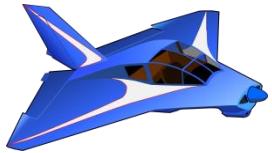
What Kills Us

A Look at Fatal Homebuilt Accidents and their Causes

Ron Wanttaja
EAA Chapters 26 & 441

Agenda

- Use the NTSB accident database to identify fatal homebuilt accidents from 1998 through 2019
- Look at the causes
- Examine which types of accidents are more likely to result in fatalities
  - And where risk reduction activities might be best applied



Who Am I?

- Retired Boeing Space Systems Engineer
- Frequent contributor to KITPLANES magazine, author of the book *Kit Airplane Construction*
- Studying homebuilt accidents as a hobby since 2000
- A presenter at DOT “Homebuilt Accident Investigation” course
- Owner/Maintainer of Bowers Fly Baby homebuilt (and the Fly Baby web page)

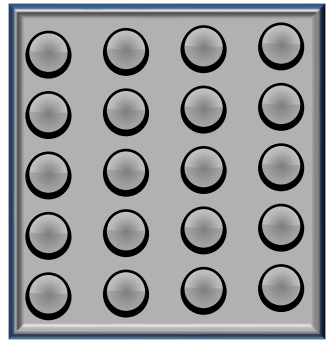
Why Look at Fatal Accidents?

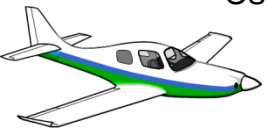
- To a homebuilt owner any accident is a tragedy
- Fatal accidents provide (mostly) the best data
  - Homebuilders QUITE accustomed to disassembling and trailering their aircraft
  - NTSB 830 open to (generous) interpretation
- FAA and EAA work together, have thresholds for fatal accidents

Boilerplate

(You'll see this on every presentation I do)

- Analysis is based on my own analysis of Experimental/ Amateur-Built (EAB) aircraft in the NTSB accident list
  - I make my own assessment of cause; don't automatically use the NTSB's "Probable Cause"
- Analysis features:
  - Download of the database itself, not on the online version
  - Data covers 20+ years starting in 1998
  - Includes only Experimental Amateur-Built aircraft built/operated in the US as personal aircraft
    - No SLSA/ELSA, Ultralights, Air Show/Racing aircraft, 737s, Beech Bonanzas, etc.
    - No foreign accidents, no foreign homebuilts in the US (were not built to US Amateur-Built aircraft requirements)
    - Above criteria eliminated ~25% of 2014 fatal accidents that were flagged as "Amateur-Built" in the online NTSB data
- Also search overall accidents for aircraft that were EAB but were not labeled "Homebuilt"…are added to the database
  - Usually 5-10 every year





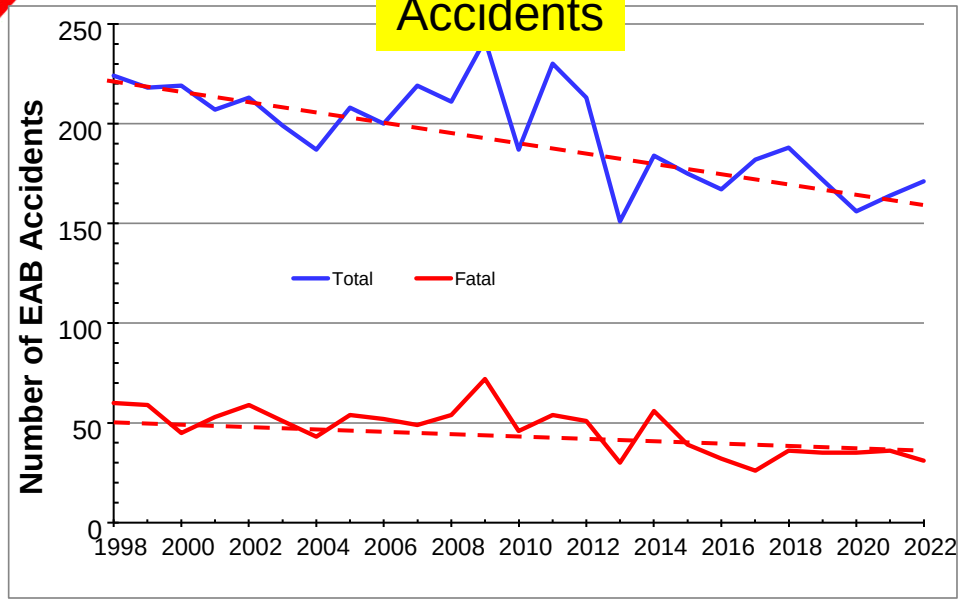
Overall Fatality Rates

Definition of “Fatal Accident”:

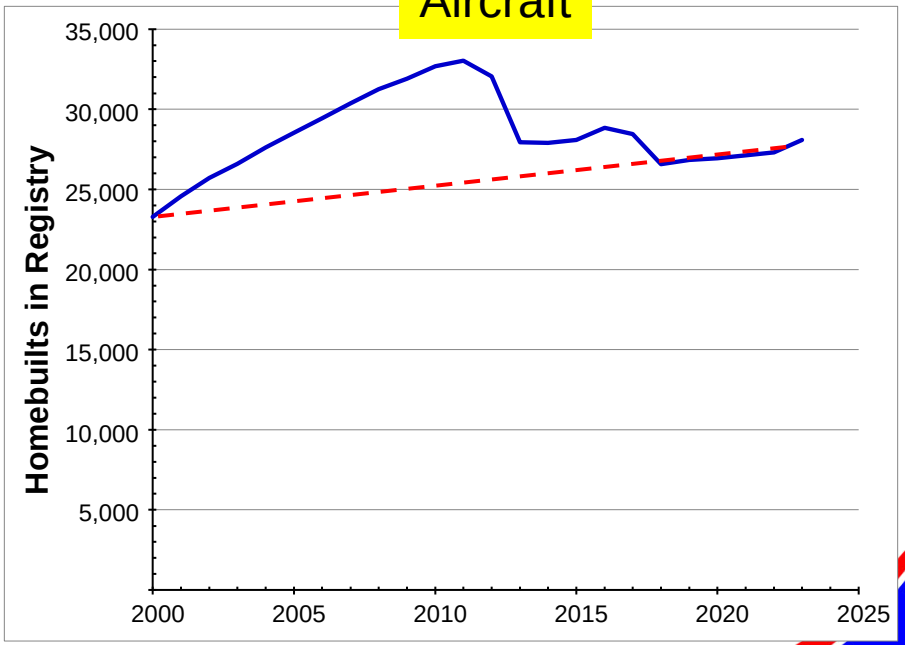
At *least* one fatality occurred

Accidents, Fatal Accidents, Number of Homebuilts

Accidents



Aircraft



Number of Accidents Trending Downward….

