BETTER SHORT FIELD PERFORMANCE

Through Technology

BY MICHAEL KOBYLIK

There is a funny but telling story about how an electronic ignition improved short field take-off performance one fall afternoon in 2010, and how that flight began to change how we think of aircraft ignition systems.

When Electroair began the certification process of its electronic ignition system, it choose a Cessna Cardinal with a Lycoming O-360 engine as the test platform for the initial electronic ignition STC. This was done largely in part because it was the "acid test" for four-cylinder Lycoming engines – carbureted, high-power four-cylinder. It just so happens that this Cardinal lives on a field with a 2,000-foot north-south grass strip, 75 feet wide, 80-foot trees at the south end, and a senior citizen oak tree at the north end. Power lines are at the north end too, just for good measure. The runway is also bracketed on either side with corn. Not exactly an ideal airport for launching an airplane with a brand new electronic ignition system.

Needless to say, that's exactly where the electronic ignition system flight testing began.

So with a production intent prototype electronic ignition system installed on the Cardinal, experimental certificate properly placed in the aircraft, the owner, Ron Cooper, and the owner of Electroair (just so happens to be me) launched off to see how everything worked.

As we rotated off and cleared the trees to the south, Ron announces "Wow! Did you feel that? That was a kick in the pants!"

I responded simply, calmly, "I guess, I'm not sure because I don't have anything to compare to since I've never flown in your airplane…"

Ron's reply was very direct and telling: "B.S.!! You were looking at those trees weren't you?"

Sheepishly I said, "You better believe it."

With a little more discussion, it was determined that the airplane rotated off about 100 feet earlier than what would normally be expected. Keep in mind too that the grass had not been cut for a while. It was obvious at that point, with the electronic ignition installed, something had very definitely changed for the Cardinal.

So the natural question becomes what changed and how did the electronic ignition system do it? The discussion in the experimental world has revolved around the fact that electronic ignition systems improve economy. But what about some of the intangibles that can be gained by using a high-energy, tuned electronic ignition system? How can technology improve what has been in place for so many decades?

Simple.

During the flight test program conducted with the Cardinal, all of the promises of electronic ignition systems were proved out. Better fuel economy (1gph was the typical improvement – again, an O-360 Lycoming with essentially a Power Flow exhaust as the only modification), easier starting and better short field performance were all experienced during the program. In fact, it was pretty impressive what could be brought out of this Lycoming by simply removing what has become one of the longest standing hand-cuffs to engine performance – the magneto. So how does it all work?

There are two principle differences between an Electroair EIS and a magneto: High-Energy spark and variable ignition timing.

First off, energy output: A magneto is an electro-mechanical device. Essentially, a generator that charges a coil. At low RPM (think while starting) the output energy is 6-8,000 Volts over

five degrees of crank rotation. During normal operation (cruise RPM), the output energy increases to 12-15,000 Volts (assuming optimal performance!). The EIS, because of the size of the coil and that it is charged from the battery (B+ is a constant supply voltage) outputs about 70,000 Volts through twenty degrees of crank rotation. A big spark is just simply more capable of lighting most any fuel-air mixture. A big spark also allows for spark plug gap to be opened up. Larger spark plug gaps, more typical of an automotive plug, helps improve hot-starts (cold-starts are improved too) and leads to better igniting of the fuel-air charge.

Secondly, variable timing: Ignition timing, the moment at which the spark plug fires, essentially the point at which peak internal cylinder pressure will occur in the power stroke of the engine. There are many resources that point to the optimal peak pressure point (as a result of combustion) occurs between 10-17 degrees after top dead center (ATDC). The magneto cannot vary ignition timing. So, the peak pressure point is going to vary as the fuel-air mixture varies. More specifically, as MAP (Manifold Absolute Pressure – a great measure of the amount of air inside the combustion chamber) changes, or drops (because of altitude changes), the peak pressure point moves and power is lost. The EIS uses a MAP sensor to detect MAP and adjust the ignition timing to help maintain peak internal cylinder pressure in the optimal range. This helps to preserve power at altitude and gets the engine to run smoother. More power at altitude means you can go faster, or reduce your fuel for a given flight plan speed, or some combination of both.

The variable timing is the key for better short field performance. As mentioned above, there is a veritable "sweet" spot for internal cylinder pressures for piston engines. The goal of any ignition system should be to start the combustion event, so the peak pressure as a result of combustion occurs at that "sweet" spot. Since the "sweet" spot is a fixed point in the power stroke, but the time necessary for combustion to develop peak pressure changes with MAP, the need for ignition timing to change becomes very apparent. And for a short field take-off, this consideration could not be more critical.

During the take-off sequence, we move the engine from idle (very low MAP) to take-off power (typically full-throttle and high MAP) relatively quickly. The change in ignition timing should also move very quickly. And with the electronic ignition system, it does just exactly that – hence the engine power will come up quicker, translating into more thrust from the prop. This has been seen time and time again in a number of examples.

Jason Newburg, Winner, Reno Air Races 2006, Pitts Silver Class: Electroair helped sponsor Jason at the 2006 Reno Air Races. Jason flew a Pitts S-1 with a 360 Lycoming modified with a single Electroair ignition system. These races are started on the runway and take-off performance is critical in getting a jump on the competitors. Because of the electronic ignition, Jason was able to get ahead of the other racers by about 100 feet before breaking ground. With that kind of a jump, and Jason's natural skill around the course, the rest, as they say, was history.

Adam White, Past-President of the Alaska Airmen's Association and currently their Government Affairs Representative, and Missionary Pilot serving Alaska: Adam reports substantial fuel savings in his Cessna 206, but maybe more importantly, he made the following comments: "The quick and smooth acceleration on take-off is a thing of beauty. I operate out of marginal bush strips, most with no options for a go-around or aborted take-offs. My climb rate has improved, and my ground roll has certainly decreased. I must say, I have a lot more confidence in the engine performance."

Zeke Valdz, Twin Comanche owner: During a flight test program that added twin-engine aircraft to the Electroair STCs, Zeke was encouraged to simply "stuff" the throttles on take-off to see what would happen. With some amount of protest about the engines not responding well under that scenario, that they would cough and sputter while they came up to power, Zeke ultimately agreed. With plenty of runway ahead, full power was applied as quickly as possible. The engines responded like they had never responded before and came up to power quickly and smoothly without a hint of problems. Zeke commented that he had never done that in the Twin Comanche before.

Electroair continues to work on expanding their product line with new approvals and new systems for various applications. Electroair has even announced the development of a new magneto – the old will become new again. Just for a tease, Electroair has said that the new magneto will have higher energy output, variable timing, and a back-up generator output. Suffice it to say, this won't be your daddy's magneto!

The future of aircraft ignition systems has finally arrived, and the timing couldn't be better!