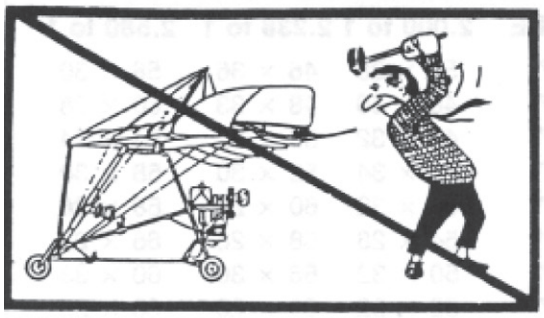

The Proper Care and Feeding of the Rotax Motor — Part 6

Delivering the Power — A Buyer's Guide for Selecting a Propeller

Few experts will dispute the fact that the propeller is likely the most misunderstood and controversial link in any powerplant. Yet, with an overall knowledge of what's available, the choice of the proper blade not only becomes less complex, but in many cases can be quite obvious. Let's take a close look at a few things to consider when selecting a prop, and then get into what's available.

Durability: Possibly the most important thing to consider is the operating conditions and possible hazards that may be encountered in the field. A puller or tractor prop mounted on the front of the aircraft is likely to take less debris than a pusher prop installation. The wheels can kick up rocks, grass, and water from the ground where a rear-mounted prop will be ready to suck up this stuff. If your ground clearance is low, this will obviously be more of a problem. It also depends on where you plan on operating from. If you like to blast out of your buddy's backyard weed patch, shoot landings on dirt roads, or just generally don't worry about the surface you run on, your prop is going to take a beating. Sandy beaches, and morning dew on the grass, are just a couple of the less conspicuous, but still deadly enemies of a prop.

Wood props are poor choices for float plane operations. A bucket of water thrown into a prop at full rpm, and any wood prop will literally explode into toothpicks! Steel leading edge props and epoxy leading edge props can handle a light spray of water, but are still going to blow with a good shot of water.

Composite props are usually a much better choice for severe applications than hardwood props. If you operate regularly off a paved airstrip, then a hardwood prop can be economical and still offer years of service.

Price and Availability: Price-wise, hardwood props generally range from 25 percent to 40 percent cheaper than a composite blade prop on most applications. Hardwood props also can be cut in most any diameter and pitch on short notice, where composite blades come in limited diameters due to the extremely expensive injection molding set-up tooling required to produce them. The vast majority of aircraft manufacturers supply their new aircraft with hardwood props. Cost, I am sure, is the major reason, leaving the extra expense of composite or adjustable-pitch props up to the judgment of the owner.

2, 3 Or 4 Blades?: This question many times invokes thoughts of, or arguments for, more power out of the same powerplant. People who claim increases of power by changing to a prop with more blades are generally finding out that the previous blade was simply not absorbing the engine's torque properly to start with. Remember that a 3-blade prop will run at 1/3 the pitch of an equal diameter 2-blade. A 4-blade will run approximately 1/4 the bite of a similar 2-blade, and is less likely to create more lift and less turbulence than a blade at a high angle of attack. Recall your basic lift versus angle of attack drawings. These drawings usually show a large amount of turbulence behind a wing at a high angle of attack. This turbulence will eventually lead to a stalled wing or loss of lift if the angle becomes too great. This can be minimized by more blades at a lower angle. These theories will be more obvious as you venture farther and farther away from the recommendations of the prop's manufacturer. Anyone with a sound knowledge of air props should also be quick to tell you that nobody has come up with the perfect solution. While some people have done more extensive testing than others, anybody who tells you he has the "perfect" equation for your application is being confident to the point of arrogance. His next statement may have something to do with blasphemy or divine providence, so beware. Prop theory is just that—theory. *Smooth absorption of engine torque is the best argument for adding more blades.* The points of balance on a 3- or 4-blade are spread out, so a smoother operating prop is easier to attain. This smoothness will more likely show up more consistently, in less vibration and a smoother sounding aircraft. This advantage is often offset by more initial expense and more grief when you do something stupid and break it.

Hardwood Props: Birch or maple are the most common material used for wood props. They are of very similar hardness and are generally considered interchangeable, depending on cost and availability. The plys or laminations can vary in number and thickness. The idea behind multiple plys is consistency of grain strength. If the wood has knots or other imperfections, the surrounding plys will compensate for, and make for a more consistent bending strength.

GSC Systems, Ltd. of Canada, uses an Eastern rock maple 3/4- inch x 3 ply construction. The advantage of this thicker ply material is that possible faults in the wood are easier to spot during the milling process as opposed to the 1/8-inch ply material used by other prop makers. At the same time, the grain of the wood must be cleaner to achieve the same consistency of the 1/8-inch ply material. The bottom line is that both are equally desirable material for the job, and should perform with similar results.

