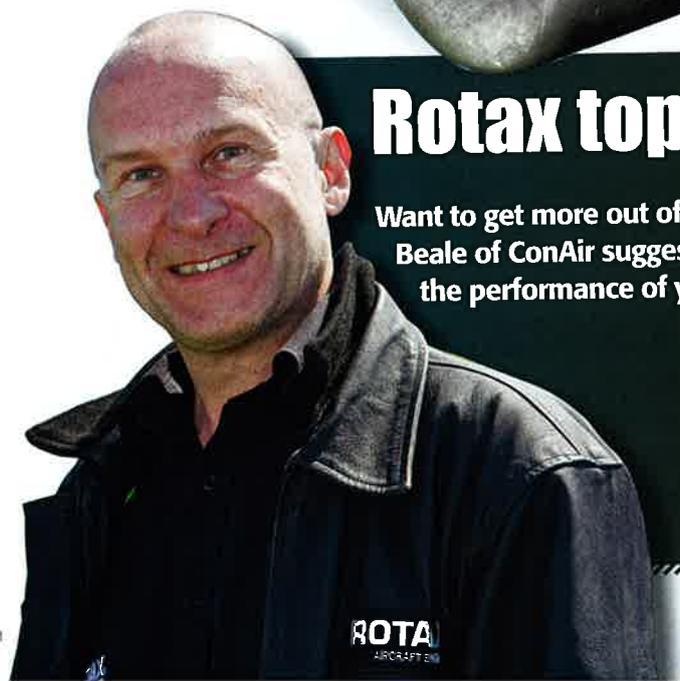


Rotax top tips

Want to get more out of your Rotax? Conrad Beale of ConAir suggests 12 ways to boost the performance of your Rotax

1 Balance carbs. Careful balancing of carbs at the normal maintenance intervals will reduce overall wear on your 912/914 engine and will make the use of your engine a much more pleasant experience. Balancing the carbs is not that difficult, but real care needs to be taken as it does involve running the engine with test equipment attached. To carry out the task some method of measuring the vacuum in each manifold is required. The carb mate is really good for this and gives good results (www.ekmpowershop2.com/ekmps/shops/conairsports/carbmate-455-c.asp). The aim is to get the same vacuum in each manifold throughout the range. The balancing of carbs is covered in our maintenance book



A paradigm shift

Ed Hicks celebrates the silver jubilee of one of the most popular engines in GA

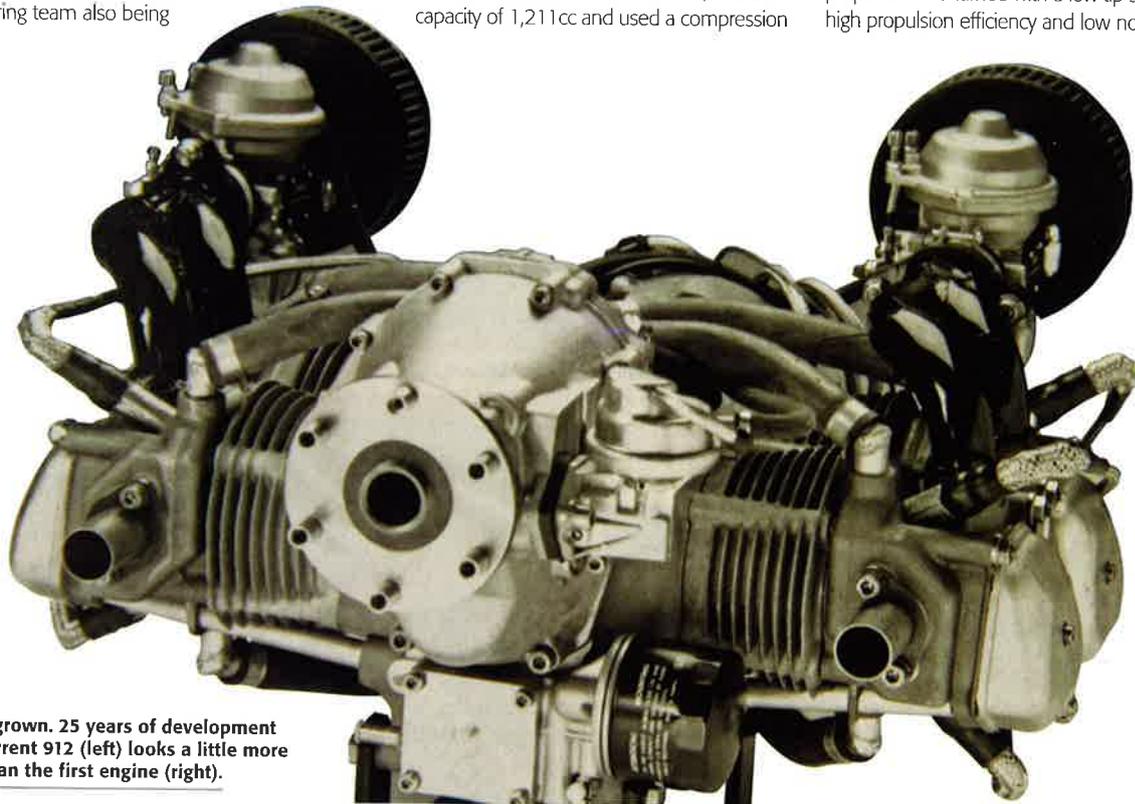
It was an aviation revolution and it happened in a quiet corner of Austria back in 1985. It was then that a company called Rotax decided to design an entirely new, small, aircraft engine, something completely different to those powerplants with large displacement air-cooled cylinders, a maximum power output at less than 3,000rpm and a direct-drive propeller. With a number of the members of the Rotax engineering team also being

