*EAA Flight Advisor*

# Development Flight Testing

## Using a team approach to work out the bugs

TERRY LUTZ

WHEN THE PILOT OF A NEWLY completed airplane contacts me for Flight Advisor assistance, I follow EAA guidelines to evaluate his or her skills and carefully prepare the pilot for the first few flights. Then I explain that once the airplane has been successfully flown, he is actually *beginning* a development phase of flight-testing to identify and continuously solve problems until the airplane operates problem free. It's essentially the same process that aircraft manufacturers follow before their airplanes are delivered to customers.

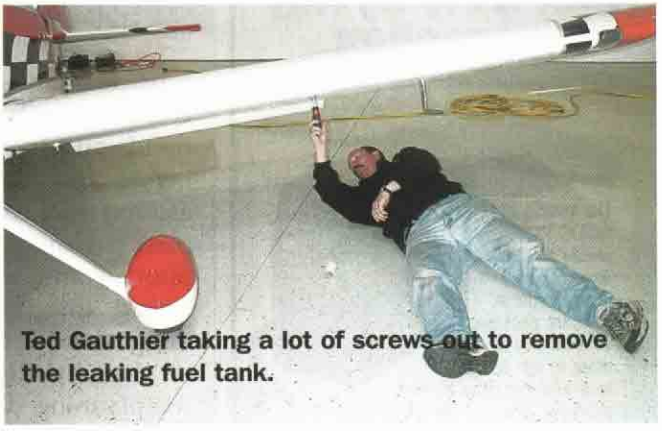
The "perfect" airplane is rarely produced. Unlike factory-built cars and trucks, amateur-built aircraft are not built with high-tech automation. A large portion of the work is still done with human hands, and to make matters more complex, each customer has different requirements (product improvement) and skills.

From a production run of 4,077 F-16s for 18 different air forces around the world, for instance, Lockheed-Martin has produced only 10 "perfect" airplanes. That means that a company test pilot flies it and finds no discrepancies, and then an air force test pilot flies it and finds no discrepancies. Next, the air force maintenance team at the factory tears it apart and inspects every nut, clamp, wire bundle, hydraulic line, and every other imaginable maintenance item. (Remember that the next time you change washers under an AN-3A bolt to get one-and-one-half threads to show.) If no problems are found, an air force delivery pilot ferries the airplane to the gaining unit. If there are no maintenance write-ups on arrival, the "perfect" status remains intact. Finally, the maintenance organization of the gaining unit tears the F-16 apart, and once again every last detail is checked. If no discrepancies are found, it's one of those rare, "perfect" airplanes.

Comments about the first flight of a new homebuilt or restoration project often read, "It was in perfect trim and flew hands off." What you don't hear about is the tail wheel shimmy, substantial air leak around

**Carl Franz assisting Ted Gauthier with the Grand Rapids Technologies EIS settings.**

**Ted Gauthier's RV-6 during an engine run prior to first flight.**



Ted Gauthier taking a lot of screws out to remove the leaking fuel tank.

**Chase pilot Lou Farhood gets ready to strap into his RV-8 before the first flight.**

the door, or the fuel streaking around one of the vents.

Knowing that your airplane is entering a development phase, what can you do to identify and resolve the discrepancies that are bound to appear? Ted Gauthier, a member of EAA Chapter 1056, in Fowlerville, Michigan, recently completed a dazzling RV-6. Power comes from a Superior SL-360 engine with a fixed-pitch prop that has a spectacular checkerboard paint design. The full gyro panel houses a Grand Rapids Technologies EIS and a lift reserve indicator. A Garmin GPS III is carefully flush-mounted in the panel, but the real navigation tool is a Compaq iPaq PDA with a color-moving map driven by Anywhere Map software. The software also has an Excel spreadsheet that automatically calculates gross weight and center of gravity from pilot inputs.

Gauthier and three other home-builders—Lou Farhood, RV-8, Chapters 1056 and 55; Carl Franz, RV-6, Chapter 1056; and me, RV-8, Flight Advisor, Chapter 55—used a team approach to resolve all the discrepancies that appeared during the first 40 hours of flight. Each of us had a specific responsibility. Gauthier had the total project perspective and shared the test flying. We expressed our technical con-

cerns to him, and he provided the construction background and the hands-on to resolve problems before the next flight. Farhood assisted with assembly details, made parts as required, and flew as chase pilot. Franz was the expert on wiring, integration, and programming of the electronic systems, and he shared the test flying. I did the test planning, data reduction, and a portion of the test flying. And we all helped each other, as spare time permitted.

So how did it go? What did we find? There were some comm problems on the first flight—no loss of radios—but there was a persistent problem that we traced to a bad ground at the microphone jack on the pilot's side. We also had a significant airspeed error, which Farhood identified from the chase RV-8 during a practice approach at altitude. There were numerous warnings from the EIS because the EGT limit was set too low. We were unable to display manifold pressure and fuel flow on the EIS. Cold air flowed from a large air leak at the back of the canopy, the transponder was not reporting Mode C, and there was a mild roll-off to the left at cruise speed. No, it was not a "perfect" flight, but we had a plan to identify and solve the problems that popped up.

### Problem Solving

Over the course of 40 hours of Phase I testing (Gauthier's RV has an uncertified engine/prop combination), we developed a "Top 5" list of problems that had to be solved:

**Fuel Leak:** The airplane was topped off just before the first flight, and we noticed a fuel seep from stains on the underside of the wing along the spar. Over the course of testing, we removed the tank twice to find the leak. It finally took a pressure test and a complete cleaning and pro-sealing of the tank seam to cure it.

