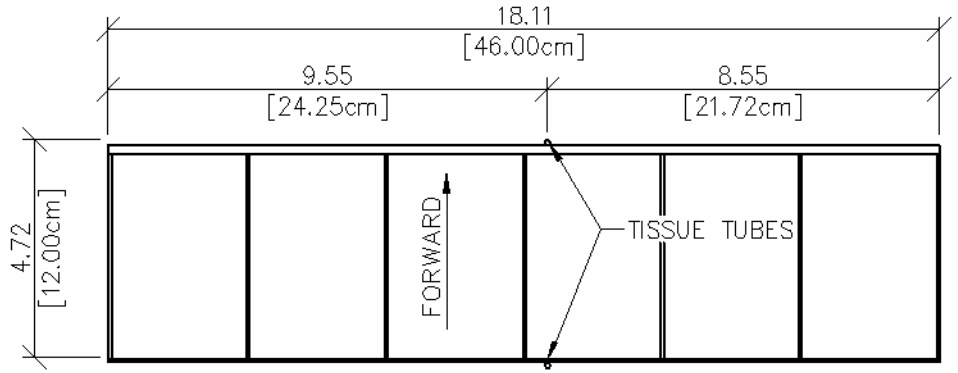
# "Double Trouble" for Science Olympiad

By Chris Goins

I got started with indoor free flight in middle school, when I built my first Peck Polymers ROG for Science Olympiad. That was a long time ago, and what I've learned since then is reflected in my latest effort, Double Trouble. I have always enjoyed this class - the models are built like tanks, but they still fly nice and slow. The rules are simple, yet open enough to allow some creative license. I was excited when the rules-writers decided to allow biplanes and plastic film for covering. This, in combination with the larger diameter prop left in from last year's rules cycle, gives the class excellent performance potential. The design of this airplane is something of an exercise in creative aerodynamics. Low profile semi-elliptical leading edge spars (a natural progression from a Banks style sharp LE) are used throughout, with the wing trailing edge spars oriented vertically to create small gurney flaps. The wings and tail are all flat with canted tip plates. I've been building models like this ever since Bill Gowen introduced me to them. The model is quite long, with all three flying surfaces separated as much as possible. The mean tail chord is increased to take advantage of a hole in the rules, and the center of gravity is set about half a chord-width behind the rear wing post. The model was originally built for low ceiling flying, so the prop blades are paper thin and flare a good deal under moderate torque. The focus on drag reduction results in a very slippery airframe. In combination these features make for a model with a slow climb and amazingly "floaty" cruise and descent.

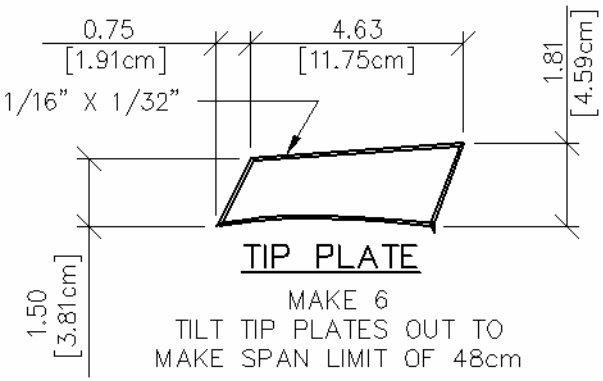
Construction begins as always with careful wood selection. For this class I prefer the flex characteristics of solid motor sticks, but finding the right one has always been a chore. After cutting and testing several blanks, I settled on a springy piece of 5.4# B-grain. The fuse must be torsionally stiff between the wing posts to keep the top wing from twisting too much. Target weight is around 2g, depending mostly on the overall length. The tail boom is 17 inches long so very light, stiff wood is critical. It must not deflect too much on launch or weigh too much - either condition would make trimming and flying difficult, if not impossible. I found my boom in the same sheet as my fuselage; it's 4.5# and has an SC of around 120. A deflection of ½" at 17 inches with a 1g test weight is acceptable. Posts should be made of the hardest balsa you can find. Bass would also work well. The posts are tall and must be as stiff as possible. They are elliptical at the fuse and taper to a circular cross section. Leading edges are made from 8.5# C-grain. Denser then normal wood is used because of the spar's small cross section. Selecting wood for the trailing edges is not as difficult. Stiffness isn't an issue because of their vertical orientation. Ribs are made from 5# A-grain, but anything light enough will do.