pilots, it must be a testament to their resolve that they decided to throw conventions aside and instead come up with a paradigm shift in the light aircraft engine world.

Look at the result. Four air-cooled Nikasil cylinders, lightweight and hard-wearing, with liquid-cooled heads, that reduced the risk of shock-cooling and meant a higher compression ratio could be run without detonation, had a capacity of 1,211cc and used a compression

ratio of 9.1:1. Here was an engine that produced its power running at a relatively high but efficient 5,800rpm, and used a small 2.43:1 gearbox to reduce the shaft speed to a more conventional 2,400rpm for the propeller. In a world that was just beginning to think more about noise reduction, the small cubic capacity would prove easier to silence, while the gearbox would allow a large diameter propeller to be turned with a low tip-speed, giving high propulsion efficiency and low noise.

Turn to
page p42



My, how you grown. 25 years of development means the current 912 (left) looks a little more substantial than the first engine (right).

[www.conairsports.co.uk/
downloads/912%20maintenance%20
article.pdf](http://www.conairsports.co.uk/downloads/912%20maintenance%20article.pdf)

2 Always carefully prime the oil system.

The 912 is configured with a dry sump and a remote oil tank. After an oil change it is essential to prime the oil system correctly to ensure that there is oil in the crankshaft bearings. We have seen a few cases of engines extensively damaged by starting the engine without having been primed.

3 TBO. It's important to be aware of the TBO of your engine. The 912/914 TBO is now 2,000hr/15-years, but early 912 engines had as little as 600hr/10-years. A simple table in the Line Maintenance Manual Section 05-10-00

will tell you the TBO of an engine. Most engines run out of calendar life before the hours-based time, so make sure you get on flying it to make the most of your investment. Most Permit aircraft are allowed to run 'On Condition' and can operate well beyond TBO limits, so for most users the TBO might not be too much of a concern.

4 Rotax 912/914 engines prefer unleaded fuels. Rotax is happy for its engines to run on fuels with up to 10% ethanol, so most forecourt mogas fuels should be OK. Rotax engines will also run on leaded fuels and fuels like avgas 100LL are perfectly OK to use, however, due to the increased contaminants in the fuels, it is necessary to carry out some additional

maintenance. The oil needs changing at 50hr* intervals instead of 100*. The spark plugs need replacing at 100hr* intervals instead of 200* intervals. Gearboxes with slipper clutches need an additional check on the slipper clutch every 600hr (the normal intervals for maintenance on gearboxes with slipper clutches is 1,000hr for the 912S/ULS or 914F/UL but 2,000hr for 912A/F/UL). Note the gearbox 100hr friction torque inspection is required irrespective of the fuel type used.

**Note: there are also calendar inspections to do and owners should check the line maintenance manuals for the latest requirements.*

Don't be scared of mogas or avgas, just be aware of the limitations. Unleaded

Viewpoint – industry views of this classic engine

Francis Donaldson
Chief Engineer, Light Aircraft Association

THERE ARE SOME engines such as the Gipsy Major and Continental flat-fours that are so successful that they come to define a whole class of aircraft. One only has to examine today's legions of microlights and LSAs to see that the Rotax 912 series undoubtedly deserves to be placed amongst that elite group.

Without doubt, it was exactly the right engine at the right time. It appeared in the late 1980s just at the point where Rotax had developed a strong presence as a producer of two-stroke engines, which had helped create an energetic market for microlights and small sporting aircraft. The relatively slippery types beginning to emerge such as the Pulsar and Europa clearly demanded a powerplant with better reliability and longevity than a two-stroke could offer. These new generation, pocket-sized touring aircraft demanded a properly equipped panel, so they'd need an engine with a reasonable electrical output and the ability to mount a vacuum pump.

