SAFETY Is No Accident

We look at whether the various "stall-proof" canard designs live up to their reputation.

BY RON WANTTAJA

Like every other field of human interest, homebuilt aviation goes through fads. Wingtips get end plates, they droop and they grow winglets. Horizontal stabilizers rise, fall, shift forward, shift aft and sometimes disappear altogether. At each iteration, we're solemnly told that the new feature will improve safety, increase efficiency and cure male pattern baldness.

Case in point: Canards. Tail-first designs have been around since the Wright brothers. But they quickly fell from favor, compared to the "conventional" tractor layout. Over the years, a few new canards showed up, generally to slink away with the passage of time.

Then came Burt Rutan. His Vari Viggen sparked some interest, but the VariEze—with not only its exotic design, but its low-cost, easy-to-build construction—dumped a tanker load of fuel on the canard craze. The VariEze sired the Long-EZ, then came the Defiant, Quickie, Quickie Q-2 and Q-200, Dragonfly, Velocity, Ibis, Cozy, Speed Queen, E-Racer, Speed Canard, Aero-Canard and the Berkut. They even bled into the commercial world, with the Beech Starship, AASI Jetcruzer and the OMAC Laser, among others, trying to attract buyers to an unconventional configuration and offering improved safety, increased efficiency and, well, you know.

Like most fads, canards faded but never really went away. Homebuilt selection is often an emotional decision, and the exotic appeal of a canard design hasn't changed. But are canards safer? Let's look at the data and find out.

Model Notes

We'll look at four of the most common type of canard aircraft: The Long-EZ (638 registered aircraft in January 2008), the VariEze (606 aircraft), Velocity (311 aircraft) the Quickie (343 aircraft). The Quickie category covers a wide variety of versions, from the single-seat Onan-powered original to the later Continental O-200-powered Tri-Q. The Velocity also includes several models. We'll also combine all of the canard-type aircraft in the accident database to compare their rates to the overall homebuilt fleet.

Pilot Error

The key claim for canards generally centers around their "stall-proof" configuration. On a properly designed, properly rigged and properly loaded canard air-

Illustrations & Photos: Ron Wanttaja, Richard VanderMeulen

The Q200 was the two-seat version of the Quickie with a Continental O-200 engine. This version retains the original position of the main landing gear on the wingtips of the canard.

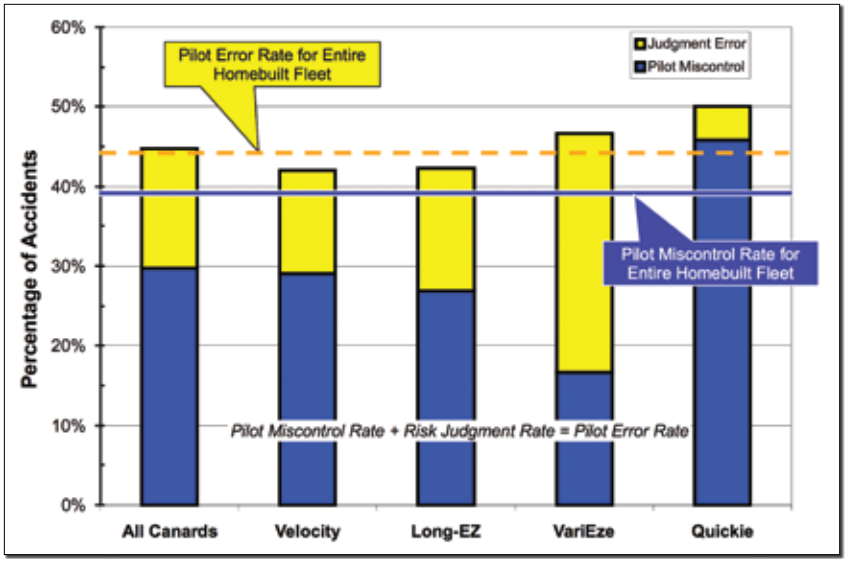

Figure 1: Pilot Error Accident Rate.

The Rutan Long-EZ was an outgrowth of builders' desires to use larger engines than the VariEze could tolerate.

plane, the canard will always stall before the main wing. A stalled canard drops the nose, lowering the angle of attack and avoiding the sudden loss of lift of a main-wing stall.

