SAFETYSPOT

With Macolm McBride Airworthiness Engineer

PHOTO www.airteamimages.com

Practice Forced Landings (PFLs) are an essential skill for pilots.

Be prepared!

Looking around for a field to land in is second nature

I'VE had lots of engine failures. Having had the privilege of belonging to the generation that brought two-stroke engines into common use within the sports aviation community, I have indeed had lots of engine failures!

With my kind of flying history I've developed a sort of neurological condition, as yet un-named, with unusual symptoms. The first, but by no means the most important, is 'Windophillia'. An obsessional desire to know the wind direction and strength at all times, and a practiced ability to make allowances for local topography and height.

The second is 'head-out-of-window' syndrome, Sufferers are easily spotted among today's 'computer generated' pilots because, even though the off-the-shelf equipment on board will tell you where you are within a couple of feet, the afflicted will be found continually looking out of the cockpit window, looking for potential fields to land in.

I jest slightly, of course. I've managed to overcome most of the problems (that one over there looks long enough) as the smaller engines (no, crops too high) have become more reliable (what's that noise?).

I was chatting the other day with one of the LAA's more experienced Inspectors and he reminded me of the last pre take-off check that should be done, "What am I going to do if...

So, "Controls full and free, what am I going to do if the engine stops?"

"Err, well, how should I know? I can't see yet, I'm not airborne and I cannot see over the horizon."

Student thinks for a second, "Never turn back?" Instructor's eyes, almost imperceptibly, flicker upwards. "Come on then, get on with it."

Actually, the only time I have broken an aeroplane after an engine failure, and yes, I appreciate I am the luckiest man alive, is when the engine has failed just after take-off. The most important thing about both of these occasions, even though the aircraft were goners, is that I walked away.

Regular readers will know that I have banged on about engine failures in the cruise. Remember, the first rule, is, "Don't panic – keep flying the aeroplane." In an engine failure during take-off this rule applies equally – keep flying the aircraft until it comes to rest. It's amazing, and don't practice this please, how much steerage you have got even at fairly low speeds. I managed to miss the 'Nemesis' tree by fractions once. OK, the wing disappeared, well, actually, so did most of the aeroplane! Remember this very old rule, "It's much better to hit the ground flat at 100 knots than straight down at virtually no forward speed."

Unfortunately, you're in the lap of the gods, in the EFTO situation. It's definitely a worst case situation because there is not much you can do. Generally, more damage will be caused by going too slow than too fast.

I remember performing a perfect EFTO in an old Cessna tailwheel from about 250ft when, just rolling to a stop, the mainwheels disappeared into a ditch and the aircraft flipped over onto its back. This was just God reminding me that if it can, it will!

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Low level flip

A PFL led to a real forced landing

CROPS caused the low level flip in the Kitfox owned and operated by LAA member Andrew Smith when his engine 'gave up the ghost' climbing away from a practice force landing one balmy June evening. Andy takes up the story:

"While cruising at an altitude of 2000ft, I decided to carry out a PFL (Practice Forced Landing) and informed Humberside Radar of this intention. I cut the throttle and made a successful PFL, the engine was warmed three times during the descent to prevent cooling damage.

On the climb out from the PFL, at a height of 400ft, I entered a climbing turn to the right to allow the aircraft to gain height prior to over flying a very large area of mature woodland.

At a height of approximately 700ft the engine suddenly, and without warning, began to run very roughly and the engine revs became erratic (surging severely), severe banging could be heard. It was no longer providing enough power to maintain level flight."

Andy went on to tell me that he made a 'text book' approach and landing, even to the extent of calling Air Traffic Control which, I confess, I've never had the presence of mind to do! The only field available to Andy was full of standing crops and (bad luck mate) the resulting inverted aircraft can be seen in Andy's photo. Actually the aircraft wasn't that badly damaged so, well done Andy.

Looks bad, but the aircraft wasn't too badly damaged. Flip caused by standing crops, not the actual landing.

Andy went on to explain that he regularly does PFLs in his Kitfox, a habit that seems to have paid off when the event happened for real. Andy informed the AAIB which, in this case was legally necessary as there was damage to the aircraft but, fortunately, neither he nor his passenger, his father, were injured. So, what caused the engine malfunction?

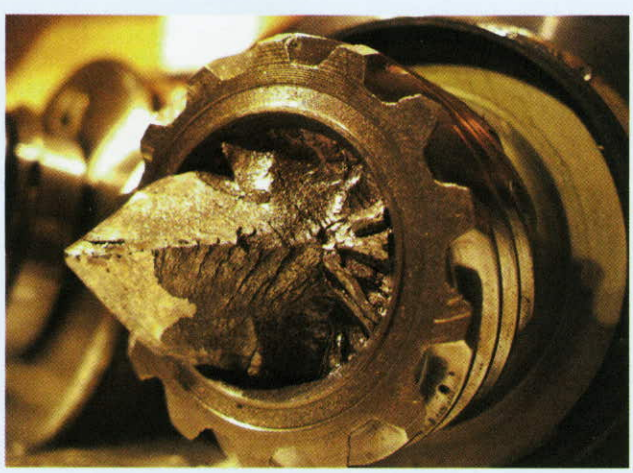
'At 700ft the engine suddenly began to run roughly, not providing enough power'

Take a look at the excellent picture supplied by Andy after he had stripped the engine.

