boom, wing leading edge, & wing saddle assemblies
34568	4	Balsa sticks, 1/16" x 1/8" x 24" long, wing leading and trailing edges
34569	10	Balsa sticks, 1/16" x 1/16" x 24" long, tail assemblies and wing braces
34579	1	Balsa stick, 1/16" x 1/4" x 24" long, wing saddle assembly
34567	2	Balsa stick, 3/32" x 3/16" x 24"long, motor stick and nose block
34570	1	Balsa sheet, 1/32 x 2" x 12" long, tip fences or wood propeller blades
M468	2	6" (15cm) dia Black Propeller
M641	8	Dental Bands
M776	1	White Japanese Tissue Sheet
M775	1	Yellow Japanese Tissue Sheet
M640	1	6 ft. Contest Rubber, "Performax", 3/32" cross section
M778	1	2 ea. Gray Plastic Propeller, 8" (20cm) diameter
		4 ea. Brass Washers
		2 ea. Motor Drive Shafts

Tools Required

Many tools and adhesives may be purchased at craft or hobby stores

Workboard: *1" thick x 12" x 22" (minimum dimensions) blue or pink insulation foam.*
GRIP PINS: *(Midwest # 587) or small T-pins*
Wax paper
Masking tape
Precision cutting tools: *Single edge razor, X-acto with #11 blade or one half of a double edge razor.*
Cutting board: *any scrap material that has a smooth, hard surface for precise cutting.*
White glue: *(Midwest Tacky Formula #362)*
***Cyanoacrylate glue* (CA-"super glue"):** *medium viscosity* only.
***OPTION-** acetate based glue (model airplane cement)*
Bottle of Accelerator and applicator pipettes: *for bonding the super glue.*
Pigma MICRON .005 waterproof drafting pen
Thread
Small paint brush
Small mixing cup
Scrap newspaper
Damp sponge
17" x 23" Wood Frame
5 Colored markers
Pin Vise
.062" drill bit
Emery Board
Glue Stick (OPTIONAL)

The Sorcerer

P-596

Indoor Competition Flying Model Instructions

Primary Construction

The most important feature of an efficient, winning model is to produce an aircraft that has a light wing loading. That is, the ratio of overall mass divided by the overall lifting surface area (Mass / Area = Wing Loading). The more lifting area the model has along with the least mass assures an easier to fly model. Keeping this basic concept in mind, let us review the process.

Preparation

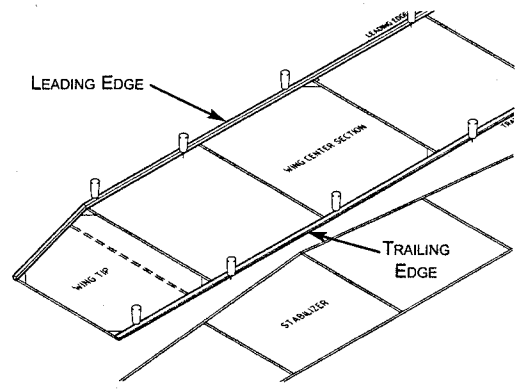
Familiarize yourself with the main plan and carefully review all the details. To make the plan lay flat, carefully run the plan over a smooth table end. When its lays flat, tape it to the workboard. Now, cover the plan with wax paper and tape it to the workboard too.

Using ruler and colored markers, measure all the strips of wood and color code, each according to their size, for easy identification.

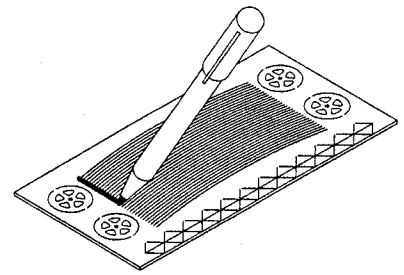
Operation #1
WING FRAMING INSTRUCTIONS

❑ 1. Select two each of 3/32" x 3/32" strips (stiff for leading edge) and two each of 1/16" x 1/8" balsa sticks and cut them to fit onto the leading and trailing edges shown on the plan.

