Examining Homebuilt Aircraft Accidents

By

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It's funny how something so simple can turn out so complex.

Take homebuilt accidents, for instance. I've been looking at them in a fair amount of depth for eight years now, and there's still some things that catch my attention.

Take the most simple, basic statistic: The annual accident rate for homebuilt aircraft vs. the overall US aircraft fleet for a given year.

Should be easy enough, right? For the overall rate, start with the total number of aircraft accidents in a year, which can be obtained from NTSB records. Then divide it by the total number of airplanes on the FAA aircraft registry.

We can then do the same thing for homebuilts—take the total number of homebuilt accidents on the NTSB rolls, and divide it by the number of homebuilts on the FAA registry. Let's give it a try using 2008 data:

	Accidents in NTSB database	Aircraft on FAA Register	Accident Rate
All Aircraft	1891	376124	0.50%
Homebuilts	269	31242	0.86%

Holy smoke…homebuilts are **bad**! According to these figures, homebuilts have an accident rate 72 percent higher than the overall US fleet!

There's one critical factor, though: The calculation is based on data from the FAA and from the NTSB, and the two agencies *use different definitions for the term "homebuilt"*.

A Tale of Two Definitions

Of course, the FAA doesn't have a "homebuilt" definition—they're called "Experimental Amateur-Built" aircraft, in their parlance (we'll call them EXP-ABs). The FAA registration database includes a "Certification" column. A "42" in this column indicates the airplane is in the Experimental category (the "4") and it is an Amateur-Built

aircraft (the "2"). To determine the number of homebuilts, just count the entries with "42" in the column.

I ran this search the FAA database for 2 January 2009 and came up with 31,242 EXP-AB aircraft.

So, what about the NTSB?

Their accounting is much simpler. Every aircraft involved in an accident is summarized in their database, and there's one column labeled "Homebuilt". If there's a "Y" in the column, you've found a homebuilt. It's simple enough to use this feature to download a list of homebuilt aircraft accidents. According to the NTSB, there were 269 in the year 2008.

But a brief examination of the list shows some curious anomalies. Here's a 1930 Laird biplane, listed as a homebuilt. A Kaman K-1200 helicopter. An Extra 300. Four unregistered ultralights.

Combining the Databases

It's a fairly simple process to combine the NTSB and FAA databases, and determine how each of the 269 accident airplanes were certified. The results are interesting:

Type of certification	# of A/C	Description
Experimental Amateur-Built	185	Traditional homebuilts
Other Experimental Sub-Categories	8	Experimental Research and Development, Market Survey, Exhibition, Racing etc.
Experimental LSAs	43	All "Grandfathered" ultralights
Special Light Sport Aircraft	1	
Restricted	1	
Unregistered Aircraft	4	Ultralights
Foreign Aircraft	1	
Normal Category	4	Two are incorrect listings
No Certification Listed	24	Blank in the "Certification" columns in the FAA database

Out of those 269 "Homebuilt" aircraft involved in accidents in 2008, eighty-four were <u>not</u> EXP-AB aircraft.

If we're going to compute the accident rate for amateur-built aircraft, then only accidents involving aircraft licensed as amateur-built should be counted. Let's see what that does to the accident rate:

"Homebuilts" in NTSB database	EXP-AB in NTSB database	EXP-AB on FAA Register	Accident Rate
269		31242	0.86%
	185	31242	0.59%

Congratulations! We just reduced the homebuilt accident rate by nearly one-third. Instead of being 72 percent higher than the overall US fleet, it's a tad less than 20 percent higher.

(You can download my list of 2008 "Homebuilt" accidents, including each aircraft's certification, at http://www.wanttaja.com/a2008.pdf.)

Tale of the ELSAs

Other than the Experimental Amateur-Built aircraft themselves, the largest single group of aircraft fell into the "Experimental Light Sport" grouping. These were all aircraft that took advantage of the FAA's program to transition two-seat or "fat" ultralights into N-numbered Experimental Light Sport aircraft.

Some will argue that these should be counted as homebuilt aircraft. This is reasonable. However, the accident rate, then, should be determined by the total number of EXP-AB and ELSA accidents, divided by the total number of Experimental Amateur-Built aircraft PLUS the total number of ELSAs.

It really doesn't effect the rate that much. There were 6,548 grandfathered ELSAs in January 2009, and the combined EXP-AB & ELSA accident rate rises only slightly (to 0.60%).

Unrecognized Homebuilts

The third largest grouping in the 2008 accidents fell into the "No Certification Listed" category. These are interesting cases. Looking at the list of names, there's no question these are mostly…if not all…Experimental Amateur-Built aircraft.

Why is their Certification blank? Discussing this with representatives of the FAA a number of years ago, I was told that these were aircraft for which the N-Number was reserved, but that the airplane had yet not been granted an airworthiness certificate.

It makes sense—but I keep encountering exceptions. I personally knew the owner of one of these "Unrecognized" homebuilts on the 2008 accident list, and that airplane had been flying for at least two years prior to the accident. I shot air-to-air pictures of an RV-6 in the early 90s. That airplane still is "Unrecognized."

