INDOOR PROP CARVING

Prop information from Flightplug for SCIF August 2001. Mike Myers, editor

JOHN MORRILL / NORM FURUTANI JULY 1, 2001

John Morrill and Norm Furutani put on a seminar on prop carving—trying to increase the knowledge of the Southern California rubber power community. The notes from their Sunday seminar are attached.

Thank you John. Thank you Norm.

INDOOR RUBBER PROPELLERS FOR SCALE AND SPORT MODELS

The propeller and motor together are an important combination for rubber model duration. You should put thought into what will work best for your model's best duration at a particular flying site's ceiling height. If you are fortunate enough to have a very high ceiling, 100 feet, getting good duration is a whole lot easier. Most of us, if we are lucky, get a local basketball gym, with a ceiling of about 25 feet. As you can guess hitting the ceiling shortens the flight considerably! Not to mention the damage it can cause a scale model.

A high wing loading (heavy model) will require a different propeller than a low wing loading (light model). Of course a low wing loading is preferable for a longer duration and every effort should be made to build every part of the model as light as possible. This is true for the propeller too. After all the wing has to lift it's weight also. You say, "Yes, but, I will need the nose weight anyhow." The question you should really be asking is, "Why is the tail end of the airplane so heavy?" Well, there is a lot to be said on the subject of weight but we better get back to our subject.

PLASTIC VS CARVED OR FORMED WOOD PROPS

1. Plastic props are very heavy. Since the weight of the model (wing loading) is directly proportional to the duration of the flight it pays to have as low a wing loading as possible. Measured in pounds per cubic foot. Styrene Plastic 66 Ibs/cubicfoot. Pine 22 Ibs/cubicfoot. Balsa 6 to 12 Ibs/cubicfoot. For any given propeller the same prop carved from Pine will be about one half the weight of plastic, or less depending on how thin you make the blades. Plastic can be formed very thin and this makes the prop more efficient. Carve your blades very thin. When carved from balsa the weight will easily be one fourth the weight of plastic.

2. Plastic props come in a limited number of sizes. There is a pretty good selection of diameters, not much selection of blade area, and no selection of pitch (pitch / diameter ratio). Carved wood props may be made in any diameter, blade area, blade shape, and pitch, (P/D Ratio). For low ceilings you need a prop that will take a long time to unwind. Low RPM and a high enough pitch to slow down that climb. Plastic props are not usually a good choice for this. When you make your own props you can experiment to get the best combination of diameter, pitch, and blade area for the best duration for a particular airplane / motor combination. You may be able to double the duration!

GUIDELINES FOR CHOOSING DIAMETER, PITCH AND BLADE WIDTH

Before we can decide what size wood block we need we need to make determinations of what prop will probably work best on our model.

DETERMINING A DIAMETER

Determine the wing area of your model. Use the Sq. Root function on your calculator to determine the sq. root of the wing area. Then multiply by one of the multipliers listed below. That is all there is to it! {This is better than using a percentage of the wing span.)

SUGGESTED MULTIPLIERS

Indoor Competition Models: 1.4 times the sq. root of the wing area; Indoor Sport Models: 1.1 to 1.4; Indoor Scale Models: not less than .75 to 1.00.

A few words about scale models. Use as large a multiplier as possible, as diameter is a good thing to have. Landing gear length is usually the limiting factor here. It is really fun to watch them take off. Plus the ceiling is four feet higher than when you hand launch. Also too large a diameter looks wrong. I try for .85 to .95 as multipliers for my models. Now that we have a diameter we can determine blade width.

BLADE WIDTH (MAXIMUM CHORD) The general rule here is: As the above diameter multiplier gets smaller, the diameter is less. To make up for the loss in diameter we increase the blade chord (width). This helps in keeping prop efficiency, but is not as good as a larger diameter. The most efficient props are the ones for competition models. To get a workable blade chord use one of the blade width factors times the diameter listed below.

BLADE CHORD (WIDTH) FACTORS: Indoor Competition: .08 to .09 times the diameter. Indoor Scale: .15 to .20 times the diameter.