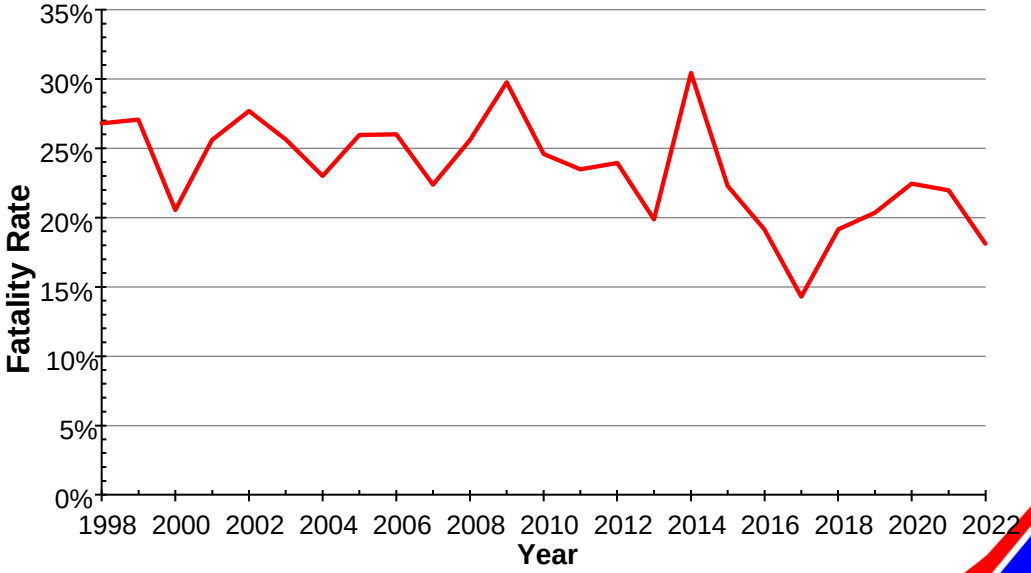
… While Number of Homebuilts Increases

Fatality Rate

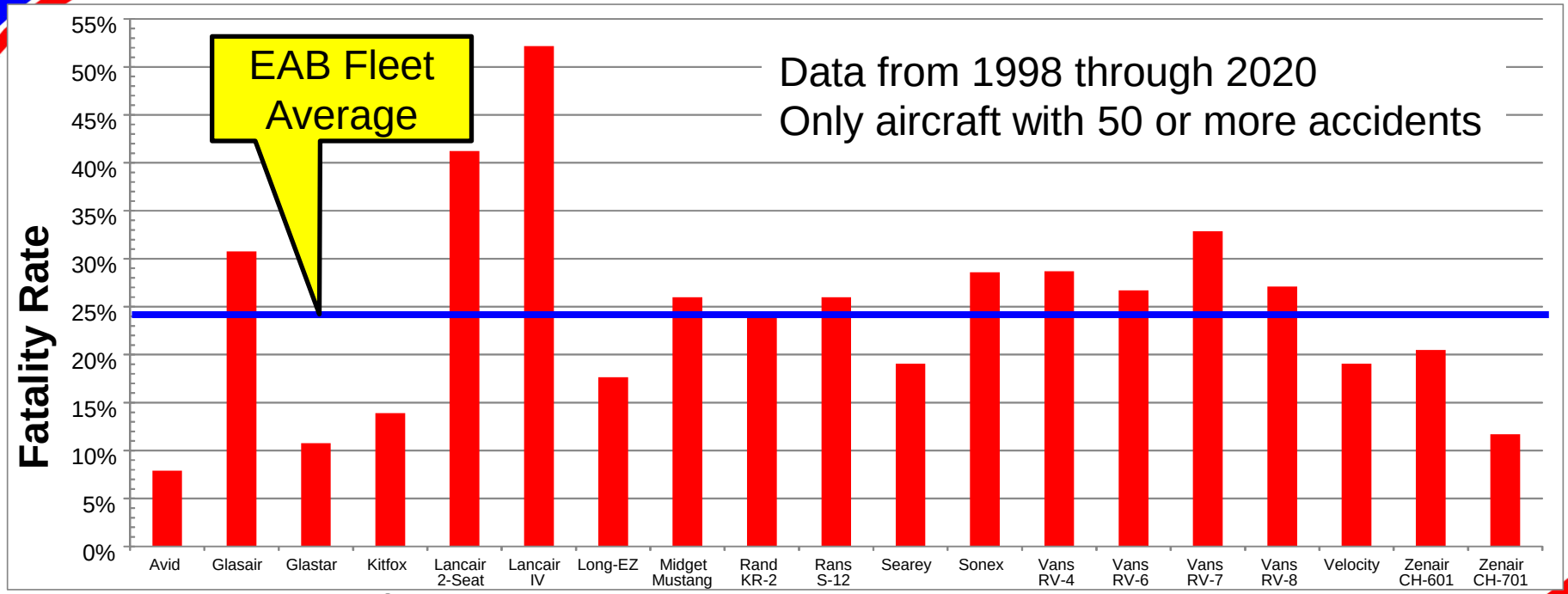
- Key analysis factor is “Fatality Rate”: How many accidents result in at least one fatality
  - E.g., three fatal accidents out of ten aircraft is a 30% fatality rate

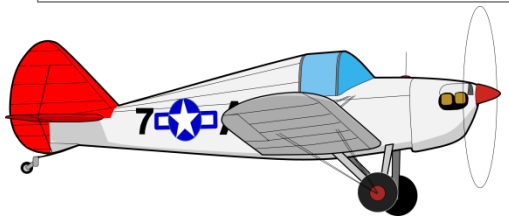
Fatality Rate Over Time

- Fatality Rate has stayed roughly the same since 1998
- General trend seems downward from 2015 on
- Overall Rate: 24.8%
  - One out of every four homebuilt accidents is fatal



