RECREATIONAL AIRCRAFT ASSOCIATION
RÉSEAU AÉRONEFS AMATEUR CANADA

Winnipeg Area Chapter of RAA Canada ***May 2014***

Executive

President: Jim Oke: – 204 344-5396
Past President: Ben Toenders – 204 895-8779
Memberships: Steven Sadler – 204 736-3138
Secretary: Marissa Selman - 204-792-2107
Treasurer: Don Hutchison – 204 895-1005

Directors

Harry Hill – 204 888-3518
Bert Elam – 204 955-2448
Ken Podaima – 204 257-1275
Jill Oakes – 204 261-1007
Tom Stoyka – 204 444-3838
Bob Stewart – 204 853-7776

NEWSLETTER: Bob Stewart Box 22 GRP 2 RR#1 Dugald, MB R0E 0K0
Phone: 204 853-7776 Email: stewart@netset.ca

CALENDAR OF EVENTS

May 22, 2014	Tire kick, summer plans **(Please note that our meeting is being held one week later than normal)**

There are no regularly scheduled meetings during June, July and August

AssentWorks Tour

Almost 30 RAA members and friends attended the tour at the Assent Works workshop. Everyone was thoroughly impressed with the facility and the options available to members of the cooperative. A thank you was sent to Robert Elms of AssentWorks for hosting an excellent tour. He replied: *"Thank you very much for all of your kindness to me. Also, thanks to those of you who fondly remembered the involvement of Mike Legary's grandfather in your association. I'll be sure to pass those compliments along to Mike and his family.*

Over the past two and a half years, I've had the privilege of giving tours of AssentWorks to more than eight hundred people, and it's fun every time. But I can honestly say that, in all that time, yours is the most engaging and enthusiastic group I've had the pleasure of hosting here! Your interest in what we're trying to achieve, and your expressed support, are invigorating. I'm pleased to know that some of you will be back again, as members."

Robert Elms
For more information on AssentWorks workshop, check out their website at www.assentworks.ca

RAA Regular meeting Thursday May 22, 2014

Due to numerous reasons, mainly the weather, the executive has decided to postpone our regular meeting for May 15 and rescheduled it Thursday May 22, 2014, 7:30pm Lyncrest Flight Centre. Our plan is to discuss a proposed project tours to Brandon and area this summer, a possible Rockwood area tour, and any suggestions for project tours that you may have. We will also discuss a tour to AirVenture at the end of July. If you have any project pictures please bring them along as we will projector.

Bud, Spud and Streak Night Fundraiser

Tom Stoyka is an Air Cadet instructor at the 249 Air Cadet Sqn. in Beausejour Mb. The Squadron is planning a tour to London England (Bletchley Circle), Paris France and Vimy Ridge next summer. Each Cadet has to raise approximately $4000 and they are having a Bud, Spud and Steak Fundraiser on June 21 at the Beausejour Legion. The tickets are $20.00 per person. If you can support the Air Cadets, please contact Tom Stoyka at 204 444-3838 for tickets.

How Do Piston Aircraft Engines Fail?

April 9th, 2014 by Mike Busch

Last month, I tried to make the case that **piston aircraft engines should be overhauled strictly on-condition,** not at some fixed TBO. If we're going to do that, we need to understand how these engines fail and how we can protect ourselves against such failures. The RCM way of doing that is called Failure Modes and Effects Analysis (FMEA), and involves examining each critical component of these engines and looking at how they fail, what consequences those failures have, and what practical and cost-efficient maintenance actions we can take to prevent or mitigate those failures. Here's my quick back-of-the-envelope attempt at doing that…

Crankshaft

There's no more serious failure mode than crankshaft failure. If it fails, the engine quits.

Yet crankshafts are rarely replaced at overhaul. Lycoming did a study that showed their crankshafts often remain in service for more than 14,000 hours (that's 7+ TBOs) and 50 years. Continental hasn't published any data on this, but their crankshafts probably have similar longevity.

Crankshafts fail in three ways: (1) infant-mortality failures due to improper materials or manufacture; (2) failures following unreported prop strikes; and (3) failures secondary to oil starvation and/or bearing failure.

