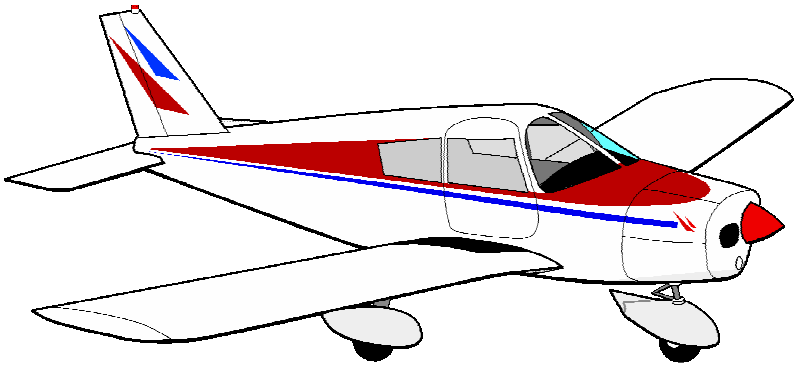
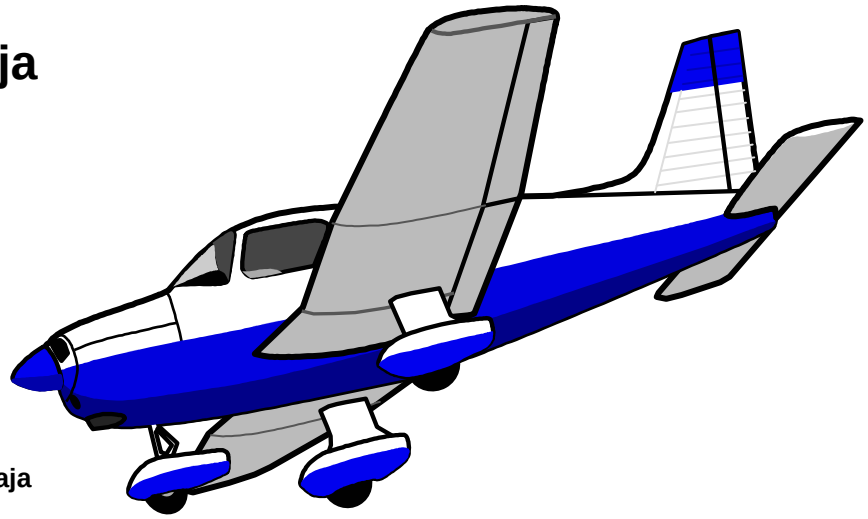


Cherokee Accidents and Safety Review

A Statistical Analysis

Ron Wanttaja



On Statistics

- **“Statistics are like bikinis. What they reveal is interesting. What they conceal is vital!”**
  - **Professor Aaron Levenstein**

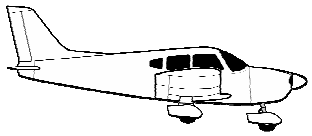
- **“The purpose of analysis is insight, not bull****”**
  - **T.C. Weston, The Boeing Company, 1974**

Basic Process

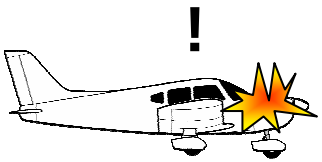
- **Extract the appropriate Cherokee accidents from the NTSB databases from 2001 to 2010**
  - **Leave off foreign accidents**
- **Determine "fleet size"**
  - **Average number of aircraft from Dec 2000 to January 2011**
- **Assemble accidents into an analysis database using existing template**
- **Determine accident causes**
  - **Read the narrative (not Probable Cause) of each accident**
  - **Assign to one of 50+ cause categories**
- **Compare causes for Cherokees vs. a "control group"**
- **Compare...contrast...analyze**

Why Not Just Use the NTSB's "Probable Cause"?

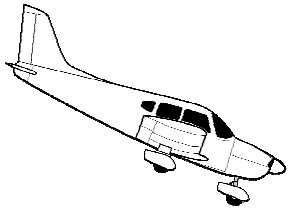
A Typical Accident



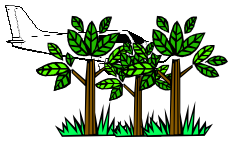
Flying Along



Engine Quits



Heading for forced landing

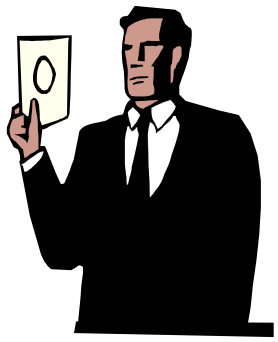


Landed Short

The Probable Cause was the failure of an oil line....