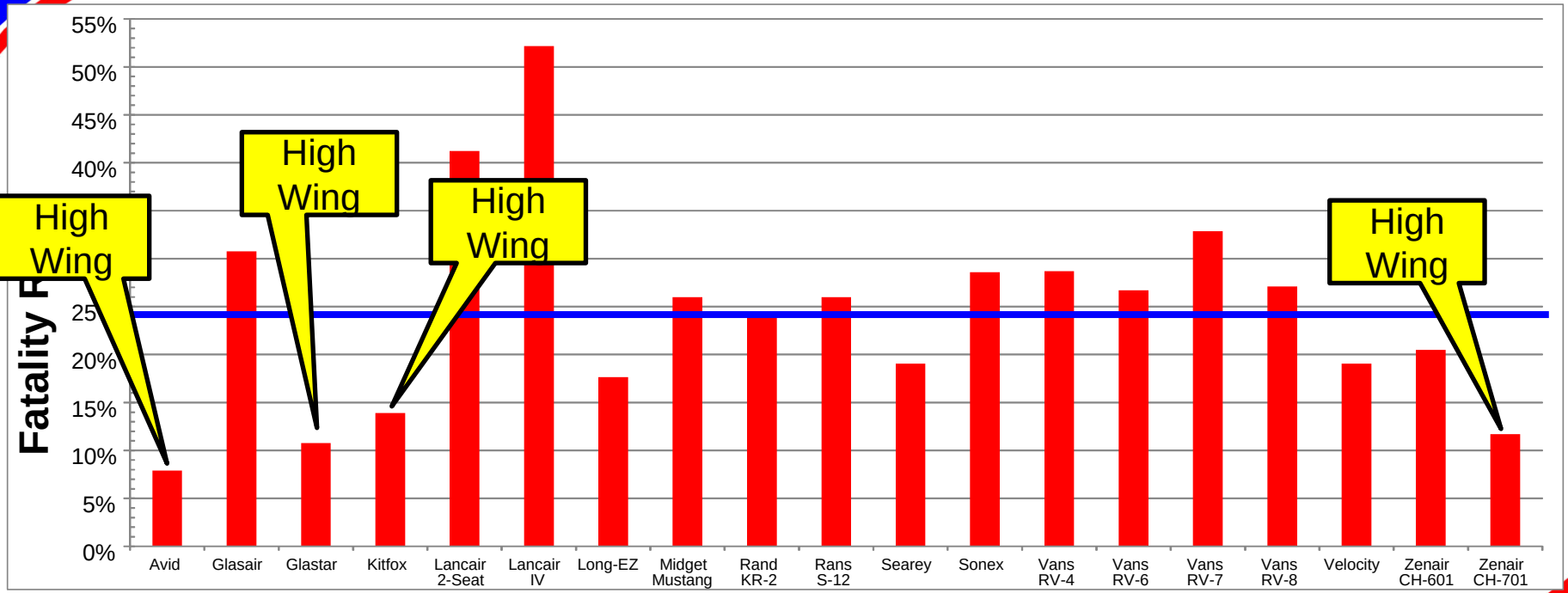
Fatality Rate by EAB Type





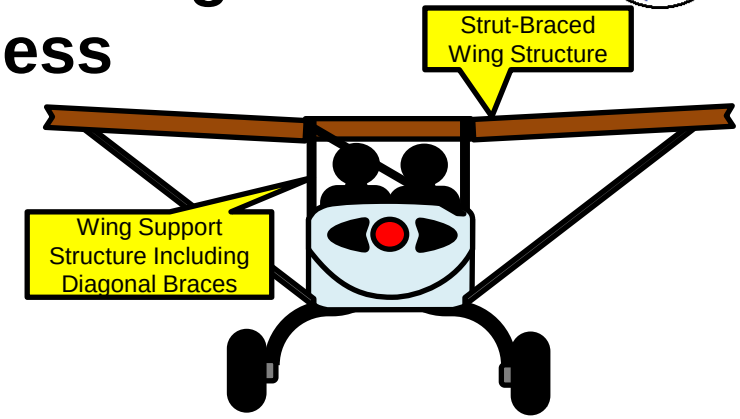
Q. What is common among the best scoring aircraft?
Q. What is common among the highest-scoring aircraft?

Best (Lowest) Scoring EAB

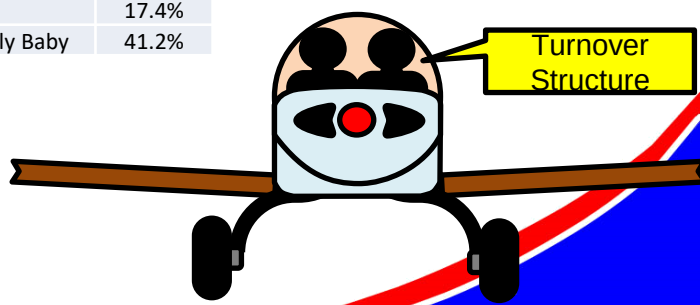


High Wing vs. Low Wing Crashworthiness

- High wing aircraft put significant amount of structure around occupant's heads
  - Struts, carry-through spars, even diagonal bracing
- Low wing aircraft might have a turnover structure
- Below-threshold aircraft are consistent
- **But…performance enters into the equation, too….**