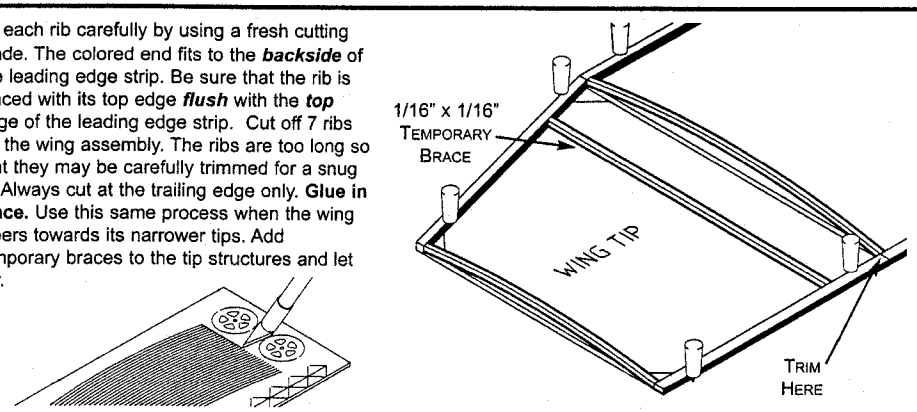
❑ 2. Precisely place them in position, according to the wing plan, and pin them carefully but securely with your **Grip Pins.** Do not place any pins at a rib juncture.



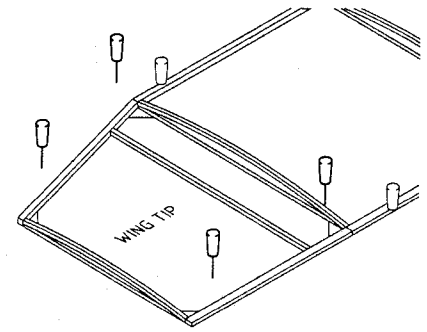
❑ 3. Locate the laser cut rib sheets. Take a permanent marker and run a stripe down the leading edge side [see illustration].To attach the ribs, follow this process.



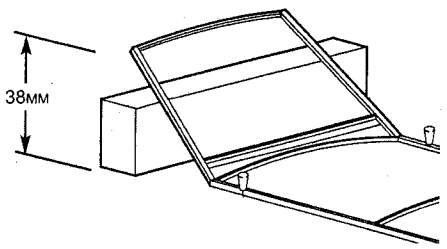
❑ 4. Cut each rib carefully by using a fresh cutting blade. The colored end fits to the ***backside*** of the leading edge strip. Be sure that the rib is placed with its top edge ***flush*** with the ***top*** edge of the leading edge strip. Cut off 7 ribs for the wing assembly. The ribs are too long so that they may be carefully trimmed for a snug fit. Always cut at the trailing edge only. **Glue in place.** Use this same process when the wing tapers towards its narrower tips. Add temporary braces to the tip structures and let dry.



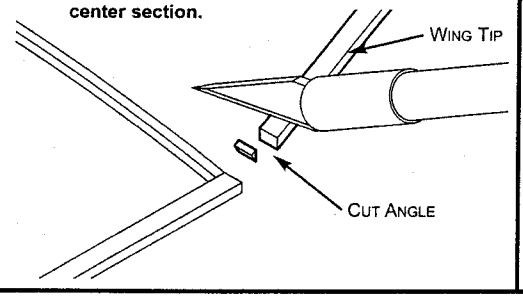
❑ 5. When dry, remove only those pins holding down the 2 wing tip sections.



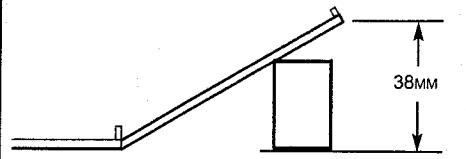
❑ 6. Prop or block each tip up 38mm (1-1/2"). Books, boxes or blocks of wood of may be used for this purpose.



❑ 7. Carefully cut the dihedral angle as shown at the open ends to butt **join the wing tips** to the **center section.**

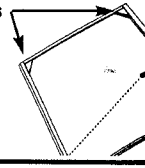


❑ 8. With the center wing section still pinned down, anchor your dihedral blocks in place so the wing tips are 38mm (1-1/2") high at the tip ends.

