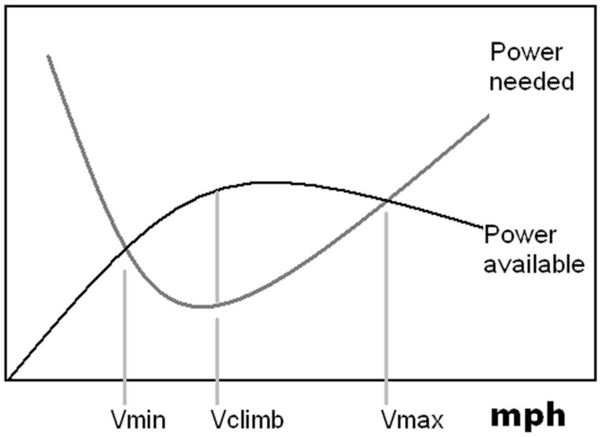
Rotor RPM

- on the 'back of the power curve'

From a suggestion by our patron,
Wing Commander Ken Wallis

Powerful autogyros, with a good power-to-weight ratio, can climb amazingly well. Most can be kept in the air on the 'back' of the power curve…..

Power available in this context is defined as thrust times speed – the rate of doing work.



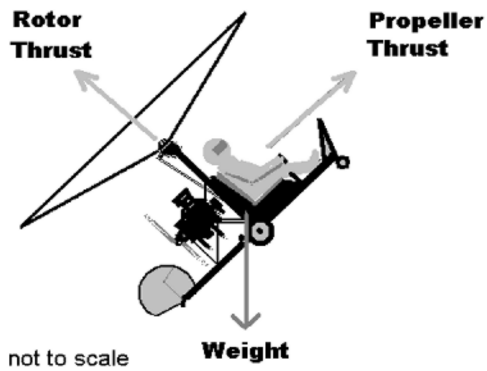
Vmin is the minimum speed for level flight, *Vclimb* is the speed at which most excess power is available for climbing, and *Vmax* is the maximum speed in level flight. All gyros exhibit a similar curve, but the actual speeds vary with power, load, and density altitude amongst many variables.

Most pilots are aware of dangers inherent in flying on the 'back' of the curve (below *Vclimb*). Finding oneself in a position where the speed reaches *Vmin*, and the gyro starts to sink.

This is easy to do because our machines exhibit a degree of speed stability in normal flight. If for any reason a gyro at fixed power speeds up in level flight, it will normally climb slightly, and then slows down to near the original speed. Equally, if it slows down in flight for any reason, it will sink slightly, and increase speed again. This is what happens above *Vclimb*. Below *Vclimb*, the **opposite** happens. The gyro that slows down for any reason finds less excess power available, and slows down some more - Negative speed stability.

This is a no-win situation, since at maximum power there is no more power to call on, and the aircraft must now sink to the ground unless its attitude is altered and we dive for more speed. To do this it will need enough altitude in reserve. An instructor will have told PPLs of this during training (or will be telling them eventually). It's something nearly all powered flyers need to learn, since it applies to fixed wings too. Nothing new here.

But something else is happening at reduced speed, when still at full throttle. The attitude of our aircraft is changing. It has to pitch up in order to fly slow, or else climb. Gyros therefore adopt nose-high attitudes at low speed and high power, whether climbing or 'on the back of the power curve'. I have seen angles approaching 45 degrees, and the aircraft can seem to be 'sitting on the prop'. Let's look at what that does…..



If we assume that rotor thrust is roughly at right angles to prop thrust, we can see that at 45 degrees half the weight is taken by the prop, and the other half by the rotor, since the weight bisects the angle between them. This is not healthy in a gyro! Rotor loading is what defines the working rotor RPM, and halving the load reduces the RRPM by nearly 30%, since RRPM is proportional to the square root of blade loading.

Could this be a source of PPO? A steep climb, near to or even on the back of the power curve, and a loss of rotor integrity due to reduced RRPM at full thrust?

How much RRPM can your rotor stand to lose? That 30% reduction seems a lot, would you maybe attempt a take off at that RPM?

Discussion invited…

Flymo