Ritz Propellers uses a multiple 1/8-inch thick birch ply construction. Mike Loehle of Loehle Aviation uses a dark waterproof glue that makes for dark lines, showing the laminations. Mike claims these "topographical map" type lines make the finish milling easier to contour. The cut of the prop will vary, of course, depending on the prop maker.

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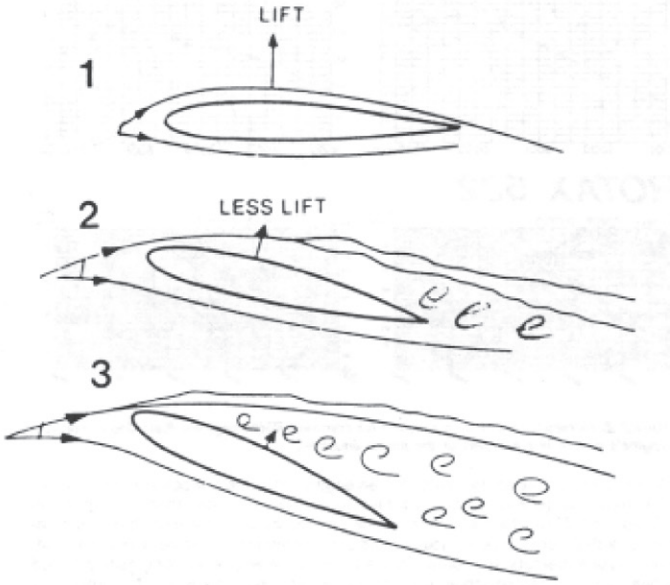
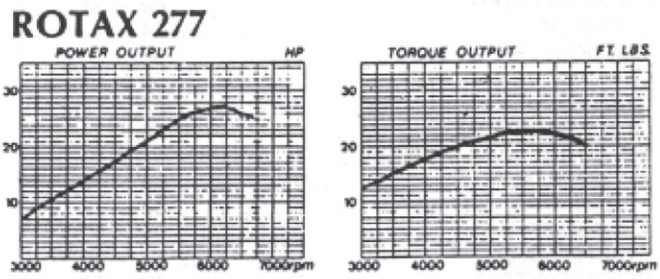
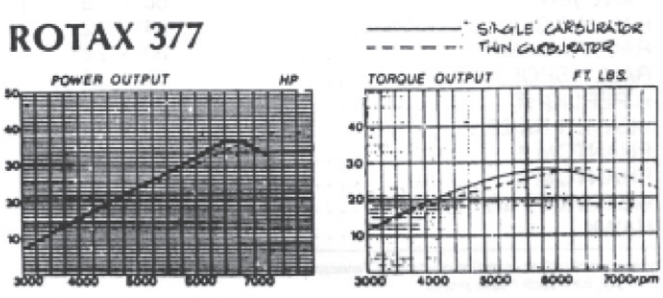


FIGURE 1. A prop in motion can be compared to a wing airfoil. The greater the angle of attack, the more turbulence left in its wake. Two-blade props pass the same point in rotation at longer intervals, allowing the turbulence to settle as compared to 3- or 4-blade props. Multiple blade props run at a lower angle of attack, creating less turbulence and more lift—a typical aircraft compromise and good food for thought.

The thing to remember here is, the prop must load the engine properly. A light load and the engine can over-rev. This will cause both a loss of power and piston damage. See *Figure 2* for the horsepower curves and torque curves of the popular Rotax engine. Notice the power loss when the rpm nears 7,000 rpm.





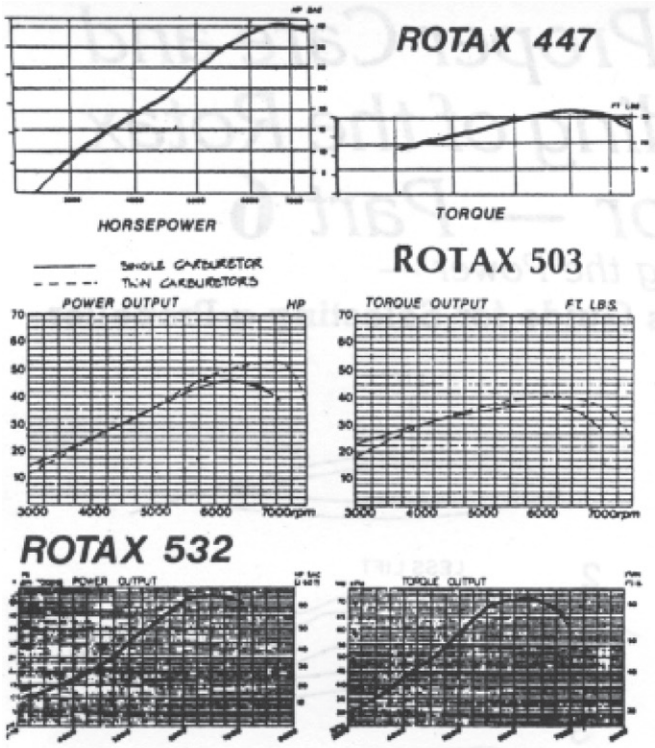


FIGURE 2. Horsepower and torque curves for common Rotax engines. Matching a prop to the engine's output is a key part of the power equation.