Over the past 15 years, we've seen a rash of infant-mortality failures of crankshafts. Both Continental and Lycoming have had major recalls of crankshafts that were either forged from bad steel or were damaged during manufacture. These failures invariably occurred within the first 200 hours after the new crankshaft entered service. If the crankshaft survived its first 200 hours, we can be confident that it was manufactured correctly and should perform reliably for numerous TBOs.

Unreported prop strikes seem to be getting rare because owners and mechanics are becoming smarter about the high risk of operating an engine after a prop strike. There's now an AD mandating a post-prop-strike engine teardown for Lycoming engines, and a strongly worded service bulletin for Continental engines. Insurance will always pay for the teardown and any necessary repairs, so it's a no-brainer.

That leaves failures due to oil starvation and/or bearing failure. I'll address that shortly.

Crankcase

Crankcases are also rarely replaced at major overhaul. They are typically repaired as necessary, align-bored to restore critical fits and limits, and often provide reliable service for many TBOs. If the case remains in service long enough, it will eventually crack. The good news is that case cracks propagate slowly enough that a detailed visual inspection once a year is sufficient to detect such cracks before they pose a threat to safety. Engine failures caused by case cracks are extremely rare—so rare that I don't think I ever remember hearing or reading about one.

Camshaft and Lifters

The cam/lifter interface endures more pressure and friction than any other moving parts n the engine. The cam lobes and lifter faces must be hard and smooth in order to function and survive. Even tiny corrosion pits (caused by disuse or acid buildup in the oil) can lead to rapid destruction (spalling) of the surfaces and dictate the need for a premature engine teardown. Cam and lifter spalling is the number one reason that engines fail to make TBO, and it's becoming an epidemic in the owner-flown fleet where aircraft tend to fly irregularly and sit unflown for weeks at a time.

The good news is that cam and lifter problems almost never cause catastrophic engine failures. Even with a badly spalled cam lobe (like the one pictured at right), the engine continues to run and make good power. Typically, a problem like this is discovered at a routine oil change when the oil filter is cut open and found to contain a substantial quantity of ferrous metal, or else a cylinder is removed for some reason and the worn cam lobe can be inspected visually.

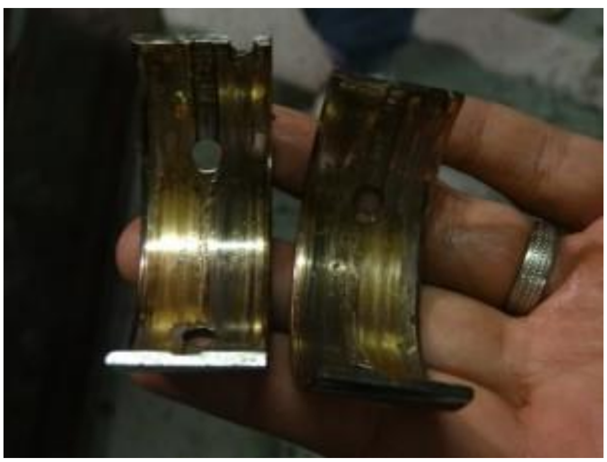
If the engine is flown regularly, the cam and lifters can remain in pristine condition for thousands of hours. At overhaul, the cam and lifters are often replaced with new ones, although a reground cam and reground lifters are sometimes used and can be just as reliable.

Gears

The engine has lots of gears: crankshaft and camshaft gears, oil pump gears, accessory drive gears for fuel pump, magnetos, prop governor, and sometimes alternator. These gears are made of case-hardened steel and typically have a very long useful life. They are not usually replaced at overhaul unless obvious damage is found. Engine gears rarely cause catastrophic engine failures.

Oil Pump

Failure of the oil pump is rarely responsible for catastrophic engine failures. If oil pressure is lost, the engine will seize quickly. But the oil pump is dead-simple, consisting of two steel gears inside a close-tolerance aluminum housing, and usually operates trouble free. The pump housing can get scored if a chunk of metal passes through the oil pump—although the oil pickup tube has a suction screen to make sure that doesn't happen—but even if the pump housing is damaged, the pump normally has ample output to maintain adequate oil pressure in flight, and the problem is mainly noticeable during idle and taxi. If the pump output seems deficient at idle, the oil pump housing can be removed and replaced without tearing down the engine.