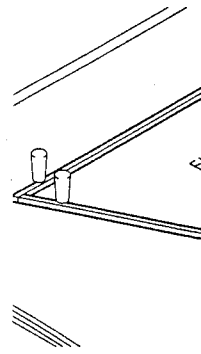


0. Carefully cut, fit ar
the laser cut sheet
extra reinforcemen
1. With the wing dry,
off any high points
trailing edge with a
bracing ribs can nc
from the wing tips

SSETS

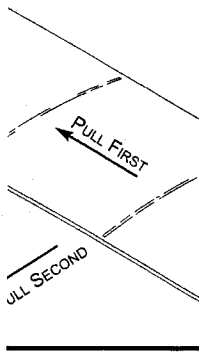


5. Assemble the fin as

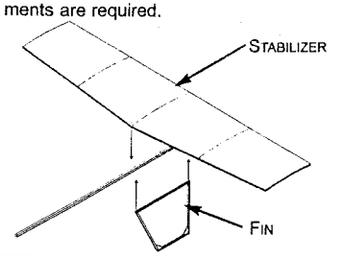


2. Make a mixture of a
glue and 10% wat
they emulsify into
sive that you use t
wood structures.

3. Lightly brush the glu
the structures. The
translucent, wet su
can tell the color of
too much. Place th
workboard and ligh
Note: A fresh glue
for the applying the
Solvent alcohol car
the tissue needs to



❑ 5. Attach the tail surfaces according to the plan.
Note: An optional adhesive could be acetate based such as DUCO or AMBROID. These glue joints may be softened at a later point with brushed on acetone if finite adjustments are required.

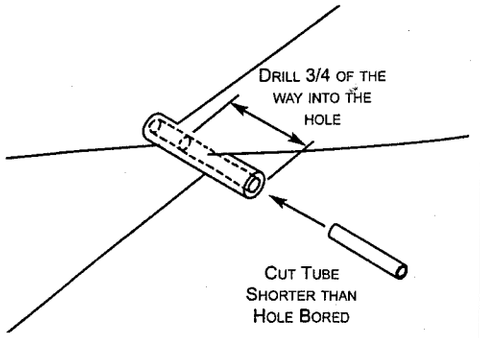


Operation #8
PROPELLER ASSEMBLY

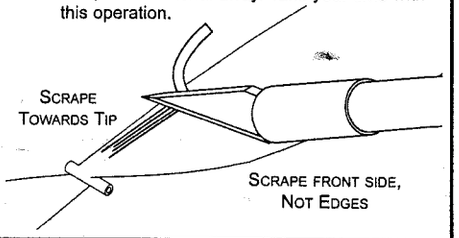
The propeller and rubber motor together offer the most opportunities for providing efficient flying operation. The stock plastic propeller must be modified to fit the current rules for maximum diameter. Further modifications will enhance performance. These include lightening, balancing, re-bushing and re-pitching each propeller. We include 2 gray propellers and 2 black propellers. The gray props offer much more area but must be shaved extensively down to less than 3 grams to be light enough to use. You will need both patience and skill for this task. As an easier option, the black props may be substituted. They have less surface area and only need to be shaved for balancing.

Check your current rules status for propeller dimensions and trim off excess tip material for compliance.

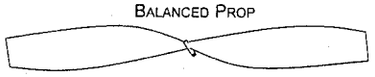
❑ 1. Re-bushing the propeller's shaft hole will keep the prop from wobbling on the small prop shaft. Use a pin vise and an .062 drill bit to re-bore the shaft hole in the propeller. It is only necessary to bore from the back 3/4 of the way through to the front. Cut an equal sized piece of aluminum tube and taper the insert end. Carefully push the new bushing in until it seats. If a small portion still sticks out the back of the propeller shaft hole, grind it off and sand it flush.

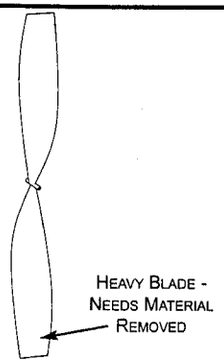


❑ 2. "Shaving" the propeller removes excess mass without losing any surface area. Essentially, the process is to carefully scrape the front, cambered surfaces until each blade becomes translucent. Use the X-acto knife to carefully scrape the material away. Take your time with this operation.