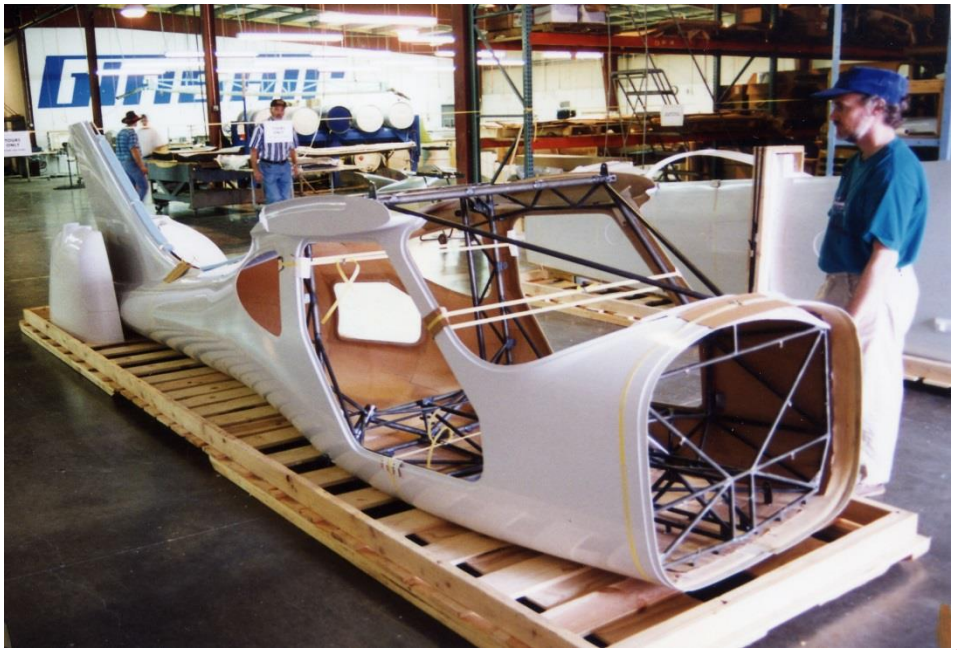


Pietenpol	11.1%
Rans S-6	21.6%
Zenair CH-750	5.9%
Rans S-7	17.4%
Bowers Fly Baby	41.2%

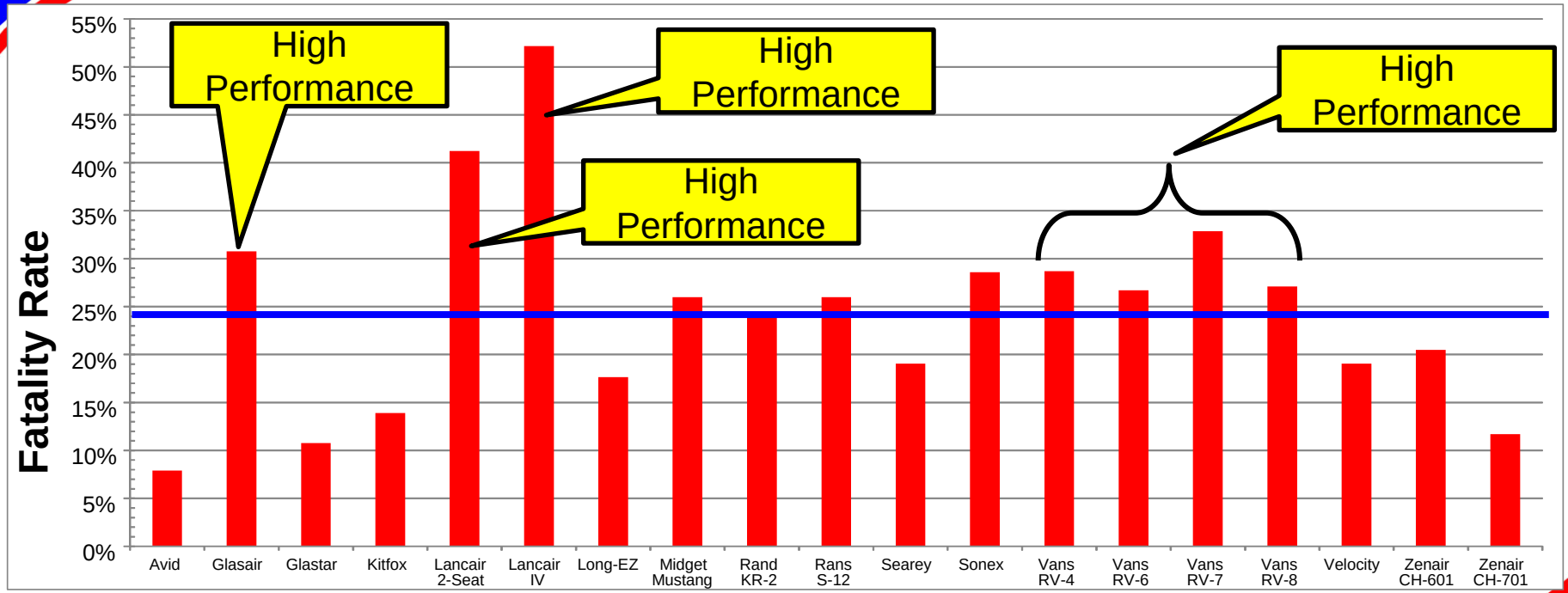


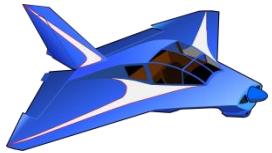
A Look at the Glastar Structure

- Higher performance than most high-wing homebuilts
- 2nd lowest fatality rate (10.8%)
- Cruises ~15% slower than the RV-9, has about half the fatality rate



