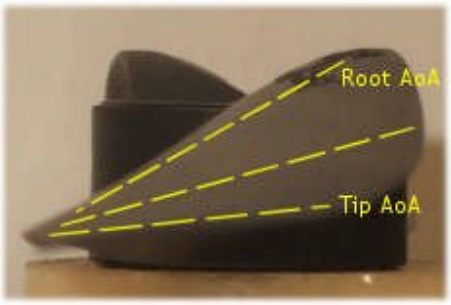
Understanding RC propeller size

The subject of RC propeller size selection can be a bit of a minefield, but hopefully this page will show you some generally accepted guidelines and recommendations for choosing the right prop.
It goes without saying that selecting the correct propeller size for your rc airplane is very important if you want to get the optimum performance from your glow engine/electric motor and plane.
In the worst case scenario, the wrong prop can cause serious damage to components and this is especially true for electric powered rc airplanes.
The first and foremost plan of attack is to follow the **engine/motor manufacturer's recommendations** for the engine or motor that you have. The manufacturer of the plane might also give a recommended prop size, but it's more common for the recommendation to come with the engine or motor.

Understanding RC plane propellers

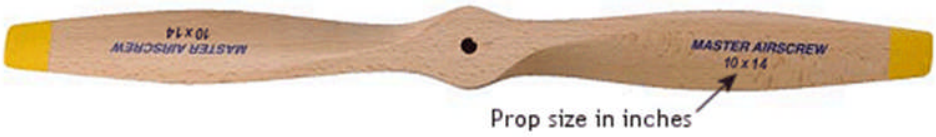
You'd be forgiven for just seeing your airplane's prop as the thing at the front of the plane that spins round very fast, but understanding a bit about how propellers work is no bad thing.
Propellers for rc airplanes are nothing more than vertically mounted rotating wings. Their job is to convert the engine power in to **thrust**, to pull/push the plane through the air. Thrust is generated in exactly the same way as lift is generated by the wing, and that's why props have a profile airfoil section.



The 'twist' in the propeller is there to create the essential Angle of Attack of each blade, just like a wing has an AoA. The twist is greater towards the hub of the prop because of varying airspeeds along the length of the blades, and hence varying thrust generation.
This difference occurs because the tips of the prop blades move faster than inner portions of the blades, so the AoA has to change accordingly along the length of the blades.
The picture to the right approximately illustrates how the Angle of Attack varies along the blade length.

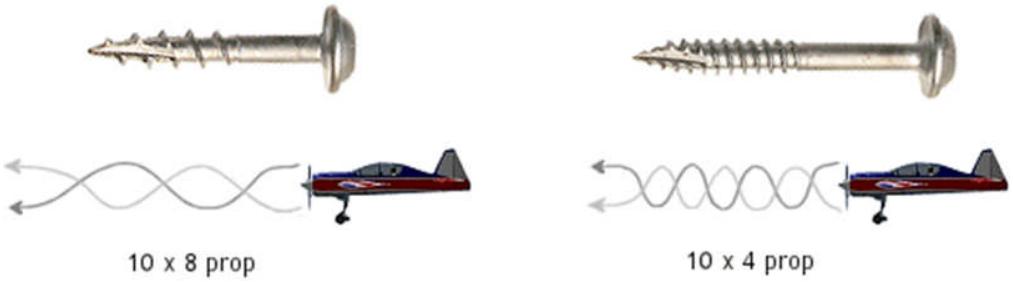
Prop size labelling

All rc propellers are designated two measurements, both given in **inches**...



The first number is the **diameter** of the imaginary disc ('arc') created by the spinning prop *i.e.* the length of prop from tip to tip. The second number is the**pitch** and this is the harder of the two to understand - but we'll give it a go...
The pitch measurement of a prop indicates how far that propeller will move through the air per single revolution of the engine (*i.e.* every single complete turn of the prop). However, the pitch measurement of your prop must only be taken as a guideline because real-life factors come in to play to influence this

distance *eg* the material of the prop, its condition, efficiency, air density on the day etc.etc...
So, pitch measurement is really only a *theoretical* value but it is good enough to help you choose the right size propeller for your airplane and your needs.
Essentially, the higher the pitch, the faster your plane will go. One way to understand it is to imagine the gauge of two different screw threads, coarse and fine, and picture both being screwed in to a piece of wood at the same speed. The screw with the coarse thread will cut in to the wood a lot faster than the fine threaded screw will.
It's the same for propellers 'cutting' through the air (hence the reason why propellers are sometimes called *airscrews*).
In the illustration below, the two arrow lines represent the path of each propeller tip. You can see that the higher pitch prop (*eg* 10x8) takes only one and a half turns to cover the same distance that the lower pitch prop (*eg*10x4) takes 3 turns to. So, with both engines and props spinning at identical RPM, the higher pitch prop will travel further in the same amount of time - hence a faster flying plane.

