Pete, James and everyone else on our Matronics list,

Short Answer:

Personally, we are getting worked up over nothing here for most of the Europa owners and it may bring up concern that the well maintained engine/prop combo are causing harmonic issues. We know it is not an issue for most of us. For those who wish to rebuild their engine, modify existing engines, produce or use auto converted engines, these are informational and thought-provoking conversations on gearboxes and engines. Let's face it, Eggenfeller is still modifying his gearboxes on all his engines (Honda and others). **But for an established aircraft with aviation engine/props that dealers recommend, these conversations are not productive except with your feet up and having a beer.**

I agree, that geared engines do have harmonic issues if operated outside the prescribed and tested manufacturers limitations. Where are those limits? In the operator's manual. Fly within the prop curve limits and the Rotax 9 series with any reputable prop will perform properly. If an engine manufacturer has no performance limitations, stay away from that engine as testing is incomplete.

There are no issues with flying the Airmaster, Whirlwind, MT, Hoffman, Woodcomp (properly maintained), on the Rotax 9 series engines. Fixed pitch props made by reputable companies (the non flexible kind) have no issues either (fixed pitch Warp Drive, Whirlwind, Sensenich, Woodcomp have no issues, but Kiev and some other thin flexible props are potentially a longevity problem.) Unlike the long stroke, over bored Lycoming 0-360/390 these engines have bore, stroke, and compression issues which do in fact cause unfavorable harmonics so some combinations of particular props and engine dash numbers to have restricted operation envelopes. The Rotax does not. Rotax does have recommended RPM/MP settings for various power settings and charts giving adequate information on operating envelopes.

Long answer for those bored or snowbound:

As for Rotax operational limits:

Most Europa Owners fly with the Airmaster Constant Speed propeller on the 914 and frankly from 4000 to 5800 RPM there are no issues from 20-40 inches of manifold pressure at a constant airspeed. In other words, there are no engine/gearbox/prop harmonic problems which will occur but you can lug the engine down and cause issues. Go back in the archives and look at our conversations on engine vibration. If you have vibration, follow those techniques to repair your prop balance, suspension or carb issues. I have found that the properly carb balanced Rotax engine with a properly static balanced prop and then a proper dynamic balance is all we need to have a smooth running Rotax. Many get by with a simple static balance but a dynamic balance is always a good idea.

In flight using a portable dynamic balancer (such as a Dynavibe) has been used in flight and found to be a better balance as the Europa bounces around quite a bit on a ground run making the dynamic balance results rather chaotic. Many times, I have had to limit the RPM in the ground dynamic balance to 4000 RPM to make it flyable.

Back to power and RPM settings.

From your Rotax Operators Manual:
For the 914:

Run the engine in accordance with the following table.

Power setting	Engine speed (rpm)	Perfor-mance (kW)/(HP)		Torque (Nm) (ft.lb.)		Manifold press. (in.HG)	Throttle position (%)
Take-off power	5800	84.5	115	139	102 ft.lb	39	115,0
max. con-tinuous power	5500	73.5	100	128	93 ft.lb	35	100,0
75 %	5000	55.1	74	105	77 ft.lb	31	approx. 67
65 %	4800	47.8	64	95	70 ft.lb	29	approx. 64
55 %	4300	40.4	54	90	66 ft.lb	28	approx. 59

For the 912S:

Engine Power-Setting	Engine speed [rpm]	Performance [kW]	Torque [Nm]	Manifold pres. [in.HG]
Take-off perform.	5800	59,6	98,1	full throttle
cruising power	5500	58,0	100,7	full throttle
75%	5000	43,5	83,1	27,2
65%	4800	37,7	75,0	26,5
55%	4300	31,9	70,8	26,3

My Notes:
Who flies at only those power settings. Most of us, but not always.
You can fly a Rotax 9 series at any power setting and RPM up to 5500 (remember the 5 minute limit above 5500) at virtually any throttle/MP setting but listen to the engine for clues on how you are operating.

Downwind airspeed is 4000 RPM and 20-24 inches depending on aircraft weight trigear or mono. Trigear is higher than a clean mono. That is about 25-30 Horsepower. Note in stabilized flight the prop is loaded so the gearbox does not clatter because the prop is pulling. You can loiter forever.