From the look of Figure 1, it works. The blue bars indicate the rate of "Pilot Miscontrol," which includes those accidents related to the physical control of the aircraft. About 39% of all homebuilt accidents are caused by pilot miscontrol, but most of the canard aircraft score far better. The overall canard rate is 10 percentage points lower, which means canards suffer pilot miscontrol accidents about 25% less often.

The odd standout is the Quickie. The type earned a bad reputation for its ground handling in its early days. This was blamed on a variety of factors, from insufficient tail area to the strange dynamics of having the maingear mounted on the wingtips of the canard, to a strong sensitivity to proper gear alignment.

Looking at the "Phase of Flight" information in Figure 2, we see that about 65% of the Quickie accidents

Open Canopy

Accident: CHI03LA228
Aircraft Type: VariEze

The NTSB report does not list an aircraft total time. As the pilot is listed as having only 10 hours in type, and FAA records indicate that the plane was 20 years old, we can assume the pilot had purchased the already-flying homebuilt.

The pilot lost control of the aircraft during takeoff, striking an NDB antenna. He reported simply, "Canopy was not secured properly prior to takeoff, and opened in flight just after rotation." Pilot lost control of the aircraft attempting to close the canopy in flight.

NTSB Probable Cause: "The pilot's failure to secure the window canopy before takeoff and his failure to maintain directional control, which resulted in a loss of control. The pilot's diverted attention is a contributing factor."

Burt Rutan's VariEze and Long-EZ became popular not only because of their performance and exotic appearance, but because of the simple, low-cost moldless construction pioneered by the designer.

occurred during ground-handling portions of flight versus about 42% for the Long-EZ. It's likely that the Quickie is still more challenging to control on the ground. Obviously, it behooves Quickie builders or purchasers to get their airplanes set up properly and obtain the right kind of training.

Ironically, while the pilot miscontrol rates are lower than the overall homebuilt population, the occurrence of judgment errors in the canard fleet is a bit higher—high enough, in fact, that the *overall* pilot error rate is about the same as the overall homebuilt rate. Canard pilots seem to have more problems with fuel starvation, for instance. Fuel starvation is having gas on board, but failing to configure the fuel system to deliver it to the engine. Canard aircraft typically have multiple fuel tanks and no "both" position for the valve, but so do a lot of homebuilt types. In addition, four out of 10 "Inadequate Preflight" cases involved the failure to secure the canopy prior to takeoff.

Finally, for planes that "can't stall," the NTSB still identified cases where accidents were blamed on the pilot's airspeed control. It's definitely lower than the overall rate (~10% vs. 16%) but not as low as some might expect.

Other Accident Causes

The biggest problem when examining any sort of statistic is the sample size. All of the individual canard aircraft saw about 25 to 30 accidents over my

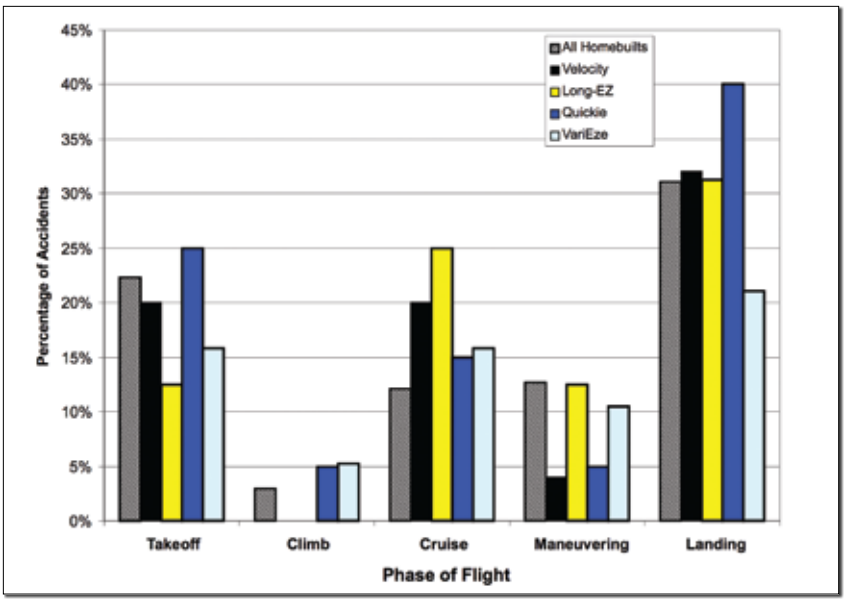

Figure 2: Phase of Flight Where Accident Occurred.