The top surface of the leading edge spars is shaped while still on the sheet, a la Cezar Banks. After it is cut free the frame is assembled, and then material is removed on the underside, between the ribs, with a razor blade followed by careful sanding. This takes time, and yes, it leaves your spars totally unmatched in deflection. That's alright though - some interplane struts on the leading edge solve this problem. Trailing edges start out rectangular and are final shaped after assembly. An alternative (and likely better) method has recently been employed - that is, to do all spar shaping before assembling the frame, and match the mating surfaces of the ribs to the spars. The original idea came from Neil Henderson. Tip plates are used for roll stability and to control sideslip. As long as they have enough area, the shape doesn't matter. I make them out of straight pieces because it's faster. They should not extend below the rib. A note about gurney flaps - I started experimenting with them about three years ago. At first, they were simply a ¼" strip of condenser paper glued to a typical trailing edge along the full length of the wing. On later models, the trailing edge spar has been oriented vertically to perform the same function. The effect they have on the model is definitely positive - the stopwatch has proven this (to me, at least). The effect is to slow the climb and lengthen the cruise, with little effect in the descent. A quarter inch seemed a bit large given the reduced wing size and biplane configuration, so they were reduced to 3/16" for this model. The stab must be kept light to make trimming easier.




## WING

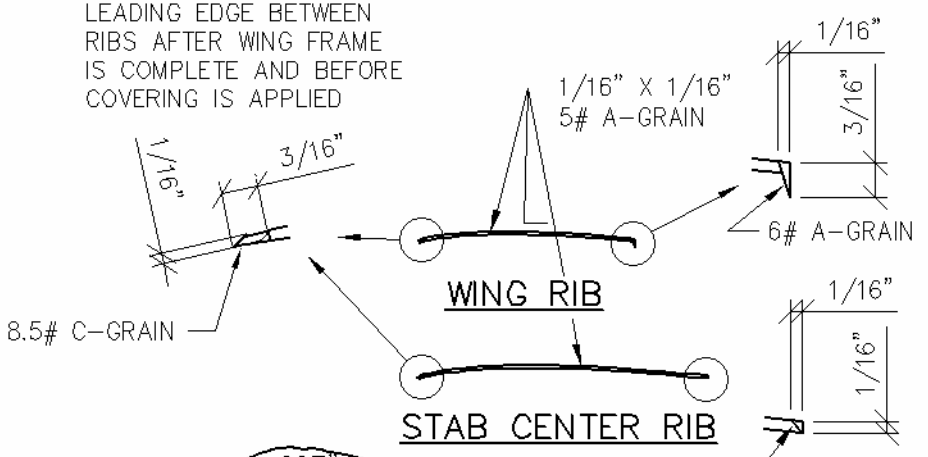
MAKE 2
(BOTTOM WING HAS STRONGER SPARS THAN TOP WING)