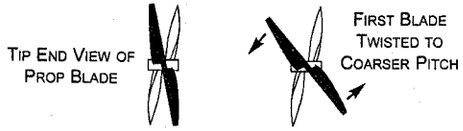


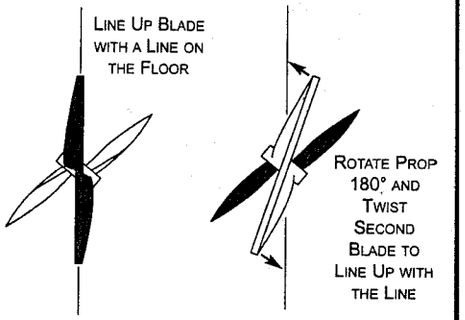
❑ 3. Balancing the prop is simply an extension of the shaving process.An unbalanced prop causes a severe wobble that reduces flight efficiency. The cure is quite simple. When the blades are both shaved equally, spin the blade to see where it stops. If one blade always pendulates to the bottom, it is the heaviest and needs more material scraped away. Do so until the prop blades rests horizontally on the prop shaft.





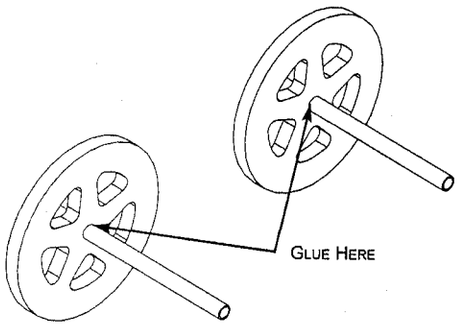
❑ 4. Re-pitching the prop is useful to dial-in the power from the wound rubber motor. It governs how fast the propeller unwinds. Too fast and the model climbs too quickly and has a short flight. With a re-pitched prop (coarser pitch) the model will climb slower and consume its power at a slower rate. The result is longer, more efficient flight times. To re-pitch a prop, start by selecting a line on the floor. While holding the prop at its hub in your left hand (as if the model was flying from left to right), look down one propeller blade from the tip to the hub. With your right hand twist that blade 10° counterclockwise. This is called adding coarser pitch where the leading edge of the prop blade is higher than the trailing edge. Once one blade is re-pitched you must do the same on the opposite blade. Align the blade tip with a line on the floor. While holding the prop shaft steady, rotate the propeller 180°. The other prop blade is now in position for adjustment. Note how it does not align with the floor line. Just twist that blade until it does. That's it, you have just re-pitched your propeller to ***coarser pitch***!



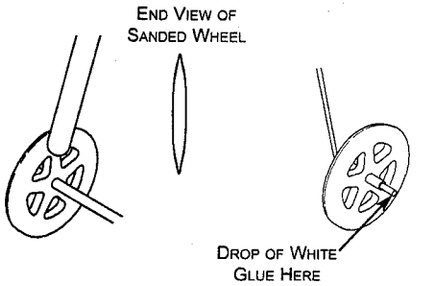


Operation #9
Landing Gear
(Applies to airplanes that must Take off and Land on wheels)

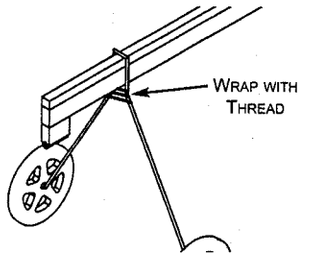
❑ 1. This kit is supplied with laser cut wheels and a lightweight wire assembly. The balsa wheels are substantially lighter than plastic wheels. The wheels may be punched out of the laser sheet. Use the leftover aluminum tube as wheel hubs. Carefully slip two wheels onto both ends of the aluminum tube. Brush on some white glue onto the axles and slide the wheels into the glue. When dry, cut the tube using a old X-acto #11 blade (refer to step #10 under fuselage assembly). Leave enough length so that the tube may be easily held.



❑ 2. While holding the wheel assembly, sand the wheels to a taper using an emery board. DO NOT remove wood from the diameter, this may risk having an illegal sized wheel. When both wheels are sanded, cut the aluminum tubes so that the wheels fit on the wire gear assembly. Retain the wheels with a drop of glue. Carefully position the assembly so the glue does not stick into the wheel hubs. Let dry.

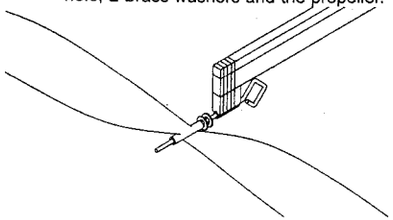


❑ 3. Slide assembly over motorstick. Wrap thread around the gear legs directly under the fuselage and glue. Let dry.