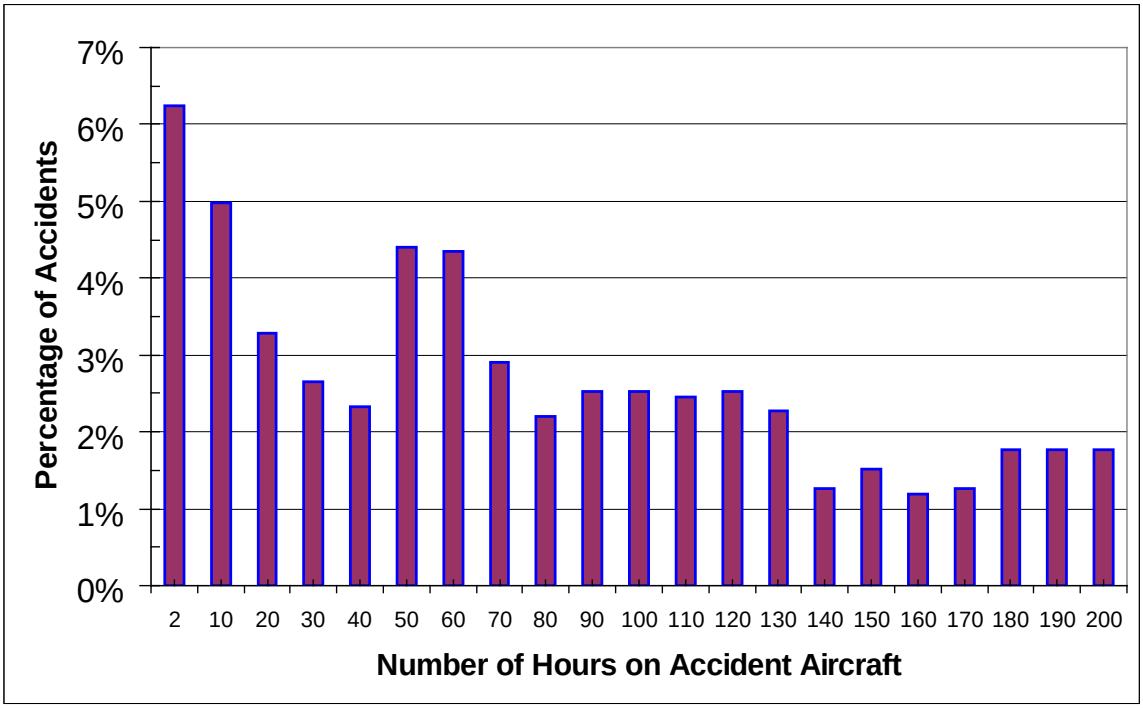
As I've mentioned, the January 2009 FAA database shows 31,242 Experimental Amateur-Built aircraft. The same database lists over 36,000 aircraft with blank certification!

Are they all Experimental Amateur-Built? Unless there's some very prolific builders out there named "Boeing" and "Cessna," probably not. But eliminating the obvious non-homebuilts and the obvious SLSAs, one is still left with over 12,000 aircraft.

This means that the homebuilt fleet might be up to 40% larger than the official figures claim. This, again, would cause a significant reduction in the homebuilt accident rate.

The Effect of Test Period Accidents

One major factor in homebuilt safety statistics is the accident rate during the first flight and test period. In the period between January 1998 and December 1997, over 6% of the total homebuilt accidents occurred on first flights. Nearly 20% of homebuilt accidents (19.4%) happened before the homebuilt reaches 40 hours (the length of the nominal Phase 1 test period). The figure below shows how the number of accidents tapers off as the plane (and the pilot!) build more time.



A pilot contemplating the first flight of his new homebuilt has about a 0.75% probability of suffering a reportable accident, or about a one in 133 chance. This is approximately equal to the overall homebuilt accident rate—which means that *the first flight of a new homebuilt has the equivalent risk to a whole year of flying*.

All told, there is about a one in 43 chance that a given homebuilt will have an accident during its 40-hour test period.