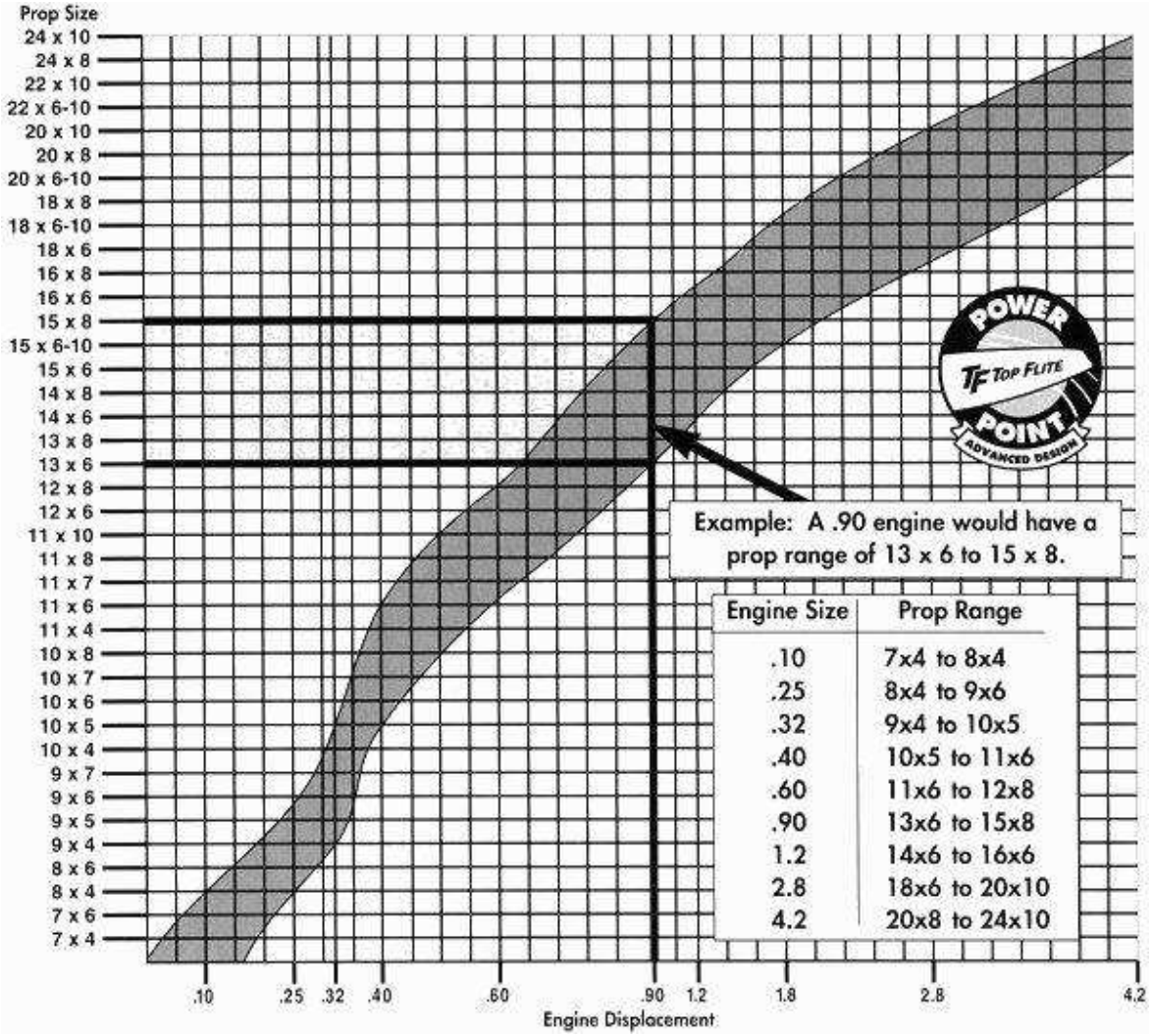


So you can see that selecting a different propeller pitch size is going to significantly change your airplane's performance, with speed being the primary factor.