In flight where are the gearbox rattle areas?
Any throttle settings (power) that allow the prop to unload to where the prop begins to windmill. Also, any power setting or throttle above that prop line RPM in the operations charts as you are lugging the engine, in other words the prop is demanding more power due to excessive pitch for the manifold pressure (throttle setting) you have set.

First: Pull your headphones off or turn off the ANR and listen to the engine and prop. Pete and Area 51 and many others know what I mean. Frankly everyone should listen to their airplane, it will talk to you.

If you descend rapidly with no regard to the sound of the engine **you are doing it wrong**. At 140-160 KTS with about ½ throttle, even with a constant speed prop, the prop is being turned by the airspeed windmilling the prop (RPM increases as speed increases and decreases as speed is reduced is your visual clue) and once you begin to slow down, you will hit an area where the forward speed puts the prop at zero thrust, where the prop can't decide whether it is windmilling or pulling. A vibration or clatter is heard or felt. The noise of the prop changes also. Get out of that range by pulling off more throttle or adding power and pulling the nose up to slow down. This action of pulling off the power more to force the prop out of the windmilling speed, or reducing the speed and keeping the power up enough to keep the prop pulling is common to most aircraft, even direct drive engine such as the Lycoming.

It isn't that hard, but it does require listening and understanding that there is slop in the gears (which you should note on every preflight) hence it is intuitively obvious to the most casual of observers that there will be areas where if I am flying at a particular airspeed and note that the airspeed is driving the engine RPM more than the throttle, the gearbox will rattle once the two power/airspeeds become equal, therefore one should think ahead. Once you slow down, you need to pull the power or that 50% throttle you have in there will go through a speed where the unloaded prop will almost go to a loaded prop (i.e. the engine will be driving the prop rather than the wind or equal to it). LEARN FROM IT.

When I and many other salesmen fly with customers, we are in tune to the demonstrator aircraft/engine/and prop, and we move the throttle as soon as we hear the prop start to windmill. Yes, you can hear it. That way the potential customer never feels this. We're not lying or sprinkling fair dust on the issue, we just understand and avoid the clack. Once the buyer closes the deal, we demonstrate that area.

Second: Regarding Heavy Props.
There are no REPUTABLE prop manufacturers that recommend props that DO NOT meet the rotational inertia requirements of the engine manufacturer. There are of course some buyers who believe that the longer the prop the faster and insist on too large of a prop for the engine. WRONG! See my paper on selecting the right prop for your Rotax powered aircraft. The inertia limit for the Airmaster with the wide chord Warp Drive blades is 67-67.5 inches. Lighter blades and hubs can be longer in blade length but the Rotax won't turn it and actually the plane will slow down. At 75 inches the Rotax powered aircraft won't exceed 95-100 Knots.

Third issue: What about over pitch or lugging the engine, can I hurt the engine?
Car analogy, it is like starting out in 4th gear. Can you do it, yes, but listen to the engine lug and the clutch slip. (Your mechanic will love you for making his car payment.) Or perhaps trying to pass in 6th gear with the pedal to the floor without downshifting the gearbox. My favorite is pulling a trailer where at full throttle in 4th gear it is causing the engine and car to vibrate, knock, and rattle as it is trying to pull the load and accelerate.

If you fly routinely at RPMs (prop pitch settings) with manifold pressures that are higher than the prop curve (recommended settings) you are potentially lugging the Rotax engine. The throttle plate is open trying to hold the RPM, the engine is running richer trying to produce the power needed and your plugs are fowling. Worse, is the engine may begin detonating (aka ping) due to the fixed ignition, low fuel octane rating or similar issue.

This lugging can be heard in the aircraft also. The prop at a higher pitch than optimum for the airspeed is stalling part of the prop. You can hear it thrashing, the engine begins to sound different. Rather than

normal, like a sewing machine, it is making a deeper hum and some minor vibration can be felt in the calf muscles of the legs. Note that the carbureted engines which have fixed timing, detonation is a possibility if operating with low octane fuel in these conditions. As an example, I have to do this particular exercise in prop testing to check go around capability in high-speed aircraft (Europa, Fascination and similar) where I simulate a prop stuck in full coarse pitch and the pilot must execute a go around. The Rotax 9 Series will do this 4000 RPM full throttle drill using 100LL fuel, but it sounds like the description above. Does the engine take it, YES, does it like it, NO.