**Airspeed Error:** Our chase airplane confirmed that a significant airspeed error existed. Early GPS runs confirmed it, and clean stalls were occurring at 45 mph indicated airspeed, which was a bit slower than expected. Gauthier took the airspeed system apart and found that an O-ring was missing on the pitot connection at the airspeed indicator. Replacing the O-ring, however, did not correct the problem.

We did a complete airspeed calibration using a method developed by Greg Lewis at the National Test Pilot School. (The spreadsheet can be downloaded free from their web-

| IAS in knots | dVpc (source at pitot) | dVpc (source at fuselage) |
|---|---|---|
| 50 | 7.7 | -1.3 |
| 60 | 4.6 | -1.3 |
| 70 | 3.2 | -1.6 |
| 80 | 0.0 | -1.0 |
| 90 | -2.0 | -1.1 |
| 100 | -5.1 | -1.6 |
| 110 | -6.6 | -2.6 |
| 120 | -5.4 | -1.3 |
| 130 | -6.6 | 1.1 |
| 140 | -8.8 | 0.6 |
| 150 | -9.2 | -0.4 |
| 160 | -11.3 | 0.0 |

**Airspeed calibration table**

site at *www.ntps.edu/downloads.htm.*) Gauthier had installed a heated pitot tube that had pitot and static sources. He switched the source of static air from the pitot tube to ports mounted on either side of the fuselage, with great results. From the table on the left, you can see that at a cruise speed of 160 knots, the error is actually 0.0 knots.

**Pitch Trim:** Even though we had enough nose-up and nose-down trim, our sharp-eyed chase pilot pointed out that there was significant trim-tab deflection at cruise.

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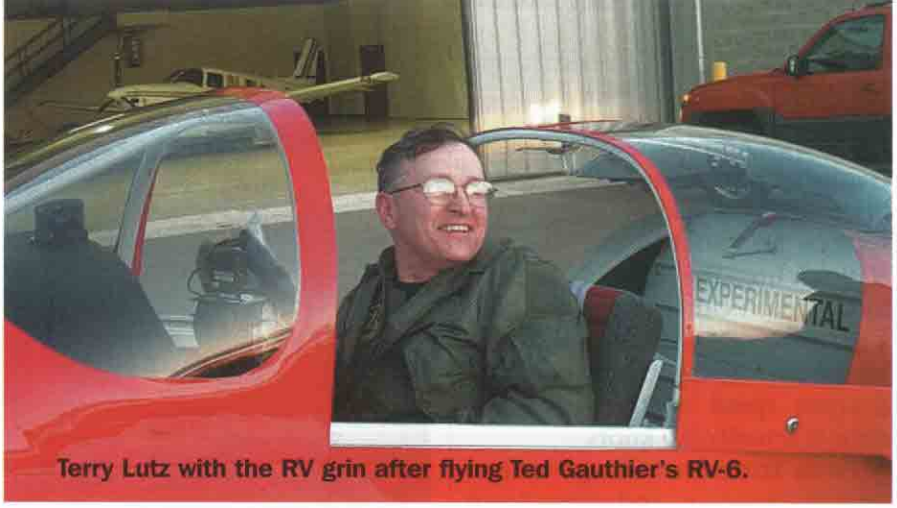
Gauthier added two 3/32-inch shims under the horizontal tail, and adjusted the travel of the Mac trim servo. After a few more flights, one more shim was added, and the tab is now at zero deflection at cruise, with a full range of trim available.

**EIS Programming:** After the problems were noted on the first flight, Franz tackled the job of verifying all the parameters on the EIS, and customized the pages that we wanted to fly with, particularly for the engine break-in period. The one remaining issue was to accurately calibrate the fuel-flow system, which Franz accomplished over a couple of flights.

**Engine-Baffle Adjustments:** Flight-testing indicated that the forward two cylinders were consistent-

ly operating cooler than the aft two, so Gauthier and Franz increased the baffle height at the front of the engine. It took a couple of adjustments to get the cylinder head temps all about the same. Some changes were also made to the baffle seals above the oil cooler and at the carburetor air inlet.

**One Important Item:** There were no problems with the SL-360 engine. From the first engine run and throughout Phase I testing, it has operated trouble free. During the engine build-up, Gauthier again used the team approach. Ron Cooper (Cooper Air Repair, EAA Chapter 1056) provided the technical expertise during engine assembly, and hands-on assistance with fittings, hose placement, and control rigging.



Terry Lutz with the RV grin after flying Ted Gauthier's RV-6.

Altogether, Gauthier had the cowl off 22 times in 40 hours of flying, and he removed the floor panels seven times to check wiring, aileron trim, and the flight controls. We often think that the most intense period during construction is when we are attending to a million details before the first flight. But unless you build the "perfect" airplane, that simply isn't so. Solving the problems identified in Phase I testing can be equally intense. The experience we had with Gauthier's airplane is an example of how important it is to properly conduct development testing after the first flight. The team approach may not work for everyone, but the value of extra eyes, extra experience, and expertise cannot be understated. The result: a superb airplane that will give Ted Gauthier many hours of trouble-free flying whenever he wants to strap it on and go.

*Flight Advisor Terry Lutz is a former Air Force pilot and graduate from the USAF Test Pilot School. He evaluates large transport aircraft and systems for the Air Line Pilots Association, flies the DC-9 at Northwest Airlines, and can't wait to finish his RV-8.*