The Velocity is one of the few survivors of the canard craze.

First Flight and PIO

Accident: LAX03LA237
Aircraft Type: Quickie Q2

The pilot was on the first flight of his Quickie. He had 500 hours, but no previous Quickie time. He had been offered the opportunity to take flight training in a similar aircraft, but had turned it down.

The pilot attempted the first takeoff in a 5- to 7-knot tailwind. After the airplane became airborne, it climbed between 20 and 25 feet (estimated) above the runway. Thereafter, its wings rocked back and forth, and the airplane descended until impacting the runway with its propeller and wingtip. Then the airplane bounced/porpoised and became airborne again. After gaining several feet of altitude above the runway it again descended, but in a steeper nose-down attitude. The airplane's nose impacted the runway, the airplane nosed over, and it slid to a stop while veering off the side of the runway. A post-impact ground fire consumed the airplane. The autopsy found an over-the-counter antihistamine in the pilot's blood and urine. It typically results in drowsiness and degraded motor skills.

NTSB Probable Cause: "The pilot's inadvertent entry into a pilot-induced oscillation and failure to maintain airplane control during the takeoff initial climb. A contributing factor was the pilot's likely impairment by an over-the-counter drug substance that degraded his physical and mental performance."

10-year analysis period (December 2007 through January 1998).

This means that each accident is worth about 3% to 4% of the total. This can tend to produce deceptive results when plotted on a percentage basis, especially in the less-common accident causes. For instance, if one type has 25 accidents and one fuel-exhaustion case, that's a 4% rate. But if one more fuel-exhaustion case happens, that's two out of 26 or 7.6%, almost twice the rate.

Because percentages are deceiving at these lower sample sizes, Figure 3 shows the actual number of occurrences for a variety of causes. The five instances of

Too Slow

Accident: ATL07CA061
Aircraft Type: Long-EZ

The pilot had about 150 hours, including 17 in the Long-EZ he'd built.

A witness saw the airplane in what appeared to be a normal approach at an altitude of 200 feet. He observed the right wing drop sharply with a noticeable decrease in altitude followed by recovery, then a second, more severe drop of the right wing. The airplane dropped completely below the tree line. The witness heard the application of full engine power followed by a single loud impact then almost immediately the sound of several impacts mixed with the "unmistakable sound of multiple propeller strikes."

The pilot had realized that he was low and increased the throttle to full power, "I seemed to drop precipitously and the tips of the trees seemed level with my wheels. At that time the right wing seemed to hit something and somehow I was on the ground." He stated that the last airspeed he was aware of was 85 to 90 miles per hour.

NTSB Probable Cause: "The pilot's failure to maintain an adequate airspeed that resulted in an inadvertent stall, and subsequent inflight collision with trees and the ground."

Rutan's ultimate Long-EZ evolution was the twin-engine Defiant. The original design used a forward rudder.