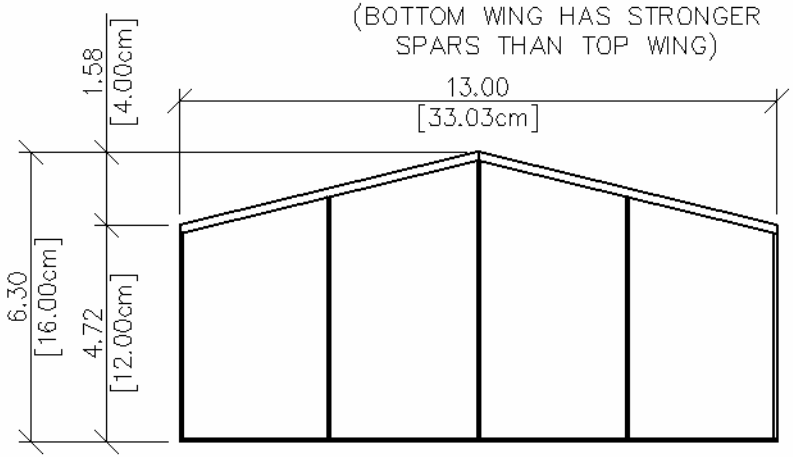



## TIP PLATE

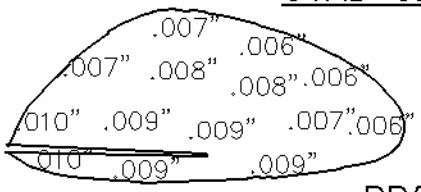
MAKE 6
TILT TIP PLATES OUT TO MAKE SPAN LIMIT OF 48cm

SHAPE UNDERSIDE OF LEADING EDGE BETWEEN RIBS AFTER WING FRAME IS COMPLETE AND BEFORE COVERING IS APPLIED



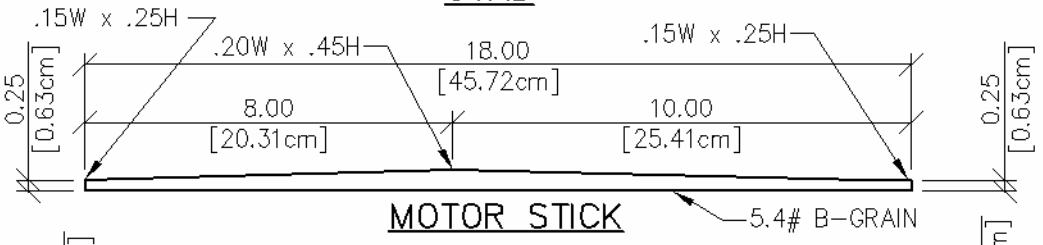




## STAB

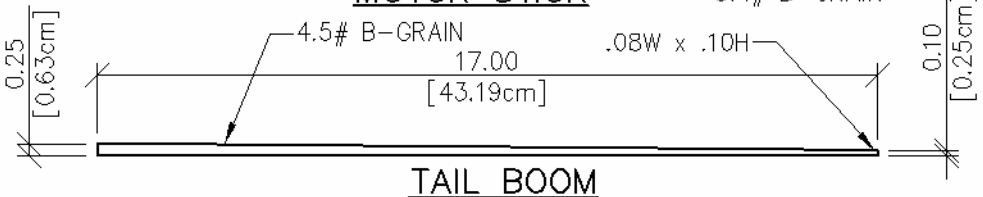



## PROP BLADE

(MAKE FROM IKARA SO PROP. SAND TO THICKNESSES SHOWN WITH 400 GRIT SANDPAPER WRAPPED AROUND ALUMINUM CAN. SAND UNDERSIDE OF BLADE.)