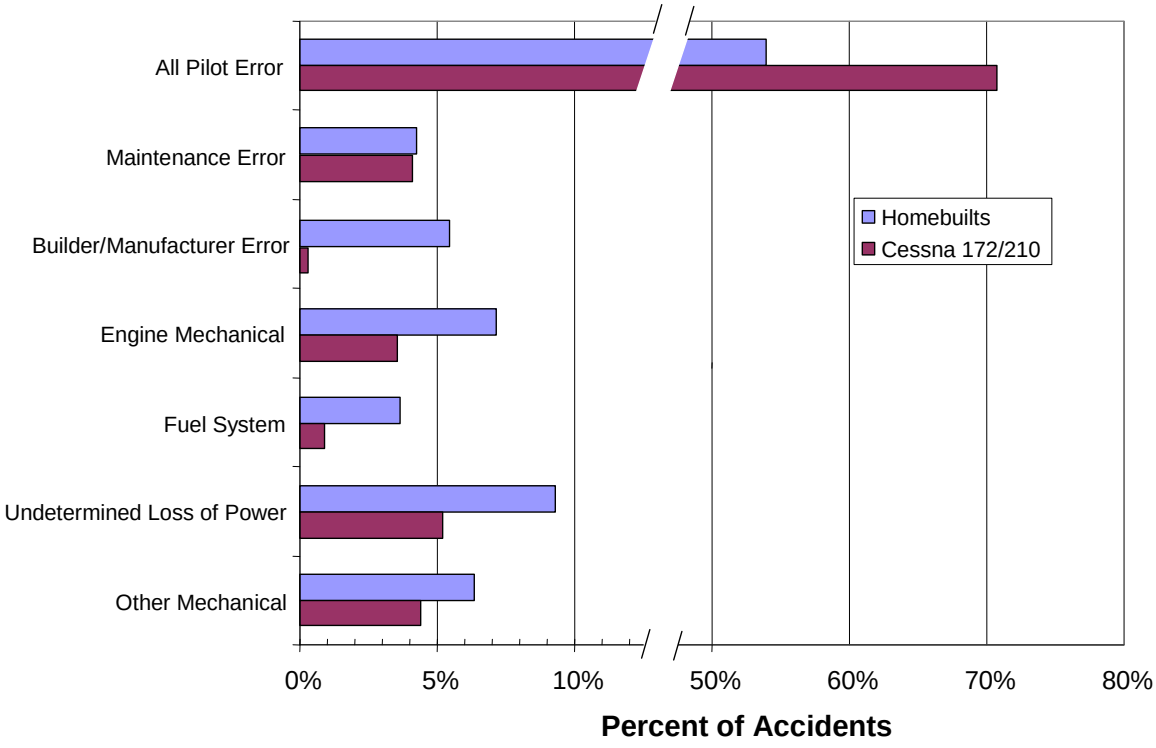
Causes of Homebuilt Accidents

Using the ten-year database described earlier, I compared the causes of homebuilt accidents vs. that of a "Control Group" consisting of Cessna 172 and 210 aircraft. Cessna 210s were added in order to provide a leavening of complex aircraft to try to approximate the high-performance homebuilts in the fleet. The Control Group did not include accidents which occurred during training, as homebuilts can be used for instruction only in limited situations.

The results are shown in the figure below. Homebuilt aircraft suffer a significantly lower rate of pilot error than the Control Group, but a higher rate of mechanical failure.

The mechanical failures related to the engine are probably due to the high percentage of experimental engines installed in these experimental aircraft. In 2008, for example, less than 40 percent of the accident aircraft carried a traditional aircraft engine (Lycoming, Continental, etc.), while 35 percent of the aircraft mounted either an auto-engine conversion or a two-stroke engines.

Use of non-traditional engines is one of the most cherished aspects of the homebuilt aircraft movement, but it does present increased risk.



The higher percentage of experimental engines may contribute to the higher rate of "Undetermined Loss of Power," as well. For accidents involving aircraft with certified engines, representatives of the engine manufacturer often contribute to the investigative process. This level of support is not as available, for accidents in the Experimental Amateur-Built category. With unusual, custom-built engine types, investigators are probably forced to list the engine failure reason as "undetermined" more often than usual.

In a number of the "Undetermined Loss of Power" incidents, the engine was able to be started afterwards. Some may, then, actually be "Pilot Error: accidents, involving carburetor icing or mismanaging a new aircraft's fuel system.

Note the relative rate of "Builder/Manufacturer Error" between the homebuilts and the Cessna control group. The reason is obvious; the typical amateur builder does not have the involvement of professional Quality Control personnel, nor are they building a continuous stream of "cookie cutter" airplanes.

In contrast, the "Maintenance Error" rate shows nearly a dead heat between the two categories of aircraft. This is a tribute to the homebuilder community, in that the "amateur maintainers" have an error rate very close to the professional mechanics that service the Cessna control group.

Conclusions

The mismatch between the definitions of "Homebuilt" between the NTSB and the FAA can result in an exaggerated accident rate. The rate of Amateur-Built aircraft failures should be determined based on Amateur-Built accidents alone, rather than lumping together a large gamut of non-Standard aircraft.

The homebuilt fleet size is larger than officially acknowledged, as well, which also argues for a lower accident rate. It's almost impossible to determine the actual number of actual homebuilts among the "unrecognized" aircraft. Certainly all 12,000 are not "real," but judging from their presence in the accident lists, many of the unrecognized homebuilts are active aircraft.

First flight and test period accidents have a significant impact on the accident rate, as well. With the higher accident rate during the test period, the importance of the EAA Technical Counselor and Flight Advisor programs should be very clear.

But when all is said and done, the accident rate for Amateur-Built aircraft <u>is</u> going to be higher than Standard-category aircraft. Homebuilt aircraft are amateur-built, amateur-maintained, amateur-flown, and often amateur-designed. The fact that more than 1,000 new homebuilts safely complete their test period every year speaks well of the abilities and dedication of the typical builder.

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