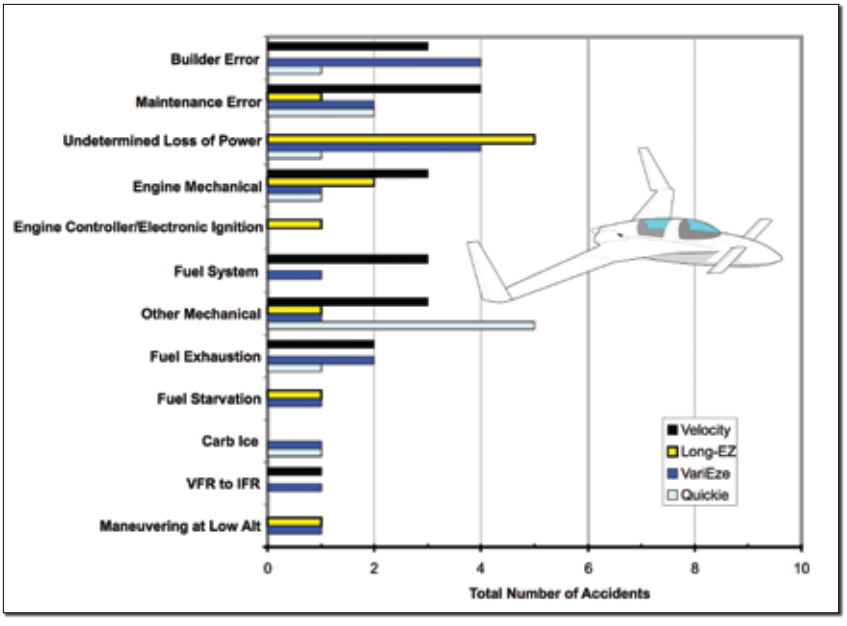

Figure 3: Accident Causes.

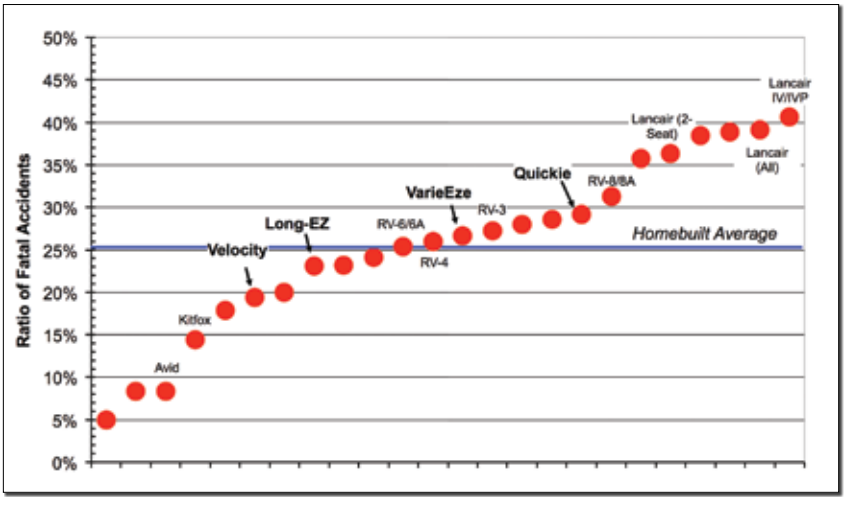

Figure 4: Fatal Accident Rate Comparison.

"Other Mechanical" for the Quickie tend to catch the eye. The failures generally varied, but two were delaminations of the propeller.

Fatal Accidents

The ratio of fatal accidents versus the overall number of accidents for most of the canard aircraft is about average, as Figure 4 illustrates. The Velocity's rate here is quite good. There's a rough correlation between fatal accident rate and aircraft speed (the less drag, the faster the aircraft might be going when it hits the ground), but the Velocity's rate of fatal accidents is quite a bit lower than other homebuilts with similar cruise speeds.

Overall Accident Rate

Figure 5 shows the overall accident rate for each type, compared to the results

Not Enough "Up"

Accident: LAX99LA060
Aircraft Type: Velocity 173RG

The pilot was the builder of the Velocity, and had about 70 hours in the aircraft.

During a landing at an intermediate stop, the pilot noted insufficient pitch authority. On inspection, he found play in the elevator control, and was advised by the factory to add washers or spacers to the rear of the torque tube to remove the play. The pilot added the washers and spacers and continued on his trip.

On his next landing, though, the nose would not come up for the flare. The aircraft hit the ground, bounced, veered off the runway, skidded across a grass area and collided tail-first with a parked Cessna 340. On inspection, it was found that the front bearing of the aileron torque tube had come loose, thus preventing a full elevator deflection.

NTSB Probable Cause: "The pilot's inadequate modification to the control systems, which resulted in a restricted elevator control."

from previous articles in this series. Accident rate is computed by taking the total number of accidents over the 10-year analysis period, dividing it by the average number of registered aircraft of that type, divided by 10 to get an average annual fleet accident rate.

The Long-EZ and the VariEze have nearly the lowest rate in the homebuilts checked. However, it's probable that these results are skewed due to a greater number of non-operational aircraft of these older designs.