Bearings

Bearing failure is responsible for a significant number of catastrophic engine failures. Under normal circumstances, bearings have a long useful life. They are always replaced at major overhaul, but it's not unusual for bearings removed at overhaul to be in pristine condition with little detectable wear.

Bearings fail prematurely for three reasons: (1) they become contaminated with metal from some other failure; (2) they become oil-starved when oil pressure is lost; or (3) main bearings become oil-starved because they shift in their crankcase supports to the point where their oil supply holes become misaligned (as with the "spun bearing" pictured at left).

Contamination failures can generally be prevented by using a full-flow oil filter and inspecting the filter for metal at every oil change. So long as the filter is changed before its filtering capacity is exceeded, metal particles will be caught by the filter and won't get into the engine's oil galleries and contaminate the bearings. If a significant quantity of metal is found in the filter, the aircraft should be grounded until the source of the metal is found and corrected.

Oil-starvation failures are fairly rare. Pilots tend to be well-trained to respond to decreasing oil pressure by reducing power and landing at the first opportunity. Bearings will continue to function properly at partial power even with fairly low oil pressure.

Spun bearings are usually infant-mortality failures that occur either shortly after an engine is overhauled (due to an assembly error) or shortly after cylinder replacement (due to lack of preload on the through bolts). Failures occasionally occur after a long period of crankcase fretting, but such fretting is usually detectable through oil filter inspection and oil analysis).They can also occur after extreme unpreheated cold starts, but that is quite rare.

Connecting Rods

Connecting rod failure is responsible for a significant number of catastrophic engine failures. When a rod fails in flight, it often punches a hole in the crankcase ("thrown rod") and causes loss of engine oil and subsequent oil starvation. Rod failure have also been known to cause camshaft breakage. The result is invariably a rapid and often total loss of engine power.

Connecting rods usually have a long useful life and are not normally replaced at overhaul. (Rod bearings, like all bearings, are always replaced at overhaul.) Many rod failures are infant-mortality failures caused by improper tightening of the rod cap bolts during engine assembly. Rod failures can also be caused by the failure of the rod bearings, often due to oil starvation. Such failures are usually random failures unrelated to time since overhaul.

Pistons and Rings

Piston and ring failures usually cause only partial power loss, but in rare cases can cause complete power loss. Piston and ring failures are of two types: (1) infant-mortality failures due to improper manufacturer or assembly; and (2) heat-distress failures caused by pre-ignition or destructive detonation events. Heat-distress failures can be caused by contaminated fuel (e.g., 100LL laced with Jet A), or by improper engine operation. They are generally unrelated to hours or years since overhaul. A digital engine monitor can alert the pilot to pre-ignition or destructive detonation events in time for the pilot to take corrective action before heat-distress damage is done.

Cylinders

Cylinder failures usually cause only partial power loss, but occasionally can cause complete power loss. A cylinder consists of a forged steel barrel mated to an aluminum alloy head casting. Cylinder barrels typically wear slowly, and excessive wear is detected at annual inspection by means of compression tests and borescope inspections. Cylinder heads can suffer fatigue failures, and occasionally the head can separate from the barrel. As dramatic as it sounds, a head separation causes only a partial loss of power; a six-cylinder engine with a head-to-barrel separation can still make better than 80% power. Cylinder failures can be infant-mortality failures (due to improper manufacture) or age-related failures (especially if the cylinder head remains in service for more than two or three TBOs). Nowadays, most major overhauls include new cylinders, so age-related cylinder failures have become quite rare.

Valves and Valve Guides

It is quite common for exhaust valves and valve guides to develop problems well short of TBO. Actual valve failures are becoming much less common nowadays because incipient problems can usually be detected by means of borescope inspections and digital engine monitor surveillance. Even if a valve fails completely, the result is usually only partial power loss and an on-airport emergency landing.