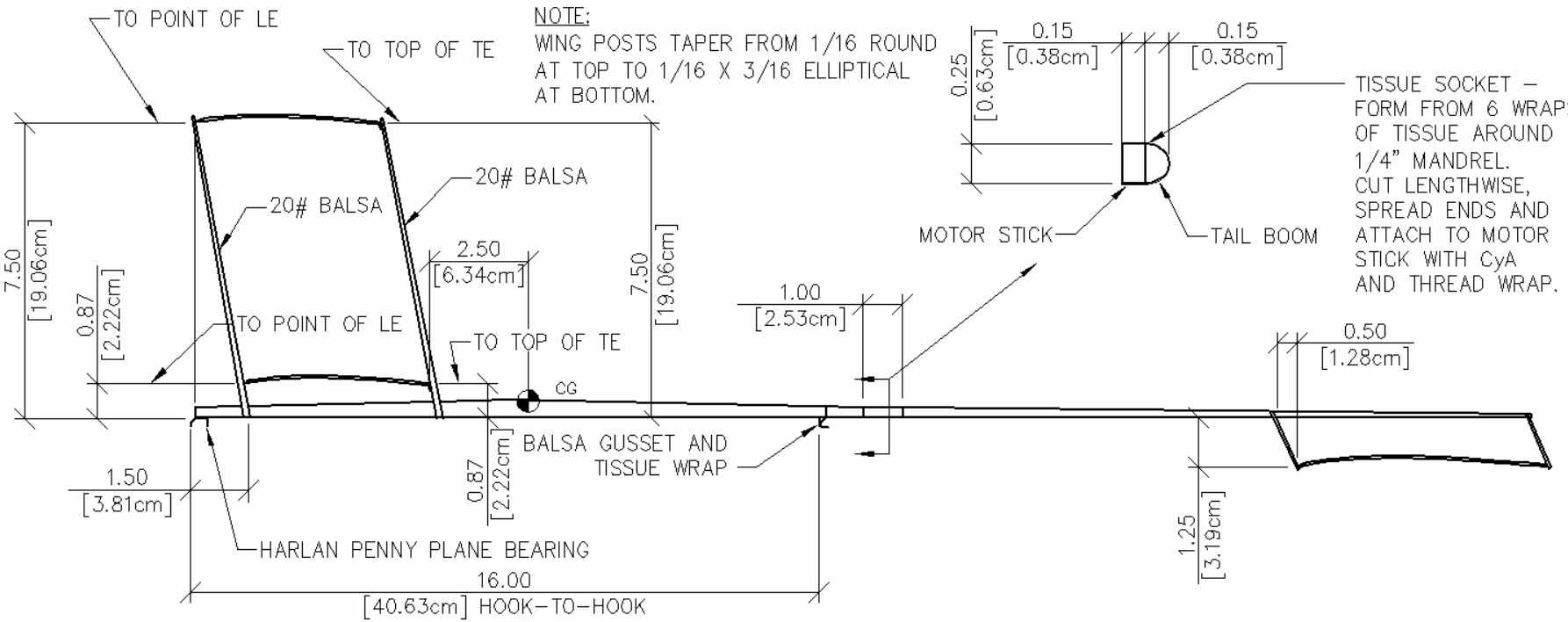



## MOTOR STICK



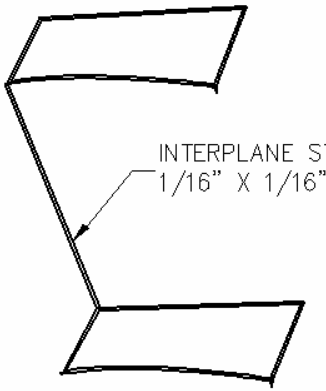

## TAIL BOOM

# DOUBLE TROUBLE




## ASSEMBLED VIEW

SCALE: 3/4" = 1"




ASSEMBLED VIEW OF TIP PLATES

## COMPONENT WEIGHTS

| | |
|---|---|
| FUSE | 2.15 |
| BOOM | .65 |
| STAB AND POSTS | .80 |
| PROP | 1.88 |
| WING POSTS AND INTERPLANE STRUTS | .65 |
| TOP WING | .80 |
| BOTTOM WING | .90 |
| BALLAST | .17 |
| | 8.00 |