PITCH / DIAMETER RATIO

Pitch is usually expressed as a ratio or proportion to diameter. Through the years many flights have shown a P/D of 1.33 to 1 makes the most efficient rubber model propeller. However for a particular model a different P/D may be better. Most competition indoor models use a P/D of around 2 to 1. This helps to lessen the climb rate to add to the duration. Indoor sport and scale models have much higher wing loadings and require a different P/D Ratio. I have found a P/D Ratio of 1.5 to 1.7 to work well. For higher wing loadings or high drag airplanes (biplanes) may require a P/D of 1.3 to do well. Lower than 1.3 usually produces too much climb.

So, to determine the pitch you wish to try, multiply the diameter you have chosen by the P/D Ratio. Example: 7" Diameter X P/D 1.5 = 10.5" pitch. Now that you have some basic understanding of what is needed go to the following table to figure out the carving block dimensions.

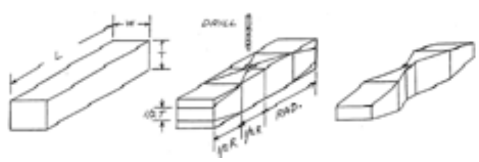
HOW TO USE THE TABLE

You have already decided on the diameter, blade width and P/D you are going to try. Now go to the table above and get the basic block dimensions.

P/D	Width Factor	Thickness Factor	Notes	Blade Angle @R/2
1.00	.846	.629	Most Plastics	32.17
1.05	.834	.660	Earl Stahl	33.44
1.10	.822	.692		34.68
1.20	.798	.775		37.04
1.30	.774	.818		39.28
1.33	.767	.836	Best All Round	39.90
1.40	.751	.880		41.35
1.50	.728	.943	Indoor Scale/Sport	43.32
1.60	.705	1.006		45.17
1.70	.683	1.069	High Ceiling	46.91
1.80	.662	1.132	Indoor Duration/sport	48.54
1.90	.642	1.194		50.05
2.00	.622	1.258	Low Ceiling	51.52

1. Diameter is: length of the block.
2. Width is: chord X width factor of desired P/D
3. Block thickness is: Width X thickness factor of desired P/D EXAMPLE: Given - Diameter= 7", Blade chord= 15% of diameter (7 X .15= 1.050), P/D 1.5 1. Block length is 7" 2. Block width is .728 X 1.05= .764, (rounded to 3/4") 3. Block thickness is .764 X .943= .721, (23/32")

WHY DOES THE PROP BLANK LOOK LIKE IT DOES?
A rotating propeller, to be effective at screwing it's way through the air, must have all the blade chord sections from near the hub out to the tip move forward the same distance in one propeller revolution. Since the speed of rotation varies from zero at the center of the hub to maximum speed at the tip the blade angle has to twist from steep near the hub to less steep at the tip. The pitch you have chosen will determine these angles. This very attractive angle twist along the blade is known as "the helical pitch distribution", and is essential to an efficient propeller. The beauty of the initial block lay out and shaping is that it provides helical pitch automatically as you carve. There are several block shapings that do this. We are only going to deal with the historically most used one. This block is called a "modified X blank".



PROP BLOCK LAYOUT
1. Cut your blank to size. Make sure all sides are square to each other.

2. Mark out the center line and then the 1/2 radius lines. Use an accurate straight edge, small square or right triangle to mark your lines. Make your measurements carefully.

3. Lay out the X lines. Note the 2 parallel lines at the hub.

4. Lay out the tip taper (1/2T). The next step is to drill the hole for the prop shaft. Make sure your drill press table is set square to the drill bit fore and aft. This hole must be square to the block so both blades have the same pitch and track evenly. The last step to prepare the blank for carving is to remove the wood according to the mark out lines. Follow the sketches. This operation is easily done using a jig saw and sanding block to smooth the saw cut edges. Note: Some drawings show reducing the hub thickness before carving, if you do this your pitch distribution will be incorrect.

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