Rocker Arms and Pushrods

Rocker arms and pushrods (which operate the valves) typically have a long useful life and are not normally replaced at overhaul. (Rocker bushings, like all bearings, are always replaced at overhaul.) Rocker arm failure is quite rare. Pushrod failures are caused by stuck valves, and can almost always be avoided through regular borescope inspections. Even when they happen, such failures usually result in only partial power loss.

Magnetos and Other Ignition Components

Magneto failure is uncomfortably commonplace. Mags are full of plastic components that are less than robust; plastic is used because it's non-conductive. Fortunately, our aircraft engines are equipped with dual magnetos for redundancy, and the probability of both magnetos failing simultaneously is extremely remote. Mag checks during preflight run-up can detect gross ignition system failures, but in-flight mag checks are far better at detecting subtle or incipient failures. Digital engine monitors can reliably detect ignition system malfunctions in real time if the pilot is trained to interpret the data. Magnetos should religiously be disassembled, inspected and serviced every 500 hours; doing so drastically reduces the likelihood of an in-flight magneto failure.

The Bottom Line

The bottom-end components of our piston aircraft engines—crankcase, crankshaft, camshaft, bearings, gears, oil pump, etc.—**are very robust.** They normally exhibit long useful life that are many multiples of published TBOs. Most of these bottom-end components (with the notable exception of bearings) are routinely reused at major overhaul and not replaced on a routine basis. When these items do fail prematurely, the failures are mostly infant-mortality failures that occur shortly after the engine is built, rebuilt or overhauled, or they are random failures unrelated to hours or years in service. The vast majority of random failures can be detected long before they get bad enough to cause an in-flight engine failure simply by means of routine oil-filter inspection and laboratory oil analysis.

The top-end components—pistons, cylinders, valves, etc.— **are considerably less robust.** It is not at all unusual for top-end components to fail prior to TBO. However, most of these failures can be prevented by regular borescope inspections and by use of modern digital engine monitors. Even when they happen, top-end failures usually result in only partial power loss and a successful on-airport landing, and they usually can be resolved without having to remove the engine from the aircraft and sending it to an engine shop. Most top-end failures are infant-mortality or random failures that do not correlate with time since overhaul.

The bottom line is that a detailed FMEA of piston aircraft engines strongly suggests that the traditional practice of fixed-interval engine overhaul or replacement is unwarranted and counterproductive. **A conscientiously applied program of condition monitoring** that includes regular oil filter inspection, oil analysis, borescope inspections and digital engine monitor data analysis **can yield improved reliability and much reduced expense and downtime.**

Mike Busch is arguably the best-known A&P/IA in general aviation, honored by the FAA in 2008 as National Aviation Maintenance Technician of the Year. Mike is a 7,500-plus hour pilot and CFI, an aircraft owner for 45 years, a prolific aviation author, co-founder of AVweb, and presently heads a team of world-class GA maintenance experts at Savvy Aviator.

Tags: condition-based maintenance, general aviation, maintenance, ownership, preventive maintenance, reliability-centered maintenance, safety, tbo, time between overhauls

---

2014 Membership Form

Winnipeg Area Chapter RAA

☐ **Full $25**

Required Information

Name		**OFFICE USE ONLY**
Mailing Address		**Renewal Date**
Phone(s)		**Chq. Cash Other**
E-mail		**Initials**
Are you an RAA national member? (1)	☐ **Yes** ☐ **No**	
Do you give permission for your information to be made available to other Winnipeg RAA members?	☐ **Yes** ☐ **No**	

Optional Information

Do you own an aircraft?	☐ **Yes** ☐ **No** **Make/model:** **Registration:**	**Are you a member of other aviation groups?**	**EAA:** ☐ **COPA:** ☐ **Others:**
Are you building or restoring an aircraft?	☐**Yes** ☐ **No** **Make and model of project(s):**	**What Pilots licences and ratings do you hold?**	

RAA Winnipeg contributes $15 per member towards the insurance program maintained by RAA national. This program provides liability insurance to cover local chapter events.

Please make cheques payable to: **RAA - Winnipeg Chapter**
Mailing Address: **c/o Steven Sadler**
7 Devos Drive
La Salle MB R0G 0A2

1) Notes: The $15 does not provide membership in RAAC.