## RECORD FLIGHT

6/4/2005
USIC – FIRST PLACE
JOHNSON CITY, TN
.075" 5/99 X 2.0G
9:23

# DOUBLE TROUBLE

BY CHRIS GOINS

2005 "C" DIVISION MODEL
FOR SCIENCE OLYMPIAD

FIRST PLACE 2005 USIC
WITH 2 GRAM MOTOR
TIME = 9:23

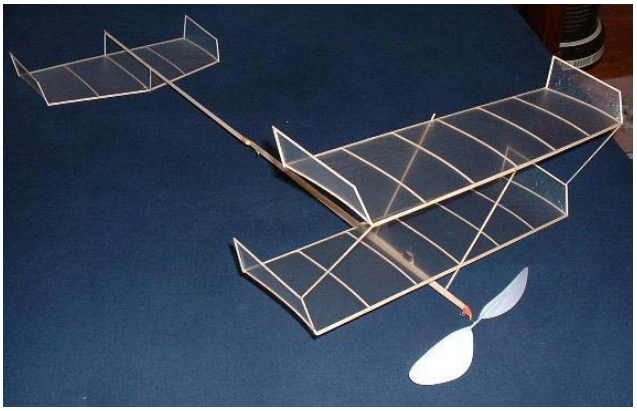
FIRST PLACE 2005
POSTAL CONTEST
TIME = 5:41 (25'-6" SITE)

UNLIMITED RUBBER RECORD
LAKEHURST HANGAR 1
7/04/2005
TIME = 10:24

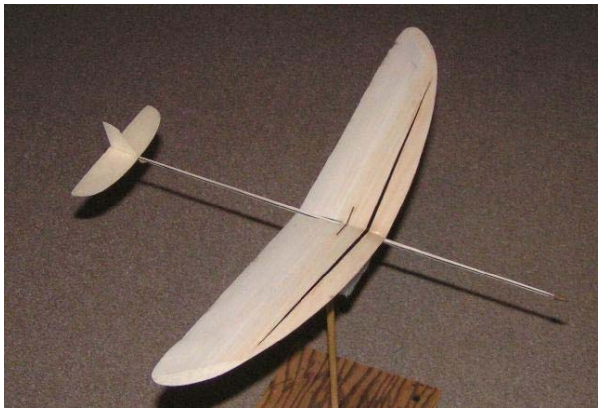
Modifying the Ikara prop is perhaps the most time consuming part of the build. Starting with one of Harlan's SO props, the blades are reduced in thickness by sanding the underside with 400 grit sandpaper wrapped around a soda can. I hold the blade cupped in my hand, with my fingers controlling where the pressure is applied. You must work slowly to keep the blade from deforming too much. Matching the blades in weight is important, but matching their flare characteristics is essential. The spar is blended into the surrounding blade, and the hub area is lightened. The blade shape is easily changed with a pair of scissors, but it's best to do this after sanding is complete. The pitch is reduced and the distribution is checked. After all that sanding, it will probably be pretty far off. The plastic can be persuaded into the correct shape with your hands if this is the case. I put a bit more camber in the blades and several degrees of washout in the tips, knowing that both would nearly disappear at full flare.

Flying this airplane is a dream. Flying speed is in the Pennyplane range, maybe slower. I expected the biplane to be more difficult to trim, but this proved not to be the case. The first time out of the box, it broke 5 minutes in my local gym. About a week later, I pulled a 5:41 to win Don's postal contest. The plane was rebuilt for USIC with a stronger fuse and bottom wing. I thought the model would be flyable without the interplane struts, but they were definitely needed at high launch torque. I spent the first day chasing the model around the floor as first one wing would tuck, and then the other. For the second day I put the struts back on, and it was back to being a well behaved airplane. After a few partial motor tests, I made my official flights. The first two were on .078" 7/02, with times of 6:30 and 7:30. I switched to 5/99 and dropped the size a few thousandths. The third flight was 8:30, followed by the 9:23, right under the rafters. I broke the motor winding for my final official flight. The plane sat in the box until I went to Lakehurst over the July 4th holiday weekend, and it sat there while I struggled with my F1D's. I have to admit that I didn't do ten minutes there - Steve Richman, Brett Sanborn, and Matt Chalker did, though. I sat and laughed while Matt wound the motor, Steven launched, and Brett steered. Or was it the other way around? Anyway, the last flight of the day was made on 3.3g of .095 7/02, and ended up being a 10:24. Not too bad for an 8g airplane!

## Chris Goins Models



**Double Trouble**
9:23 on 2 gram motor!



**Micro-Poker**
Cat 1 Open UCLG Record Holder
90.5 sec 2 flight total