Higher Fatality Rates





You can't avoid $\frac{1}{2}mv^2$

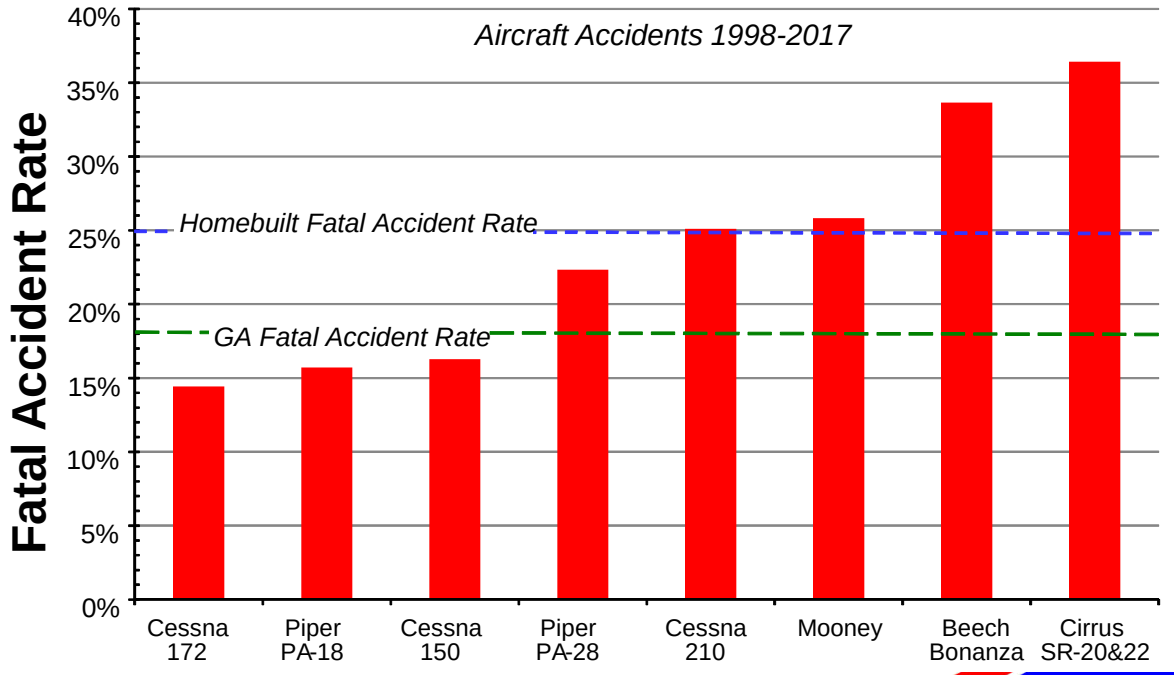
In Defense of the Lancair IV

- Lancair IV has about the same performance envelope as the Curtiss P-40!
- Accidents have dropped drastically
  - 2001-2010: 38
  - 2011-2020: 23
    - Just four in past five years
- Low-Time pilots NOT a factor!
  - Overall EAB accident median 1000 hours
  - Lancair IV accident median 2500 hours!
    - Less than 1/10th of accident pilots had less than 1,000 hours

	Lancair IV	P-40	
Max Speed	342	334	MPH
Cruise Speed	335	308	MPH
Stall Speed	71	75	MPH
Wing Loading	36.2	35.1	Lb/Ft^2
Power Loading	0.1	0.14	hp/lb

Comparing Homebuilt to Production Fatality Rates

- Homebuilts have a ~25% Fatality Rate
- GA Average is ~18%!

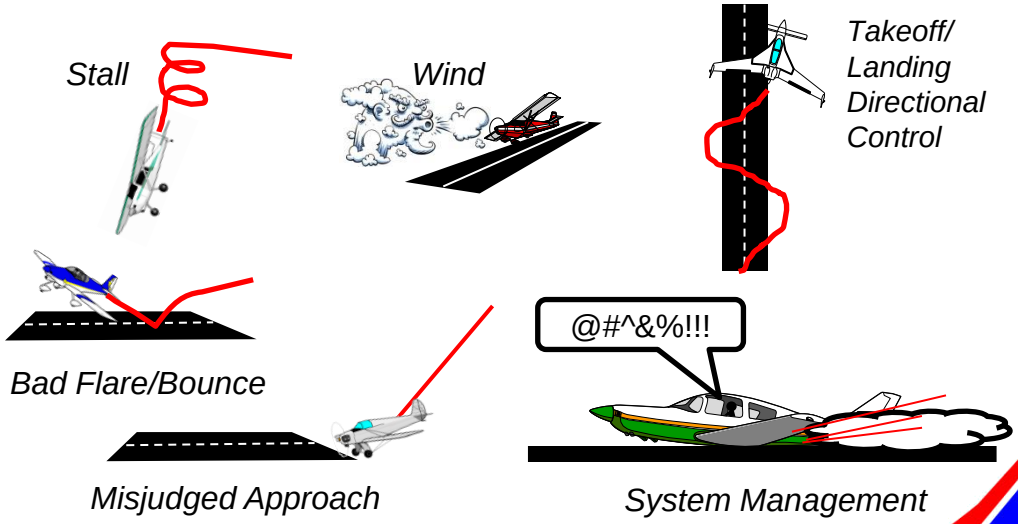


Causes of Fatal Homebuilt Accidents

Pilot Miscontrol

- "Pilot Miscontrol" is my version of "Loss of Control"
  - Accounts for 40% of all accidents
- Refers to accidents caused by failure of the pilot's stick-and-rudder skills
  - Judgement issues (fuel exhaustion, CG, Continued VFR in IFR Conditions) are tallied separately
- "Pilot Miscontrol" is assigned only in cases where there weren't any problems with the aircraft
  - Doesn't include, for instance, stalling after an engine failure
- Secondary causes added to Pilot Miscontrol where appropriate
  - Can list more than one sub-category

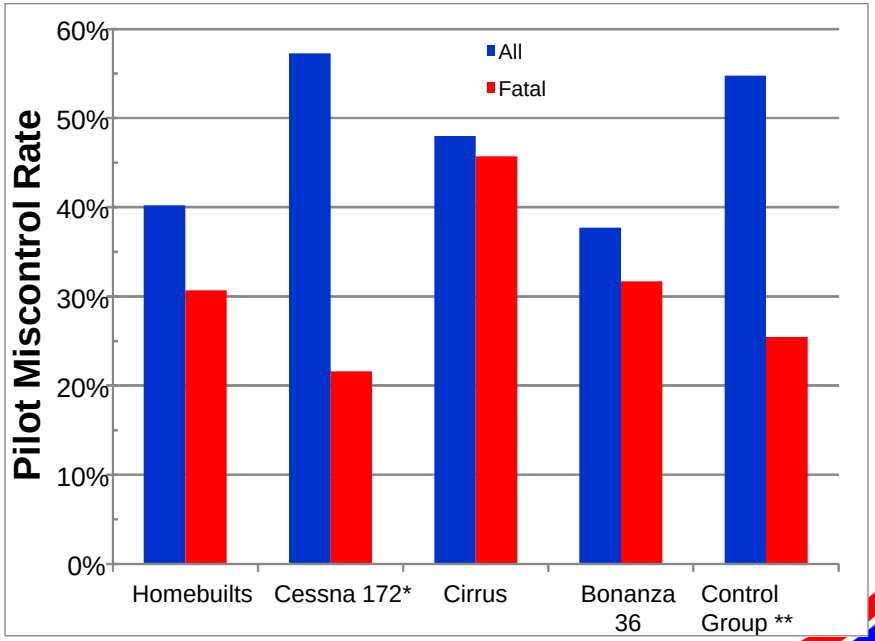
Pilot Miscontrol Secondary Causes



Pilot Miscontrol is the Single Most-Common Accident Cause

Pilot Miscontrol Rate in Fatal Accidents

- Pilot Miscontrol is less apparent in fatal accidents
- However: Most Pilot Miscontrol cases occur in the runway environment!
  - Lower speeds, closer to ground, less likely to be fatal
- Need to look separately at stalls after engine failure