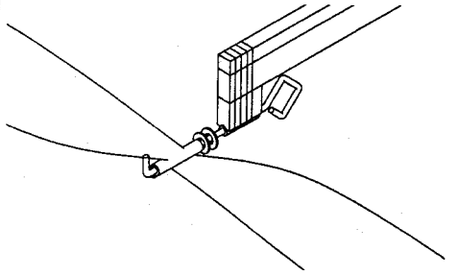


Operation #10
FINAL ASSEMBLY

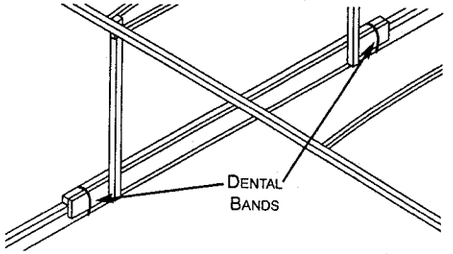
❑ 1. You can now wrap up the details of construction and final assembly. Pass the propeller shaft through the aluminum shaft hole, 2 brass washers and the propeller.



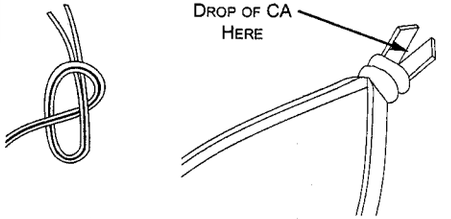
❑ 2. Take the needle nose pliers and bend the front end of the shaft to 90° so that the prop's clutch takes effect. Trim off the excess wire.



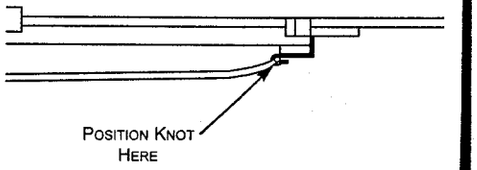
❑ 3. From the back end of the motor stick, loop on 2 dental bands. They will hold the wing saddle in place. You should already have 2 bands in place to hold the tail boom in place.



❑ 4. Cut and tie the rubber loop to the specified dimension. Start with a 30cm loop. Lock the tight knot by adding a little super glue (CA) to the back side. Lubricate with Amour All® or Son-of-a-Gun®.

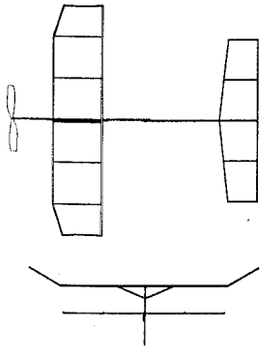


❑ 5. Attach the loop to the front hook and position the knot at the back onto the motorhook.

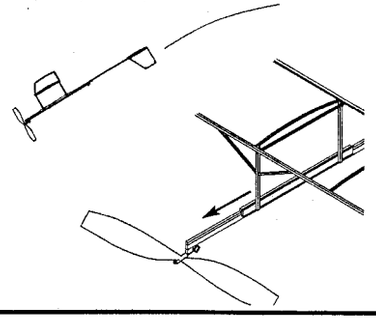


Operation #11
FLYING PREPARATIONS

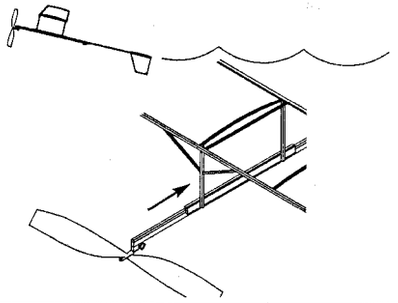
❑ 1. Before any flights the model must be inspected for warps, odd twists or broken components. If we assume the model is "square" then it may be glide tested. All flight testing (trim flying) should take place in a obstruction free room or gym. Hand wind the propeller until the rubber has 50 turns. Holding model at a slight nose-down angle, release the prop and gently launch the model forward as if it were a feather.



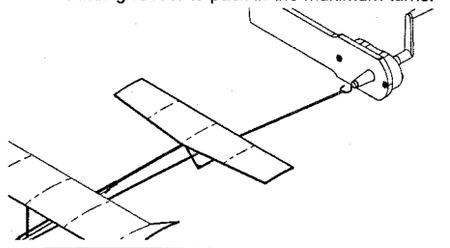
❑ 2. If the model dives, move the wing forward 1cm (1/32") and repeat.