It is also important not to "overprop" an engine. Note the low power outputs under 4,000 rpm. It is quite common for a prop to be more of a load than an engine can pull "up the hill" to where a 2-cycle engine's power starts to come on. It is also common for a slight drop in power, due to loss of compression or weather change, to suddenly cause a dramatic rpm drop. This is because the engine was originally propped so heavily that it can no longer get into the power band. This is why it is important to rely on the propmaker's recommendations and experience when choosing a prop. If he is familiar with your powerplant, his props are cut with these factors in mind. Yet, at the same time, it is important to note that all powerplants will vary slightly in output even if they are identical. The propmaker should not be held responsible for this, and usually will not guarantee his recommendations for obvious reasons. *Figure 3* shows some common powerplants and prop combinations.

ULTRALIGHT	PROPELLER
COBRA	54 × 30
J-3 KITTEN	60 × 28
J-4 SPORTSTER	60 × 28
CHINOOK	54 × 32
QUICKSILVER GT	60 × 28
QUICKSILVER MX	52 × 32
QUICKSILVER MXL	52 × 32
QUICKSILVER MX II	52 × 34
FP-101	54 × 27
FP-202 KOALA	60 × 28
FP-303	60 × 28
ASCENDER II+	54 × 27
DRIFTER DR277	60 × 28
DRIFTER XT503	60 × 32
FLIGHTSTAR	58 × 27
COYOTE	60 × 28
PANTHER	60 × 28
RALLY 2-B	54 × 32
RALLY CHAMP	60 × 28
RALLY SPORT	60 × 28
HIPERLIGHT	60 × 28
BEAVER RX-28	60 × 28
PHANTOM 1	58 × 22
PHANTOM 2	68 × 34
WEEDHOPPER	44 × 19
HAWK	60 × 28

Common applications, supplied courtesy of Tennessee Propellers, Inc., makers of high-quality 1/8-inch ply, hard rock maple props.

ENGINE	2.000 to 1	2.238 to 1	2.580 to 1
277	50 × 28	46 × 36	58 × 30
277	48 × 30	48 × 33	60 × 28
277	45 × 32	50 × 32	64 × 24
277	43 × 34	52 × 30	58 × 30
377	52 × 32	60 × 26	68 × 26
377	54 × 28	58 × 28	66 × 28
377	50 × 32	56 × 30	60 × 33
447	52 × 32	60 × 28	68 × 28
447	54 × 30	58 × 30	60 × 38
447	50 × 34	54 × 34	66 × 32
503	52 × 34	60 × 30	68 × 31
503	54 × 32	58 × 32	66 × 29
503 D/C	50 × 36	62 × 28	68 × 32
503 D/C	56 × 31	56 × 34	60 × 32/3
532	60 × 36	68 × 32	68 × 36
532	64 × 32	64 × 36	72 × 32
532	66 × 30	62 × 38	66 × 32/3
532	60 × 38	60 × 40	60 × 38/3

NOTES: -/3 Following propeller sizes indicates 3 blade prop.

-Pitch is measured 75% from hub.

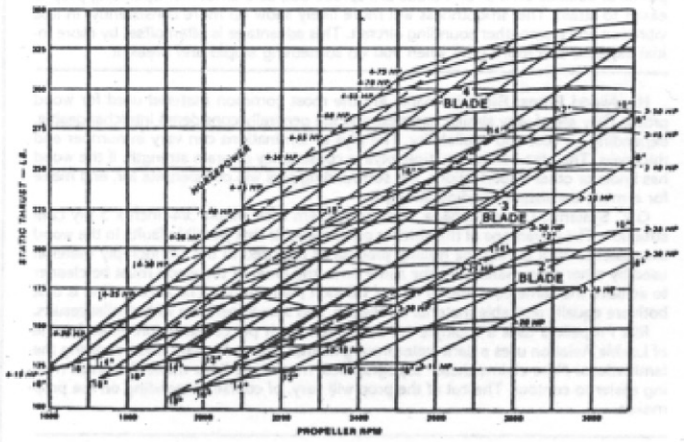
The above recommendations supplied courtesy of **CGS Systems LTD** of Canada.