Bottom line, the Europa has a wide speed range so we can fly in areas where the prop may be driven rather than the engine driving the prop. This can cause the gearbox to rattle. Those who have too much prop pitch for the power setting (constant speed commanding lower RPM than the prop power curve in the manual) the engine is potentially lugging and you are wasting gas and running inefficiently at a minimum.

As a pilot and student of aviation learn your Manifold/RPM settings until you get experience.
In the 912 or 912S equipped with a fixed pitch prop, set the prop pitch to achieve 5200 static at full throttle. Go fly with reckless abandon without over speeding the engine in a dive. Note in a dive to pull the throttle or slow down to keep the gearbox from rattling or over speeding.

I do not recommend setting a fixed pitch prop to below 5000 RPM at full throttle static any longer. Those using lower octane auto fuel may find the engine begins to detonate in some conditions. (Note: for sales testing our cruise numbers were done at 4000 static and full throttle to get the top speed and 10,000 foot cruise speed numbers up. Not a good rule with auto fuel, but we didn't notice detonation using 100LL.) 5200 at full static power precludes these detonation issues, especially with MOGAS.

With a Constant Speed prop and a 912 or 912S Set Climb RPM (5500) nearly any throttle setting will do. Cruise at 5000 and above sea level just about any throttle setting won't lug the engine.
Personally, "Takeoff" setting and full throttle for takeoff, then once safely airborne, simply click or set 5500 for climb at full throttle, climb to altitude and click or set 5000 at full throttle and you will be fine as I've never seen a manifold pressure on the 912 series go above 26 inches in a Europa at full throttle above sea level. It is as close to a FADEC as one can get. Just slap the throttle up to full and click for the phase of flight.

The 914 power settings are not as simple but easy to remember.
These numbers are for efficiency and are not limitations:
Takeoff prop setting and full throttle (5700 RPM / 38-40"MP) until safely airborne.
Climb: Click or set 5500/34-35" (a 100% stop is really nice to have)
Cruise Normal click or cruise at 5000/31", for better milage 4800/28-29" is nice and comfortable and gas milage is about 30 MPG.
Loiter with the prop at 4300-4500 / 22-28"MP. You will be airborne forever. But going slow.
Downwind to landing, set prop to Climb or Takeoff, the prop will be stopped at the fine pitch limit, and normally you will be 4000 RPM / 20-22" or so at 1000 MSL.
No issues will occur at these settings and the engine runs superbly. Setting Manifold Pressures below the prop curve is not an issue in operating the 912 or 914 series.

Anytime you have a constant speed prop on a Rotax, set the fine pitch stop to limit full power max RPM to about 5650 RPM to prevent an overspeed due to rapid throttle advancement in an emergency go around. Set the coarse limit stop to about 4000 for the Europa static on the ground at full power. If you

have a 914 please install a 100% stop as you will reduce the potential for overspeed or lugging on a go around or touch and goes. Should you have a prop stuck at the coarse stop (4000 or so) the climb out at 100% or 115% is quite comfortable with no issues for short term operations. The engine operates fine up to the 100% stop limit in the 914 and even the 912S but you can tell it is lugging from the sound and vibration.

I prefer to have my clients keep their head in the books, know the recommended pitch and power settings for flight and the RPM/MP limits of the 914/912S. Running cheap gas and excessive pitch can cause detonation, avoid it. Keeping the plane light and simple increases speed and reduces wear and tear.

As far as changing the gearbox design, getting more power or speed by adding components and then doing reliability testing is fine, but my comment is changing the gearbox/fuel system/ignition may fix one thing but it will affect many others (like weight size and complexity). Not worth my time. For me, if the engine isn't broke, don't fix it. But performance increases is an interesting topic over a beer or two.

Have a happy and productive new year to all.
Bud Yerly