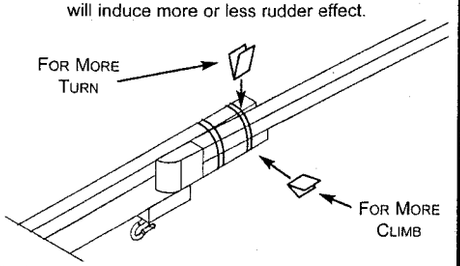
❑ 3. If the model climbs and stalls, move the wing back 1cm (1/32") and repeat.



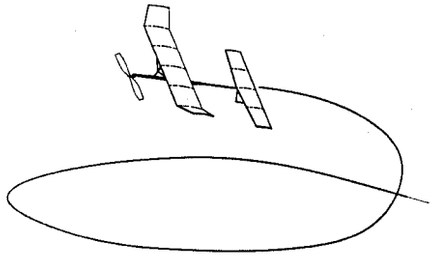
❑ 4. Once the model glides smoothly, you are ready to move on. Gradually make longer flights by increasing the turns. It is best to use the **Midwest #388 15 to 1 Winder** for stretch winding rubber to pack in the maximum turns.



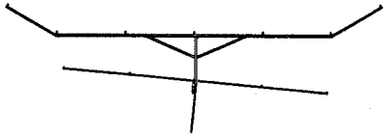
❑ 5. For turn adjustments: Use the boom lock with thin paper wedges (1 sheet thick or 1 fold) inserted between the boom and boomlock to increase or decrease the boom's angle. This will induce more or less rudder effect.

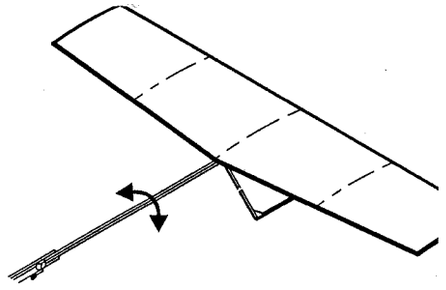


❑ 6. Note that the model should fly in left hand circles to use the natural torque effect of the wound motor.

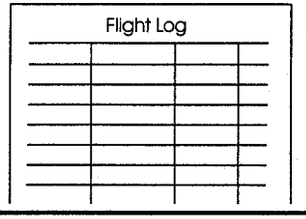


❑ 7. If one wing tends to dig in with a hard bank, you may twist the fuselage boom slightly to counteract. ***Use hot breath or light moisture on the area to be twisted.*** This relaxes the lignin or wood's natural cell to cell bond temporarily. As a note of information, ***the stabilizer always flies parallel with the floor.*** Twisting the boom will change the turn/bank angle for the wings.





❑ 8. Maintain a record of flights and adjustments to make setting up trim adjustments easy at the contest site. Use the Flight Log on the back of this sheet to speed up the process of trimming.



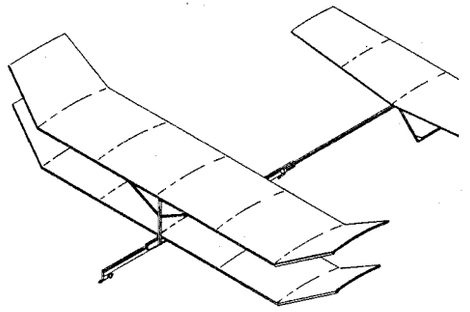
MODIFICATION and CONSTRUCTION OPTIONS

Midwest Products Co., Inc. challenges you to consider various design modifications to possibly improve performance and to make your model unique. We include construction materials to produce at least one other model whether it is stock or modified. The following is a list of possible modifications. Refer to your competition rules for specifications to design by.

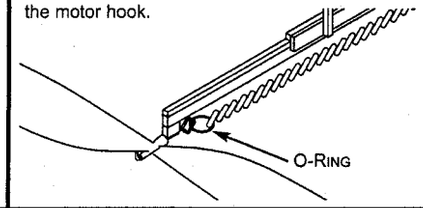
Scale Size- As the rules change so may the size of allowable components. Use a copier to increase or decrease the size of the model to comply with regulations. Use the graph paper to draw up your own concepts to try.

Outline Changes- Once you have mastered the basic model, making subtle changes to the wing or tail shapes to improve performance may be attempted. Just be mindful of the pros and cons. As an example, a pointed wing tips creates very little drag. That is a good. But, a pointed tip severely reduces possible lifting area, that's bad. It may pay to compromise with a tapered wing tips or one with a curve. The same is true for the empennage tail group. Keep in mind that at this size, mass has more importance than fancy shapes or configurations.