** Training accidents excluded*
*** Combination of C172 and C210*

Stalls After Engine Failure

- Current Miscontrol/Stall records don't include cases where engine quit
- Do have a flag for accidents involve loss of power (mechanical or pilot-related)
  - Fatality rate when engine failure occurs is actually lower (30.5% vs. 21.9% for fatal accidents)
- Generate second flag from "Stall" or "Airspeed" keywords in NTSB Probable Cause
  - Manually check for ambiguity

11/18/2021: Slight update to table (correcting a tenth of a percent either way)

	All	Fatal
Percentage involving Miscontrol with Stall (e.g., no engine issues)	8.5%	16.6%
Percentage with engine failure and Stall Flag*	3.7%	9.5%

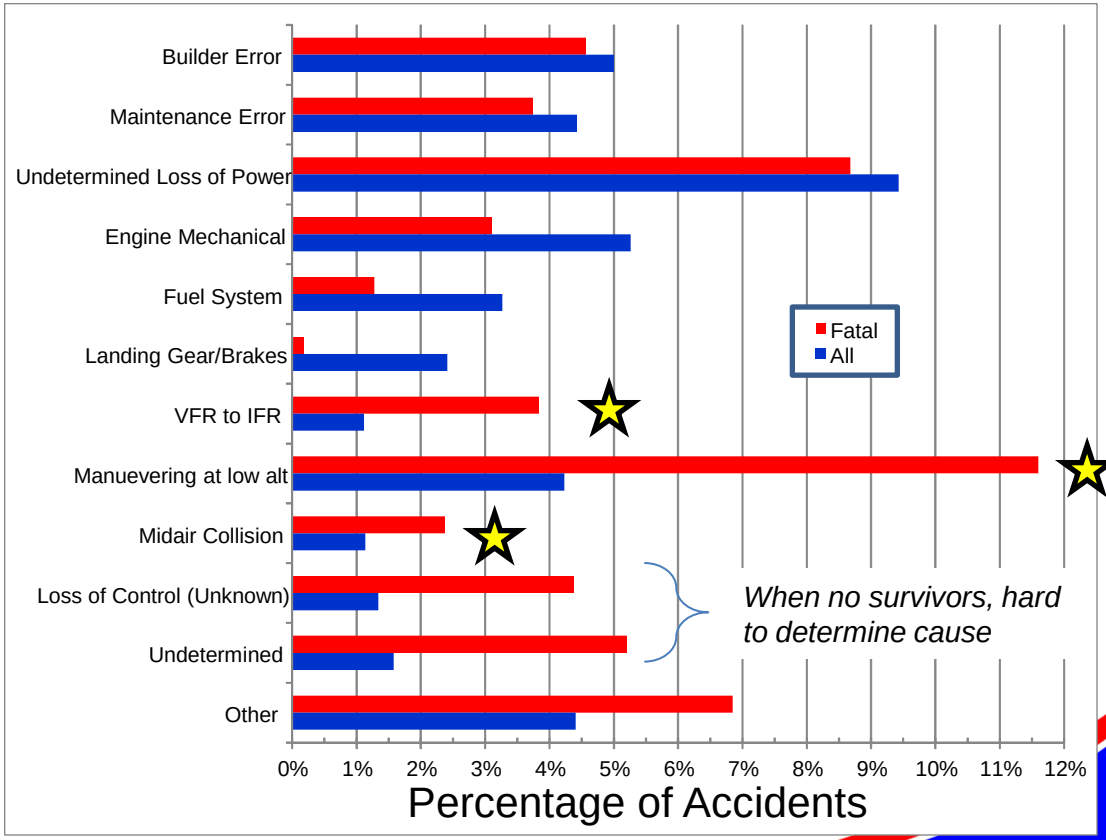
Percentages are of either all accidents or all fatal accidents