Once an aircraft is on the FAA rolls, the only way it's removed is if the owner requests de-registration. The FAA doesn't automatically de-register an airplane after a crash. Owners (or their estates) may not realize this, and long-destroyed aircraft may remain on the FAA rolls. Similarly, an owner may decide to part-out or scrap an airplane, either due to mechanical problems or fear of liability. It may not occur to them to cancel the N-number.

This affects both old and new homebuilt designs, but as a design gets older, the decommissioned aircraft start to add up. In January 2008, there were about the same number of Quickies and Vans RV-9s on the FAA registry. It's a safe bet that there were more operational RV-9s than Quickies.

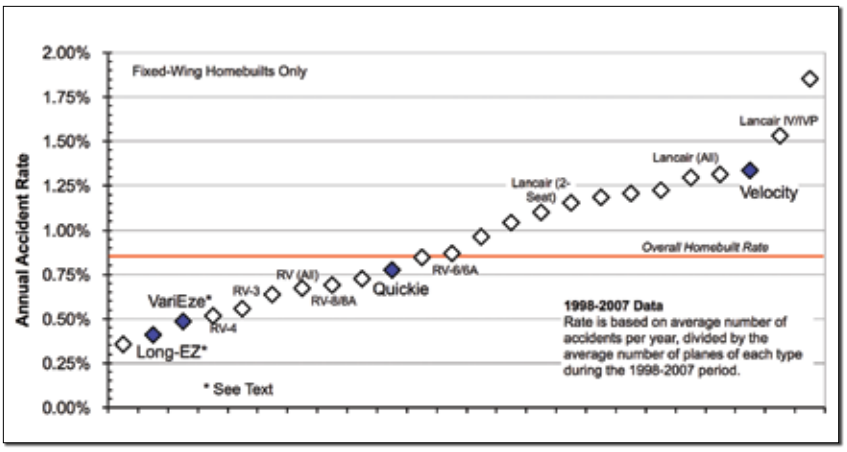

Figure 5: Overall Accident Rate Comparison.

The FAA is trying to identify inactive aircraft; the registration data includes a code that tells the status of the effort for each aircraft. The effort is still in its infancy, though. For the VariEzes, for instance, eliminating all examples with questionable status codes causes its fleet accident rate to rise just one-hundredth of one percent.

So why use fleet accident rate to compare homebuilt aircraft? Because there isn't anything else. The FAA makes an estimate as to how many active homebuilts there are, and how many hours they each fly per year, but they don't break this down by homebuilt type. And many persons, including myself, question the accuracy of the FAA's estimates for the overall fleet.

Fortunately, most of the airplanes in these accident studies are relatively recent designs. Once one rises past "RV (All)" on Figure 5, all of the designs date to 15 years or less from the start of my analysis period—with the exception of the Quickie. The Quickie was a contemporary of the VariEze and Long-EZ, and its higher accident rate probably reflects the reported difficulties with ground handling.

Canards visiting Oshkosh in the 1980s and '90s clustered on "EZ Street."

Rutan-inspired canard aircraft such as this Cozy usually include turnover structures built into the seats. This improves accident survivability.

Wrap-Up

The data seems to confirm some of the claimed safety advantages of the canard design. As illustrated by the Quickie, however, the advantage can easily be overcome by other design decisions and variations incorporated by the builder.

The canard configuration offers a stall-proof design, but only if it's properly built and the CG remains within the allowable range. Fly with the CG too far aft, and the aircraft may enter an unrecoverable "deep stall."

Even if the plane doesn't actually stall when it gets too slow, the nose may still pitch down unexpectedly. This has caused a few accidents where the pilot got too slow on approach and the plane pitched down near the ground. Canards are not short-field airplanes, and given that most are pusher designs, they are not grass/gravel runway airplanes, either. Still, they can offer good safety, good performance and a distinct appearance. Most homebuilders don't ask for anything more. ✚

RON WANTTAJA

Ron is a systems engineer, engaged in satellite orbit/constellation design and analysis, launch vehicle and onboard propulsion system trades, and operations concepts for space systems. He worked on the early design studies for the International Space Station.