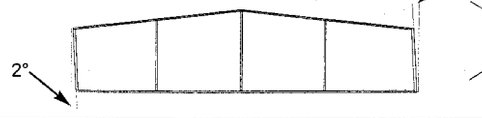
Biplane- In some rules there are only wingspan and chordspan maximum dimensions. If there are no specifications of **Wing Area** then one option would be to create a **biplane.** We suggest using the same basic wing format but slightly reduce the chord dimension on the lower wing. Then mount the lower wing on shorter stalks to the wing saddle and make simple sockets to capture the stalks on the upper wing. This doubles the lifting surface but will not excessively increase drag.

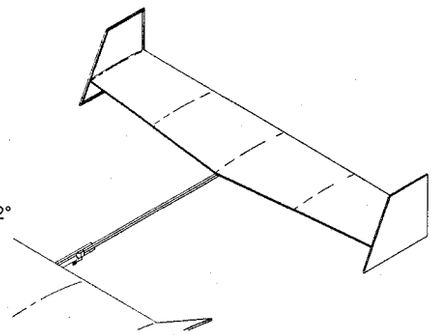


O-Rings- O-rings will make removing and attaching the wound rubber motor much easier. Insert the new rubber strip through 2 black o-rings of 4mm ID max. (not included) before tying the knot. Now when the motor is fully wound, the o-ring in the front cushions against the metal prop shaft while the rear o-ring is easier to remove from the winder hook and attach to the motor hook.

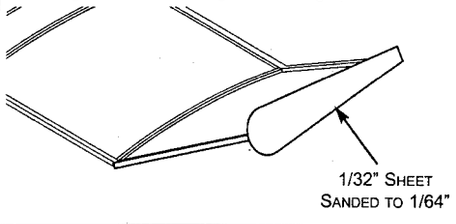


Twin Fins- Having two fins will increase yaw stability. They also increase mass so unless you can build them extremely light, wait to make this modification until you have more experience. It is best to mount them at the tip ends of the stabilizer to also act as vortex (swirling masses of air off any moving surface causing drag) fences forcing the air to pass over the lifting instead of spilling off the tips. Consider offsetting the fin by 2° to (trailing edge to the right of the leading) to induce a natural left turn.

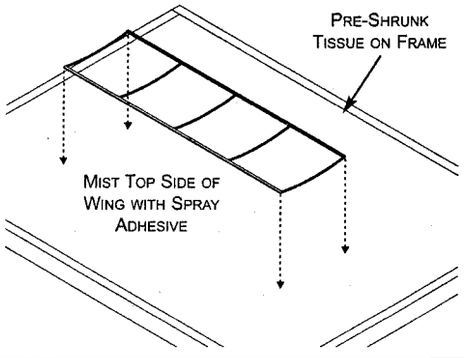




Wing tips Fences- As reviewed in the twin fins option, reducing tip vortex drag vastly improves the lifting efficiency of the wing or lifting stabilizer. Tip plates made from very thin balsa sheet can function as simple fences causing the airflow to continue over the wing instead of spilling off the wing tips.

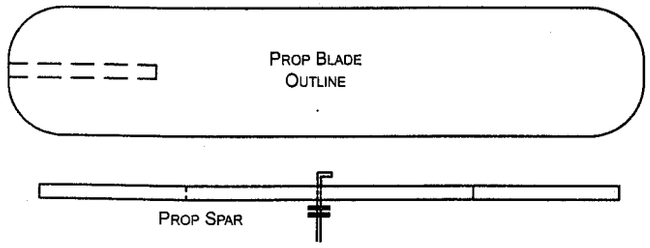


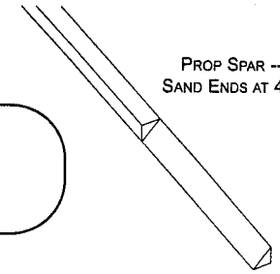
Tissue Application- The same frame used to to pre-shrink the tissue may also be used with an optional method of tissue application. You can take the center section of the wings' framework and spray 3M77 adhesive above it so only the lightest misting of adhesive floats down to the framework. Then just press it into the tissue still held on the frame. When dry, trim off the tissue without waste and finish the wing tip assembly as covered in section #1.
The stabilizer and fin may also be covered using this spray adhesive process.