About 6.3% of ALL Homebuilt Accidents are Stall-Related Fatals

** "Stall Flag" based on keywords in Probable Cause*

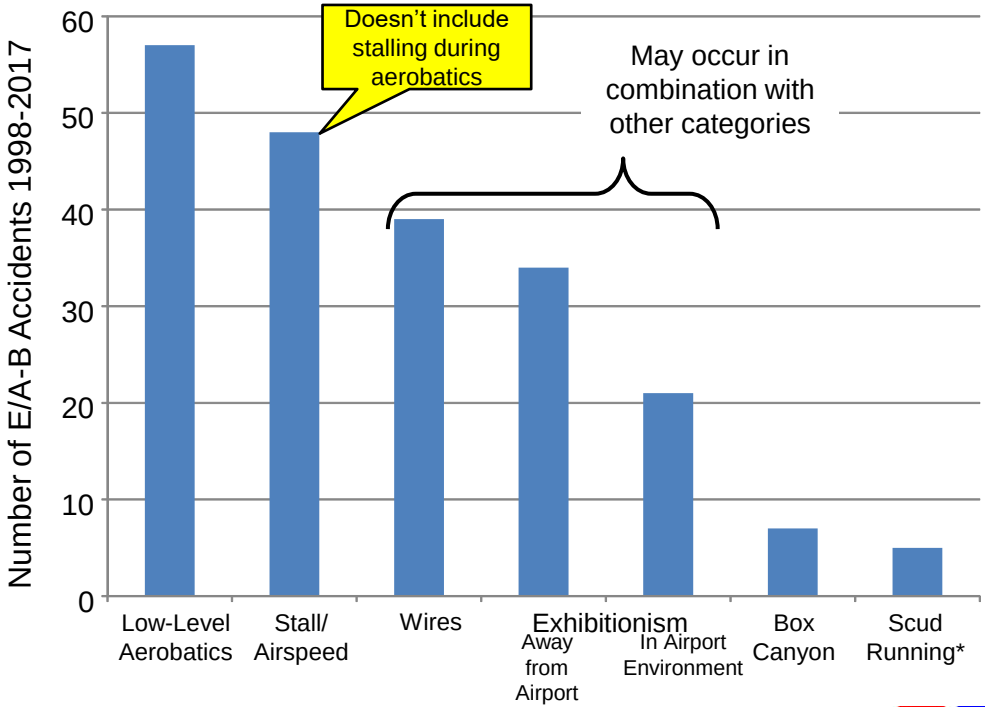
Other Causes

- Engine failures have a lower fatality rate
  - 21% vs. 30% for all accidents
- Over 11% of all fatal accidents involve maneuvering at low altitude
  - Overlap with some stall cases, of course
- Continued VFR into IFR conditions is a concern, but not as much as some people think
  - Barely 1% of total homebuilt accidents
  - Does tend to be fatal!
- 36% of the midairs involved formation flying!
  - 68% of the formation accidents were RVs!



Maneuvering at Low Altitude – What We're Doing

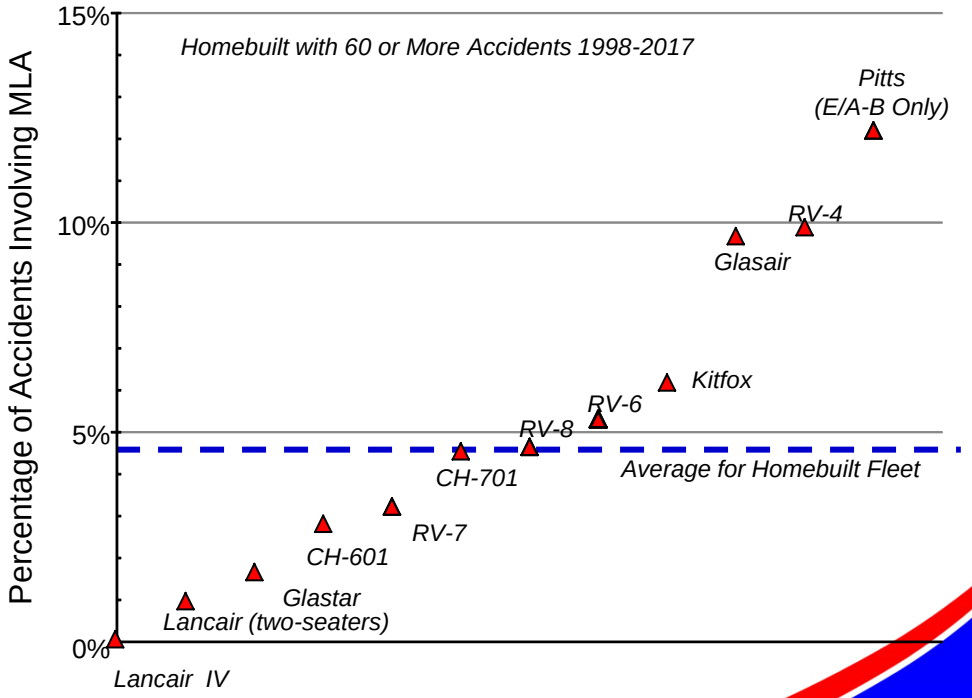
- "Maneuvering at Low Altitude" covers a number of risky activities
  - "Used to call it SALA ("Stupidity at Low Altitude")
- Instances may also be counted among the "Stall" tally
- Failure to recover from an aerobatic maneuver NOT included in this category
  - As long as maneuver was started at a legal altitude
  - 24 cases of this type
- Airshow accidents also not included



* Does not include clear cases of continued VFR into IFR conditions

Maneuvering at Low Altitude – Who's Doing It?

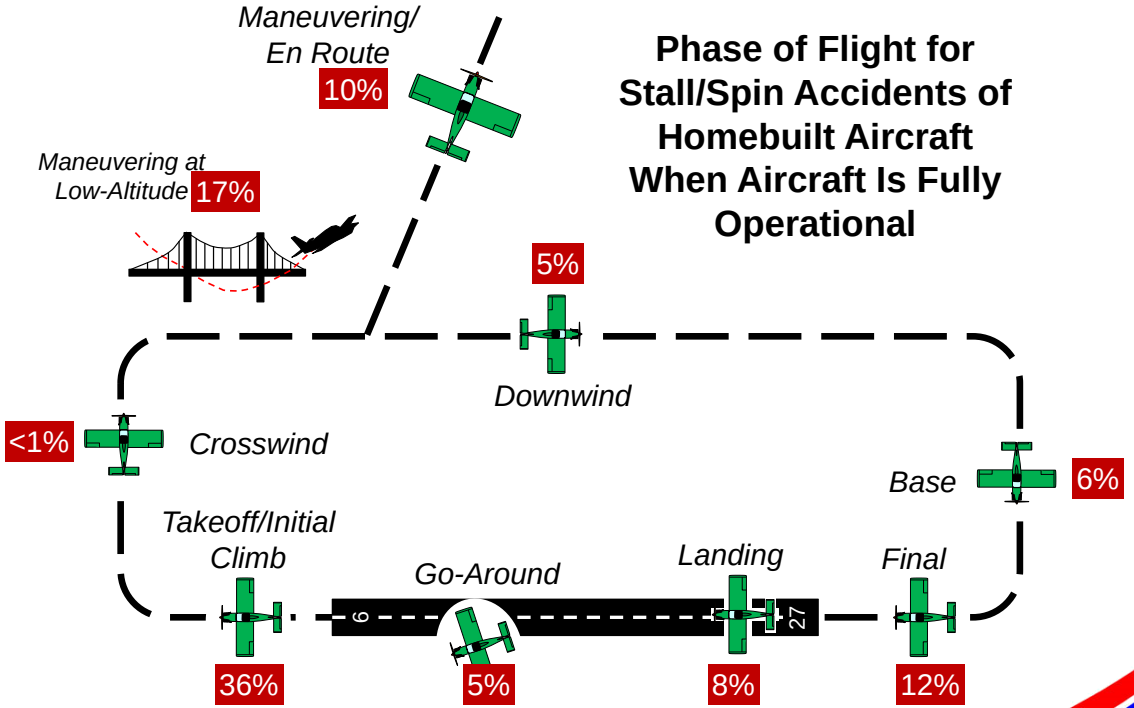
- You'd think it would be biased towards "Sport" homebuilts (vs. cross-country cruisers)
  - Yet nine out of 104 Glasair accidents involved low flying
  - Five were low-level aerobatics!
- Pitts also had nine accidents
  - All but two involved aerobatics….
- Surprisingly, in terms of <u>number</u> of accidents, the Kitfox is the "winner"
  - 14 during the analysis time period
  - Lower percentage due to size of fleet
  - RV-6 and RV-4 get the #2 and #3 position…