A lower fuel consumption would more than offset the higher initial cost and greater weight of a more sophisticated four-stroke power unit. With its flat-four configuration the 912 series even looked like an aero engine in miniature, appealing more to pilots of traditionally-engined craft than the in-line two-strokes with their pervading and somewhat poisonous reputation as snowmobile-derived screamers.

True, with its 5,500 max continuous rpm and a habit of starting and stopping with a horrible jerk, the 912 took a little time to penetrate the 'Ly-Continental' market, but even in the early 90s we were seeing the 912 not only as the almost universal choice among new kitplanes and microlights, it was also proving itself as a retrofit rescue package for types as diverse as the Hewland-engined ARV Super Two and Continental-powered Piper Vagabond of 1940s

vintage. In the UK, the perceived benefits of using the 912 series engine over existing two-strokes, was a strong factor in the raising of the two-seat microlight weight limit from 390 to 450kg.

Undoubtedly a major factor in the success of the 912 success is that unlike almost every other new engine type hitting the light aircraft market, it has had a superb reliability record from the very start. Without doubt this was testament not only to good basic design but also the benefits of coming from a major engine manufacturer with significant technical and financial resources, plus the customer support and local advice that has been available through the dealer network, ably led in the UK by Nigel Beale and his team at Skydrive.

Unusually amongst successful products, none of the alternative engines that have emerged to challenge the Rotax have copied the format of the 912, the designers knowing perhaps that they couldn't hope to compete with a similar product with such a well-established reputation. Considering how inevitable it seemed back in the early 90s that a modern aero engine would be a high-revving unit with a reduction drive to the prop, it seems curious now that the engines knocking on Rotax's door are direct drive units such as the Jabiru, UL Power and Sauer, and that the incredibly light and compact D-Motor has side valves that went out of fashion, so we thought, in the mid-1930s.

With the 912 series passing its quarter-century, it will be very interesting indeed to see whether its next aero engine carries on with the familiar format or emerges as a more radical development.

Bill Brooks
Technical Director, P&M Aviation

IN THE EARLY days of microlight flying, we were flying powered hang-gliders using converted chainsaw engines with a glass-fibre

gearbox reduction drive and centrifugal clutch. We happily flew these, regarding the powerplant as reliable as the thermals we usually required. An hour's flight without something seizing/cracking/falling off was an achievement! Later we progressed to the Fuji Robin and Rotax snowmobile engines with belt reduction drives of dubious longevity.

It was Rotax who saw the market opportunity and designed a proper aero engine gearbox reduction drive. These engines cleaned up the microlight market with reasonably priced and quite reliable two-strokes like the 447, 503 (air-cooled) and 462, 532 and 582 liquid-cooled engines.

We thought in the microlight world that when the Rotax 912 arrived it was far too powerful, expensive and heavy. Mainair sports had fitted one for an Italian customer; we at Pegasus followed suit thinking it would have limited appeal. In 1998, Brian Milton was the first to fly a microlight (Pegasus Quantum) around the world, including the Bering Strait (full of icebergs) and the Timor Sea (full of sharks). The 912 engine just kept on running.

Quite soon the instructors realised that, compared to the 582 two-stroke, the 912 would pay for itself in about 500 hours, because of its reduced fuel consumption and requirement for less maintenance. Then students would come in, learn to fly and also take up the four-stroke option. Within about 18 months we had sold 100 912-powered Pegasus Quantum, many of which are still being flown hard in training schools.

The only thing that irks is that, having built up the track record, the price seems to continually grow out of reach. Everyone is looking for the holy grail of everything a 912 delivers at half the price! Early Quiks had practically no depreciation because the engine price kept rising. It is now circa £10k. It's hard to make a profit on a £30k aircraft when the engine cost is a third of the aircraft purchase price.

avgas appears to be the best of both worlds for the 912/914.

5 Service that gearbox. Rotax supplies engines with an integral gearbox which may or may not have a slipper clutch, which acts as an overload protection device to protect the engine in the event of a prop strike. There are different maintenance intervals depending on the type of gearbox you have and there is a simple torque measurement to do every 100hr if you have a slipper clutch called friction torque.