FIGURE 3. Common prop combinations on Rotax powerplants.

Adjustable-Blade Props: Ground-adjustable pitch props are ideal for people who have an experiment powerplant application, or just like the flexibility they offer. While they are quite a bit more expensive than fixed-pitch hardwood props, they can be adjusted to match these powerplants more precisely. There are three major types of adjustable props on the market:

Ultraprop: Made by Competition Aircraft Inc., the Ultraprop uses a thermo plastic nylon of 43 percent fiberglass and 57 percent nylon #612 for the blades. This injection molded material is well-suited to handle water spray, sand, and so on. With minimal wear, this prop is ideal for float plane and airboat type applications. Ultraprops come in 2-, 3- and 4-blade configurations. The maximum blade length is 59 inches. This length can be reduced by simply cutting the blades shorter with a fine tooth saw or hacksaw. While this may seem a questionable idea, the blades are equipped with molded scribe lines every 1/2 inch. To make this easy and fairly precise, the blades can be weighted and matched for balance. The Ultraprop uses pitch blocks to vary the pitch of each blade. These blocks vary from 8 to 18 degrees, and are available every 1 degree in between. This bolt-together design offers a lot of flexibility. *Figure 4* shows a chart obtained from dynamometer tests. While at first glance they may seem confusing, there is a wealth of information illustrated for anyone who takes the time to understand these two charts.

Chart "A" — for 59" Ultra-Props



Ivoprop: This recently released design is a unique combination of the injection molded blades (75 percent fiberglass, 25 percent epoxy) found in the Ultraprop, and the rotating socket pitch-adjustment design used by Precision Propellers. The composite blade handles the abuse nicely while being infinitely adjustable like the Precision Propeller design. Currently, only a 60-inch diameter, right-hand rotation is available. A 60-inch left-hand, as well as a larger 68-inch diameter should be available soon. Again, remember that tooling costs for injection molding can be astronomical, and often are the limiting factors in composite prop variety.

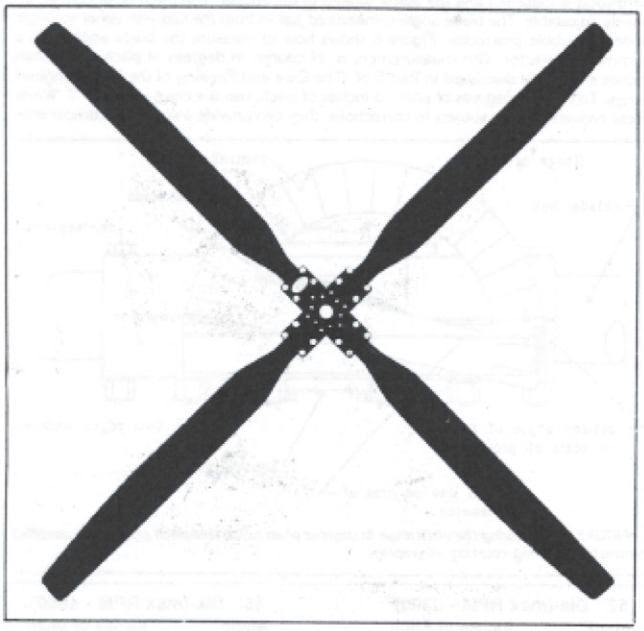


FIGURE 10. Ivdprops are available in 60-inch diameters of 2-, 3- or 4-blade configurations.

ROTAX	277	377	447	503	532
2 BLADE	9°	11°	14°	16°	
4 BLADE		8°	9°	10°	13°
60 inches diameter			1:2.58 geardrive		

FIGURE 11. Shows recommended pitch settings for the Ivoprop when run on a 2.58-to-1 gear box.

The Ivoprop comes in 2-, 3- or 4-blade configurations. The 1- inch center hole is surrounded by a 6-bolt, 75mm diameter, 14- inch bolt pattern for Rotax gear boxes. Only the center hub is made of 50 percent epoxy, and plenty beefy to handle the higher horsepower engines. Price-wise, this prop is right in line with the competition, and should provide a good combination of both durability and versatility. *Figure 10* shows the clean lines of a 4-blade Ivoprop. *Figure 11* is a chart showing the common settings found to be right for the Ivoprop on Rotax powerplants with a 2.58 gear box.

An interesting note about the designer, Ivo Zdarsky. He became world famous by escaping from Czechoslovakia in a homemade ultralight trike several years ago. This guy is not only resourceful, but makes a nice prop too. Chances are, Ivoprops will be a common sight on Rotax powerplants in the future.

Mike Stratman is a contributing editor for Ultralight Flying! magazine, and a factory-authorized and trained Rotax mechanic. Mike is also owner of California Power Systems, a full line ultralight aircraft parts and service supplier.