Stalls and the Homebuilt Owner

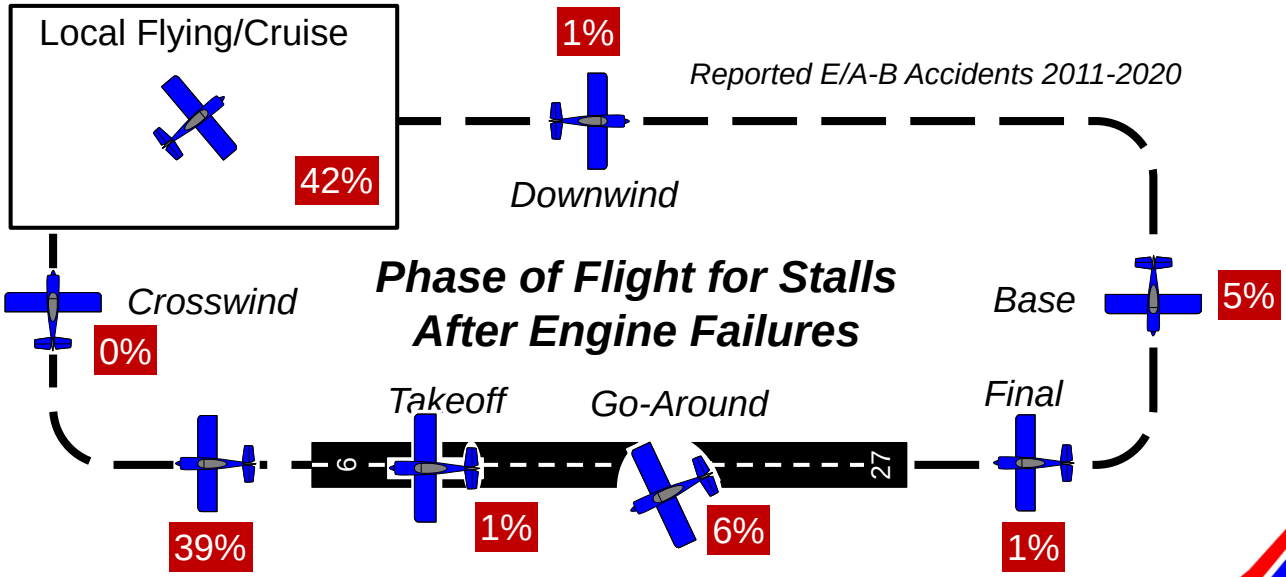
Where Stalls Occur: Engine Running

- Diagram shows where stall/spin accidents occur when engine power is available
- Base-to-Final is about 18%
  - TWICE as many stalls happen on the takeoff or initial climb



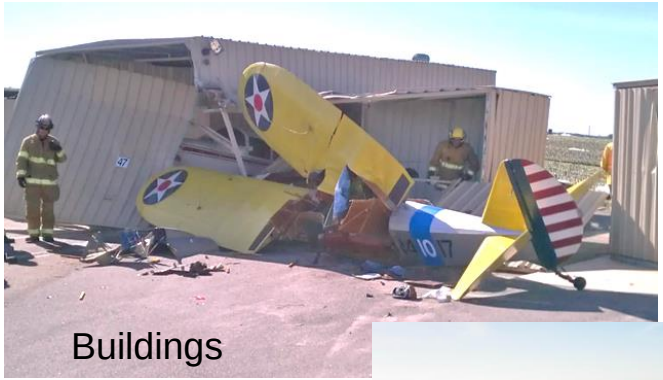
Where Stalls Occur: After Engine Failure

- Majority occur on takeoff, initial climb, or go-around
  - Engine under the most stress



Picking the Forced-Landing Spot

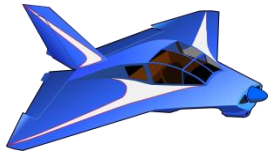
- If you keep control of the aircraft, you might have a choice in the spot the airplane will end up
- What's the survival rate for various types of terrain?


Buildings


Open Fields


Water


Trees



Survival Rate After Engine Failure

When the Pilot Maintains Control of the Aircraft

	Runway Environment	Heavy Brush	Buildings	Fences	Rough Terrain	Water	Road/ Ditches	Power Poles/ Lines	Trees	Marsh	Short of Runway	Pasture/ Fields
Cases*	71	15	18	22	13	12	50	16	70	9	27	162
Survival Rate	92%	100%	75%	100%	92%	100%	96%	80%	82%	75%	100%	93%

Average 89% Survival Rate

* Some cases involve more than one object

Survival Rate After Engine Failure

When the Pilot Maintains Control of the Aircraft

	Runway Environment	Heavy Brush	Buildings	Fences	Rough Terrain	Water	Road/ Ditches	Power Poles/ Lines	Trees	Marsh	Short of Runway	Pasture/ Fields
Cases*	71	15	18	22	13	12	50	16	70	9	27	162
Survival Rate	92%	100%	75%	100%	92%	100%	96%	80%	82%	75%	100%	93%

Average 89% Survival Rate

When the Pilot Loses Control and Stalls the Aircraft

39% Survival Rate

Summary

Type of Accident	All	Fatal
Miscontrol Stall	8.5%	16.3%
Stalls during engine-out	3.7%	9.4%
Manuevering at Low Altitude	4.2%	11.6%
Midair Collisions	1.1%	2.4%
Continued VFR in IFR Conditions	1.1%	3.8%

- About 24% of homebuilt accidents result in fatalites
- More than a quarter of fatal accidents involve stalls
  - 6.3% of all accidents
  - Continued emphasis on airspeed control and AOA systems
- Almost 12% of fatal homebuilt accidents involve “stupidity at low altitude”