Gearbox overhaul intervals vary depending on the engine model and gearbox configuration:
912 (80hp) with slipper clutch – TBO*
912S/ULS (100hp) with slipper clutch - 1,000hr*
914 (115hp) with slipper clutch - 1,000hr*
All 912/914 series without slipper clutch - 600hr

**Note: there is an additional inspection of the slipper clutch if using leaded fuels at 600hr intervals.*

6 Cool down. Take a bit of time, ideally several minutes, to allow the turbo on a 914 to cool down. A turbo has engine oil circulating through bearings and if adequate cooling-down time isn't allowed, oil will coke up in the turbo resulting in blocked oil galleries. With high power settings the turbo might glow red hot and cooling down for several minutes will help to reduce the chance of oil carbonising in the turbo.

7 Carb ice prevention. The 912/914 is a partly liquid-cooled engine and the abundance

of hot coolant is a really good source of energy for a carb heater. Skydrive produces a simple carb heater that presses onto the carburettor body and uses the waste energy for carb heat without any engine power loss.

8 Get that oil warm. A simple oil thermostat can help get the oil temperature up to the minimum of 50°C more quickly before take-off, and helps achieve a suitable oil temperature to boil moisture off. Thermostasis produces a great oil thermostat designed for the 912 series engines, which is available in the UK from ConAir Sports.

9 Flush out fuel lines. When carrying out the five-year rubber parts replacement,

Other innovative inclusions included dual capacitive discharge ignition, independent from the battery and alternator (which was built in on the crank), and operated by a rotor/stator arrangement behind the flywheel. The dry sump oil system used an ingeniously simple blow-by crankcase oil scavenge/breather, which saved the weight and cost of a scavenge pump, while fuelling was from twin Bing constant-velocity carburetors, something at the time more familiar on motorcycles.

Launched in 1989, the 60kg, 80hp engine offered a very respectable power-to-weight ratio of 1.66lb per hp. Flight testing would reveal a smooth, easy-to-operate engine that at 5,500rpm was sipping just 22 litres-per-hour of unleaded fuel, hitting one of the prime aims of the designers in the process. Thirty non-certified units would be delivered in the first year, with a Time Between

Overhaul (TBO) of 600 hours. It was a seemingly small number of hours to those pilots used to seeing figures like 1,800 or 2,400, but for Rotax this was a big leap, and was twice what its two-stroke engines were rated at.

A certificated model followed, the 912F, in 1994, fitted in the DA20 Katana from the newly-formed Diamond Aircraft Company. This introduced the flight training community to what the new Rotax had to offer.

Continual innovation

And the innovations kept coming. In 1993, a turbo was fitted to a 912 in an HK36 Super Dimona, allowing it reach an altitude of 33,000ft. Three years later that engine would join the product line-up as the Rotax 914. Boosting the capacity to 1,352cc and the compression ratio to 10.4:1 resulted in the 100hp 912S appearing in 1999.

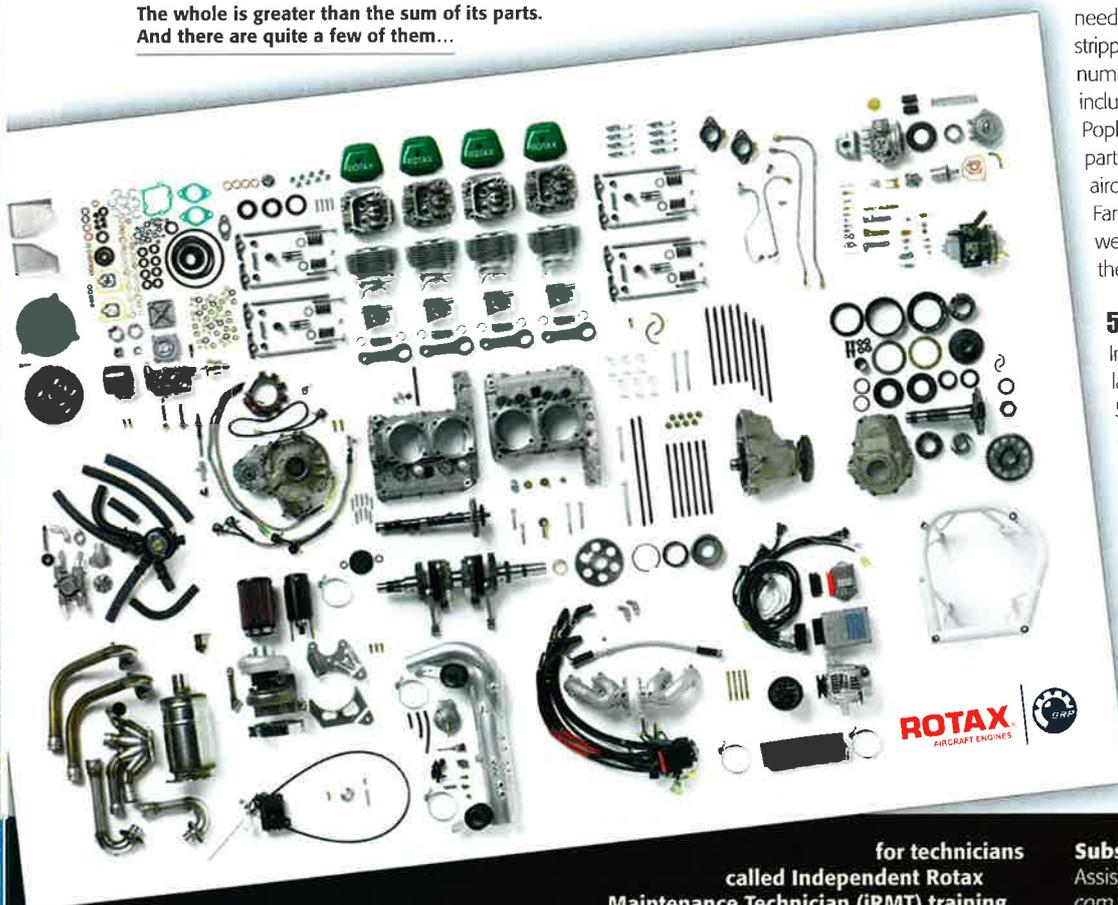
It would be a longer wait until the next significant change, when in 2012 Rotax announced the 912 iS. Power was still 100hp, but the big headline was dual-point fuel injection and a digital engine control unit that improved the engine's already meagre fuel consumption by 30%. The same engine was treated to a new metal airbox, tuned to reduce intake turbulence and some ECU reprogramming in April 2014. With more torque, Rotax branded this one the 912 iS Sport, although its introduction caused some debate, with a few remarks that it appeared to be a fix to the original 912 iS, where some had questioned why the range-topping unit had less torque than models further down the price list.