First impressions – yes, I know, it's broken – note the multiple failure initiations, especially the radial fracture faces at the periphery of the shaft. These are sometimes known as ratchet marks and are formed during the torsional failure of material under relatively low stress (remember it's a big lump of quality steel!) but with high stress concentrations.

The high total stress at the exterior, caused by stress concentrations built in due to the crankshaft's lightweight assembly, are common during failures caused by rotational bending. It might be that this is an example of reversed, sometimes called 'two-way', bending, where the two faces of the (and I will quote Francis Donaldson here) 'Mount Eiger' section actually separates two fatigue zones.

Please feel free to write to me if you have specialist knowledge in fracture analysis. I would be most happy to hear any of your comments.



Broken crankshaft from Andy Smith's Kitfox engine.

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Crankshaftaphobia!

If the service schedule says change the crank at 300 hours, do you?

ROTAX has known about the problem with its two-stroke crankshafts for many years and has given this part a life of 300 hours. Experience has shown that there are many crankshafts operating in the field with many more hours than this, in some cases over a thousand hours have been recorded on the Rotax 582.

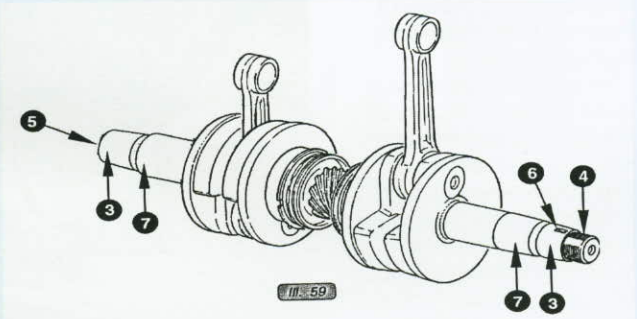
I spoke to both Nigel and Conrad Beale, who have both lived through (and to some extent managed) the evolution of these engines. A crankshaft change would cost about a thousand pounds – three or four quid an hour. In their view (but they might be afflicted by the fairly rare condition 'Crankshaftaphobia') 300 hours is the major service interval of these engines and the crankshaft has to be replaced.

The concept that an engine, or engine component, should be allowed to run beyond the manufacturer's recommended overhaul period is reasonably well established. Experience gained in service has shown that, provided the engineer is able to assess the condition of an engine by prescribed inspections carried out at defined intervals, engine life can be considerably increased.

It should be noted here that this was never intended to allow a situation where engine life should be defined as 'time to failure'.

Also, and this point is particularly pertinent, the rules have been made with regard to many thousand of hours of experience on engines which were built to entirely different specifications. To my knowledge, no in-depth investigative work has been done to extend the TBO of any aircraft two-stroke power unit.

The crankshaft in Andy Smith's accident had completed about 400 hours. There had been some early history of engine over-revving during initial flight tests and it had not been fitted with the Hydro-Damper, an optional device designed to smooth out the torsional crankshaft loads.



Pressed crankshaft as fitted to two-stroke Rotax engines.

Also, there is a maximum inertia limit for the earlier type gearboxes, and there is a possibility that it was running a bit outside this. Perhaps, bearing in mind all these factors, running the engine over TBO, ie 'on-condition', was not the correct decision.

The Rotax crankshaft is an assembly – the individual components are pressed together, hence the stress raisers. It is not a serviceable item as far as Rotax are concerned and it will not supply big end pins etc. As with all types of cracking, corrosion can play a significant part as, among other things, it can cause microscopic 'stress raisers', so watch out if your engine is not used very often.

Nigel recommends that regular monitoring of the big end wear should be made – big end wear significantly reduces crankshaft fatigue life for obvious reasons. For this purpose he produces a clever test kit that goes by the name of CCBCT (Cyclone Conrod Bearing Clearance Tester).

Engine failure... almost

The PFL that got away (thank goodness)

SURELY there cannot be an LAAer who doesn't lust after the Midget Mustang. We've got Jez Cook's freshly repainted example based here at Turweston and it sends a shiver down my spine every time I see her climb away. Keep practicing the saxophone, McBride, you never know!

I have just received a telephone call from another Midget Mustang aficionado, Phil Jackson. He called me with this precautionary tale as I was writing Safety Spot so I thought I would share it with you straight away. Phil takes up the story:

"Planned flight from Headcorn to Redhill (Phil is a member of the Tiger Club). Departed Headcorn, and routed north of Maidstone and Sevenoaks at 2000ft. RPM started to fall and engine did not respond to full throttle. Fuel pressure dropped to nearly zero. Height rapidly lost and speed fell from cruise (200mph) to 120mph. Mags checked, hot-air selected and alternative fuel source selected on tank – no change to RPM.