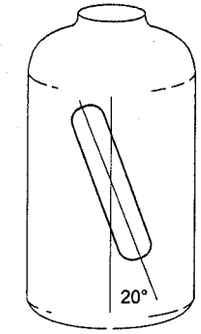
Light Weight Balsa Prop
(Refer to contest rules before using)
Note: extra parts not included

A simple, light weight propeller may be carefully manufactured using thin balsa sheet (1/32" thk) for the prop blades and the prop spar made from scrap 3/32" square ***hard or stiff*** balsa. Cut the spar to length and drill out the center hole as shown. Carefully make the two 45° cuts to slice in an angled surface for mounting the propeller blades at a 45° pitch angle. Apply glue and temporarily pin the blades in place. Let dry for one hour. The propeller can be mounted to the airplane in a similar fashion as the plastic props if you use the aluminum bearing. The prop shaft should pass through the tube bearing, then 2 brass washers and through the hole in the prop spar. Carefully bend the shaft 90° and cut the excess shaft leaving enough to anchor with glue and thread onto the prop spar.

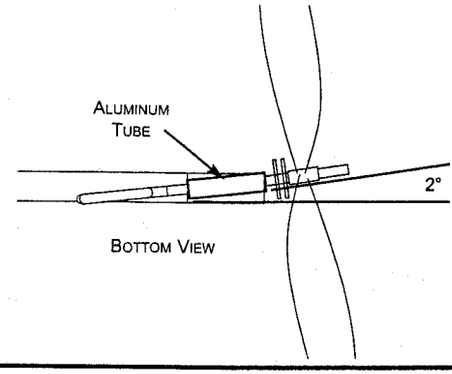




A more efficient helixed wood propeller may be molded around a glass gallon jug. Soak the wood blades in hot water for 15 minutes. Then apply to the bottle's side with an offset to the centerline by 20°. Carefully wrap the props tightly with a elastic bandage and let dry for 24 hrs. Finish the assembly as discussed in the previous sections.



Side Thrust- In some cases, pointing the prop bearing (aluminum tube) a 2° to right or left can be used very effectively to induce or reduce a turn. This may be a better choice than adjusting the fin. The fin/rudder becomes more effective as the power winds down which could cause it to develop a "death spiral" at the end of the flight. The best time for making this adjustment is during construction but it can be accomplished, if done carefully, after the initial test flights.



Two Glues- The indoor flying community uses this trick for making finite adjustments on their models. At any glue joint that a flying surface makes that anchors it to the fuselage, such as the stabilizer to the boom or wing to the uprights, use a solvent based glue or acetate, "model airplane cement". If the surface needs to be located differently, the glue can be softened by a paint brush dipped in acetone. This way it is unnecessary to "break" or crack the joint to re-position the surface.

Additional Trouble Shooting

All aerodynamic adjustments are made while the model is viewed from the rear

Problem	Cause	Solution
Model spiral dives to the left	1. Too much torque 2. Too much lift from right wing 3. Too much left rudder	1. Use longer motor or thinner motor 2. Re-mount stabilizer with left tip down 5°. Add more if needed 3. Shim boomlock to neutralize hard left rudder effect
Model climbs quickly and runs out of winds	1. Rubber motor too short 2. Propeller pitch too low	1. Use longer motor loop 2. Twist in coarser pitch -- See Operation #8, Propeller Assembly
Model dives and the wing is as far forward as possible	1. Too much mass ahead of wing 2. Prop needs to be lightened	1. Add a small shim at the front of the wing saddle to increase wing incidence 2. See Operation #8, Propeller Assembly
Model barely wants to fly	1. Insufficient power 2. Bent prop shaft	1. Add more winds on the motor 2. Straighten out the prop shaft
No matter what I do, the model doesn't work	1. Too many adjustments 2. Model not built true according to plan	1. Neutralize all adjustments and start over 2. Start again and build with care

Flight Log

Using a Flight Log will speed up the process of **trimming** (adjusting for optimum flight). Be sure to fill out each column and **make only one adjustment for each test flight.**

Pilot_____ **Aircraft**_____

Caution: Visually inspect your aircraft before each flight

Flight #	*# of Winds in Motor*	*Time Aloft*	*Flight pattern*	*Trim Adjustment*	*Sign Off / Date*