The **diameter** of the propeller (10" in the example above) will also effect how the airplane flies, but also how the engine runs and, again, following your engine manufacturer's recommendations is the place to start.
Roughly speaking, diameter influences the amount of thrust generated but an ever-increasing and non-performance related issue these days, linked to prop diameter, is that of **noise**.
A faster turning propeller (and props can easily turn in excess of 10,000 RPM) generates a lot of noise as the tips cut through the air. In fact, when you hear an rc airplane flying it's more than likely the propeller that you're hearing more than the engine.
So a larger diameter prop *reduces* the engine's RPM at any given power setting, because there is more for the engine to turn over and hence more work to do. And slower turning props generate less noise - therefore, larger diameter props run quieter than smaller diameter props, all else being equal.

IC propeller size recommendations

As already mentioned, following the propeller size recommendations made by your engine manufacturer should always be your first point of reference. But there *are* generally recognised prop size ranges for each engine size and these are the sizes to choose if you're unsure about propeller selection.
The following **propeller size chart** (© *Top Flight*, reproduced with permission) is easy to use; select your engine displacement along the bottom scale, then follow the vertical line up to the shaded area to give the prop size range for that engine.



Although this chart is related to Top Flight's *Power Point* range of props, the size ranges suit all brands.

EP propeller sizes

It's no secret that matching a prop to an IC engine is fairly straightforward if you follow the general size recommendations outlined in the above chart, which have long been accepted in the hobby. Fitting an incorrect prop would mean the engine would still run, but your plane would perform poorly.
But with the advent of electric power (EP), propeller selection became a whole new minefield!
EP prop selection is much more critical because different combinations of motors, ESCs and battery packs can generate huge differences in operating speeds and loads.

As with IC, electric motor manufacturers give a specific propeller size range for their motors but it's more critical that the range must be adhered to. Under-propping or over-propping can do irreversible damage to electric motors and ESCs, because an incorrect propeller will force the motor to work harder than it was designed to.
If you put an oversize prop on an IC engine, the engine will likely stall. No harm done. Put an oversize prop on an electric motor and the motor won't stall, it'll just keep on trying to turn the prop.
The motor will draw more and more current, to keep turning the prop, and eventually it will exceed its max amperage rating and will burn out. Or the ESC maximum rating might be exceeded as the motor tries to draw more current, and so that burns out.

With too small a propeller, the motor can exceed its RPM rating and damage can result from the motor spinning too fast.

Out of the two, a propeller size that's too large can do the most damage, and very quickly. If the prop is too big then the motor will just keep drawing more current to try and cope with the extra load, until something goes bang!
The *only* accurate way to know whether or not your EP propeller is resulting in the correct current draw through the ESC and motor is to use a **Watt meter** connected between battery pack and ESC.

Number of propeller blades

The majority of propellers used in the radio control flying hobby have two blades but props with three or even four blades are available.
Two-bladed propellers are commonly used because they are relatively efficient and easy and cheap to produce but sometimes an rc airplane will call for more blades, particularly where a scale look is required.

Adding more blades decreases the overall efficiency of the prop because each blade has to cut through more turbulent air from the preceding blade - in fact a single bladed propeller is the most efficient but these are rarely (almost never!) seen in our hobby although they have been experimented with. Incidentally a single bladed prop has to be balanced with a counterweight on the other side of the hub to the blade, otherwise the plane would shake itself to pieces as soon as the prop was turning!

If choosing a three or four bladed propeller the general rule of thumb is to decrease the prop diameter by an inch and increase the pitch by an inch, but on some models fuselage and ground clearance issues might dictate which propeller size you can and can't have on the model. As with everything, trial and error...

Well hopefully this page has given you an understanding of propellers used on rc airplanes, and an idea of how to select the right size propeller for your model. Remember to follow your engine/motor manufacturer recommendations whenever you can!