Build a Simple Pitch Gage

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You may want to experiment with a different pitch for your propeller. Also, your propeller may have slightly different pitches in the two blades. To set the pitch and be sure both blades are the same, you need a pitch gage. There are commercial gages available, but the one shown here is simple, accurate and quick to build.

Before getting into construction, let's look at the design theory. There is a simple formula for figuring the pitch at any point along its radius:

$$\frac{P}{2\pi R} = \tan A$$

where P is pitch, R is the radius where you are measuring pitch and A is the angle between the blade and the plane that the propeller rotates in (perpendicular to the prop shaft). For example, if you measure an angle of 40 degrees (tan = .839) at a radius of 10 cm, the pitch is 52.7 cm. The idea behind this formula is that every place on the blade tries to go the same distance forward in each revolution; that is, the pitch is the same for every section of the blade. There are a lot of little issues ignored in this simple theory, but nothing that would dramatically affect the performance of our indoor models.

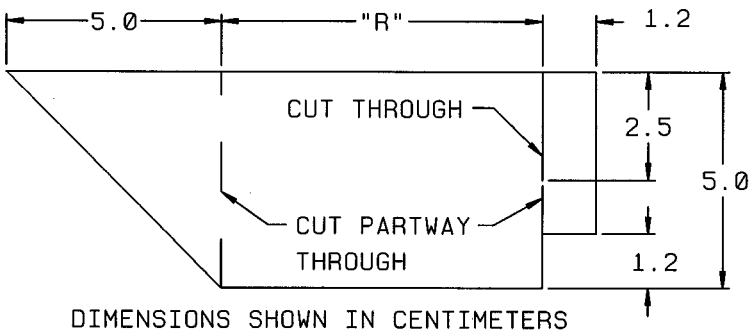
With indoor models, we usually talk about the pitch/diameter ratio. Ratios of 1.5 to 2.2 are typical. If all we want is to check a prop for this ratio, we just need to measure it at one point. If we measure where the blade should be 45 degrees, tan A = 1, and we can solve for the radius for this measurement. The following table gives the radii for several P/D ratios for both 24 cm and 18.5 cm props. R is given in centimeters.

24 cm props		18.5 cm props	
P/D	R	P/D	R
1.5	5.7	1.5	4.4
1.6	6.1	1.6	4.7
1.7	6.5	1.7	5.0
1.8	6.9	1.8	5.3
1.9	7.3	1.9	5.6
2.0	7.6	2.0	5.9
2.1	8.0	2.1	6.2
2.2	8.4	2.2	6.5

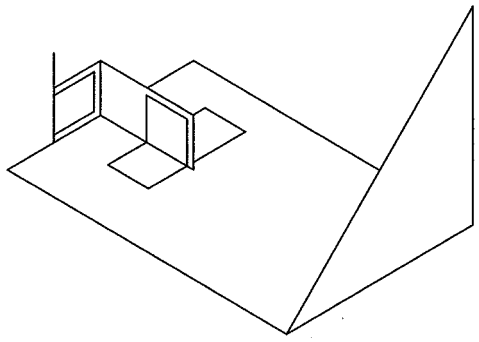
The picture below shows the layout for the pitch gage, which is made from thin cardboard (back of a pad of paper). The dimension "R" is the radius from the table above. Just choose the P/D ratio and then carefully draw the pattern on the cardboard.

There are two important points. Be sure all edges, except the angled one, are parallel or perpendicular, being very careful that, when cutting out the notch at the bottom right, the

horizontal side is exactly parallel to the bottom edge. Where it says cut partway through, just cut about halfway through the cardboard.



After it is cut out, bend the left and right panels down until they are square with the center panel. Turn it over and bend the cut-through portion of the right panel over onto the center panel. Tape it in place as shown in the picture below. Also tape the little square that you cut out to the back corner of the angled panel to keep it square to the center panel. This is hidden in the picture. Finally, tape a 2 cm long piece of .020-inch music wire (from a hobby shop) to the front edge of the vertical panel as shown. Be sure it is tight against the edge.



To use the gage, tape it to a flat surface, such as a counter top, or glue it to a flat board. Place the prop on the wire and swing the blade over to touch the angled panel. Do not push hard on the prop; it will distort the blade. If the gage is on a board, you can add a little piece of masking tape to the blade to weight it and tilt the gage so the wire is nearly horizontal. The blade should drop onto the angle. If both the leading and trailing edges touch the angle, the pitch is set correctly. If not, the hub needs some twisting.

Hold the short square section of the hub with two pairs of needle-nose pliers; one close to the round section and one near the blade. The best pliers to use have narrow tips and smooth, non-serrated jaws. Twist a little and then recheck the pitch. The hub can be twisted a lot without breaking, but you should not have to go to extremes. Once one blade is set, do the other.

Choosing the right P/D might seem difficult, but for Wright Stuff models, something near 2.0 is a good start. This will need fairly wide rubber and shorter loops, but the RPM will be lower and the prop will be more efficient. If you have trouble making the model climb on the widest rubber you have, make another gage with a lower P/D and retwist the prop to lower pitch. As with all Science Olympiad events, a lot of practice will pay huge dividends in performance at the Championships.