"Plane positioned north of Ide Hill/Toys Hill for an emergency landing in fields. At approximately 200ft, flaps deployed and electric fuel pump switched on, small increase in fuel pressure noted and RPM partially restored. Flaps closed, climb initiated and plane turned back south-east and rapid climb initiated to 2500ft. Engine producing nearly full power but surging and banging. Routed direct to Headcorn and landed without further incident.

"After shut down I could see fuel dripping from the engine cowl. I removed the top cowling and I found the fuel line from the gascolator to the mechanical fuel pump was loose and leaking. After tightening this line the fuel leak was stopped and the engine ran-up normally."

Phil explained the aircraft had flown about 11 hours ➡

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since the Permit Renewal inspection and the gascolator bowl had been taken to bits for the usual filter inspection/clean. To gain easier access the fuel line had been disconnected at the bowl and, yes, you've guessed it, it wasn't done up correctly during reassembly.

Phil suggests it would be a good idea to mark all these fittings, when tightened, with torque seal. I'm not so sure. Remember, every nut/bolt/fitting/attachment/assembly or part is essential on an aircraft, particularly on a sports aircraft where there is almost never any 'redundancy' built-in to the design. So, every fitting needs to be checked, then checked, then checked again. I speak with some experience here, but the tale will have to wait for another time, "it is not a good idea to have fuel spraying around an engine compartment."

A fuel line is as safety critical as a spar bolt. We've had a few cases recently where bolts and fittings have not been done up correctly, remember the various propeller incidents. It's good workshop practice to tag a 'half-finished' job, why not leave a note in the cockpit?

Midget Mustang of Phil Jackson, which suffered an engine problem in-flight.

WHEN IT GOES WRONG

It always comes as a surprise when something goes wrong during a flight. After all, most of the time everything works as it should and, even with the best intentions, it's easy to get complacent.

Ask yourself this question, 'when did I last perform a practice field landing?' Be honest with yourself, 'are my emergency drills up to the mark? When did I really consider the 'dark side'? What would I do if...'

Phil's example above is a good case; because he was under a lot of stress his point of focus changed, time itself appears to change during an airborne emergency and there is a tendency to rush things a little. I have discussed these matters before in other articles but, at the risk of sounding like a broken record, I have the following view.

It is natural to panic a bit when something horrible happens, so accept this panic for what it is, a normal reaction. Get over the panic and resort to practiced drills. Here is the rub, if you haven't practiced these you'll be in a bit of trouble. Phil did a good job, but he would have been better off thinking through the situation a bit longer. What Phil did was, when he got to the procedure line 'Establish the Cause' he decided that the mechanical fuel pump had failed – he wasn't far out was he?

Malc's drill: 1 Panic. 2 Sort your head out. 3 Get the aircraft flying, establish the wind, select a good area to land (if you cannot see anywhere, turn downwind) then, and only then, sort out what's going on.

Don't do it all in a blur of activity. Close the throttle, what's the effect? Carb heat, what's the effect? Electrical fuel pump, what's the effect? But remember during all this technical testing type stuff, concentrate on getting the aircraft down in one piece.

DOOR FAILURES

We received an AAIB report of a door coming off a Europa XS a little while ago which, and I am sure you can empathise, came as a bit of a shock to the two occupants. Luckily for this crew, the Europa has been shown to fly well with the 'doors off' and the aircraft remained in complete control; this is in contrast to other examples we've seen (remember the Long EzE crash).

I spoke with the captain of this machine, LAAer Ian Dole, to find out what had gone wrong. He explained:

"As you know the Europa has gull-wing doors, one for the pilot and one for the passenger. The doors are hinged at the top and are secured by front and rear latches at the bottom of the door. I cannot remember checking the rear latch on the passenger door. The passenger, also a Europa pilot, also doesn't remember checking the rear latch. I'm fairly sure that this latch was not secured before take-off. I think that we both assumed that the other person had done it."

Thanks Ian for being straight about it. Readers will be pleased to hear that the door was found and that there was no damage to anybody on terra firma. I will leave the reader's imagination to do the work regarding the possible consequences of this, but let me put this into the mix. What would have happened if the door had fallen onto a busy motorway or taken the tail off the aircraft?

I had a report of a slightly more alarming incident where a canopy came off in flight. The pilot of the Minimax aircraft involved lost control completely and, from what I hear, was lucky to get away with it.

AAIB informs us of any accidents or incidents that occur to UK Permit aircraft. I will quote the report form: What Happened? Canopy came open in flight, then ripped from aircraft and hit tailplane. Aircraft went into a negative g dive. Started at 3800ft and pulled out at 800ft. All sounds a bit scary.

Ken Craigie, the Chief Inspector, investigated this one as I was away on my hols and he tells me that, after chatting to the pilot, it seems that he caught the canopy catch with his arm (while messing about with the GPS) and the (mandated) safety catch failed to prevent the canopy from snatching open. The reason the aircraft became uncontrolled was that the pilot lost his grip on the stick and, presumably due to the g forces, couldn't reach the stick to regain control. Fortunately, he regained control and lived to fly another day... all's well that ends well!