TBO has increased as in-service experience has grown. Since 2009, all Rotax 912 engines are supplied with a TBO of 2,000 hours. Confirming 912 engine longevity, Paul Dewhurst at Flylight Airports told **FLYER** about one 80hp 912UL on his fleet that's notched up 4,500 hours without needing any major bits or being completely stripped. Paul says it's just one example of a number of high-time 912 in the UK, with a few, including an 912 run by Airbourne Aviation at Popham, exceeding even that figure. In fact, that particular example, from a C42 flight school aircraft, has just been completely stripped by Farnborough University who are studying it for wear. Initial signs seem to indicate it's still within the factory tolerances.

50,000th engine

In the year the 912 celebrates 25 years since its launch, the first week of June will see the 50,000th engine from the 912 family being assembled on the GunsKirchen, Austria, production line. Five million flight hours will be added during 2014 to a 912 family total of 40 million hours; around the world, more than 200 aircraft manufacturers now use the 912. With an enormous GA market just awakening in China, the question is, will greater demand see prices reduced or will they just continue their steady climb? Perhaps the only problem with this gem of an engine is commanding prices that an upmarket jeweller would be proud of! ■

The whole is greater than the sum of its parts.
And there are quite a few of them...



always flush out fuel lines with fuel to wash out any debris that may have collected in the hoses.

10 Fit a fuel pressure gauge. This is probably one of the most important instruments after the oil pressure gauge. It can tell you all sorts of information about the health of your pump, it can warn of vapour-locking issues, it shows that a filter might be blocking and will even tell you if your vapour return nozzle is blocked.

11 Get trained. The best way to get the most out of your 912 is to get know how it works. Rotax has a training programme

for technicians called Independent Rotax Maintenance Technician (iRMT) training, offering five levels of training to accommodate those who just want to know how to carry out routine service to those who want to know how to overhaul engines. www.flyrotax.com/customer-service/Impressum/training.aspx

12 Online resources There are a number of online resources to help you understand and work on your Rotax engine. **Familiarise** yourself with the Rotax Aircraft engines website www.flyrotax.com Here you will find a whole host of useful information, such as maintenance manuals, service documents, data sheets, service bulletins, etc.

Subscribe to the independent Rotax Owner Assistance Network (ROAN) www.rotax-owner.com and watch the educational videos. This site is not the official Rotax site but contains a lot of useful information.

Download the free ConAir Sports maintenance article which puts servicing the 912 engine into layman's terms www.conairsports.co.uk/downloads/912%20maintenance%20article.pdf

Buying used engines can be a great way to get flying on a budget, but it can also be an expensive mistake. Before buying a used 912, check out the ConAir Sports guide on purchasing second-hand engines and minimise the chance of being caught out with costly mistakes. www.conairsports.co.uk/buyers%20guide.html