NTSB Investigator #1

The Probable Cause was the pilot's failure to maintain his glide path...



NTSB Investigator #2

Data Sources

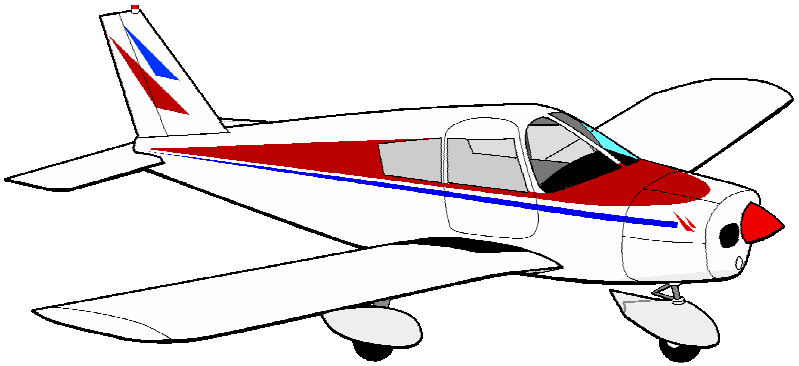
- **NTSB makes the full accident reports (less the exhibits) available for downloading**
  - **Only addressed US accidents of N-Numbered aircraft**
- **For aircraft fleet sizes, used FAA registration database**
  - **Personal tradition of downloading every January**
- **Compared PA-28 rates to those of the Cessna 172**

Average Fleet Size 2001-2010

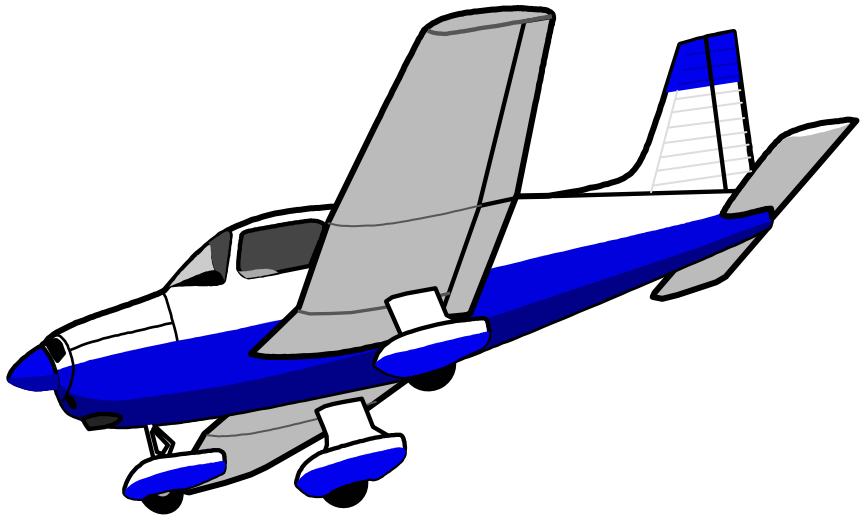
Cherokee 140	6127
Warrior I	1238
Warrior II/III	2033
Cherokee 180/Archer I	4256
Archer II/III	2509
Pathfinder	1062
Arrow II	1572
All PA-28	21417
Cessna 172	25870

Analysis Challenges

- **All "PA-28s" are not created equal!**
  - **"PA-28-XXX" Runs gamut from 140s to Arrow IIIs**
- **Several different models used the same model number for significantly different airframes**
  - **E.g., Cherokee 180 and original Archer were both PA-28-180s**
    - **Lengthened fuselage, larger wing and tail span, higher gross weight**
- **Many models have too few accidents to produce a decent sample size**
  - **For detailed analysis, required >100 accidents in the ten year period**
- **Therefore: detailed analysis only of the "PA-28 Set"**
    - **PA-28-140, -161, -180, -181**
    - **Covered other models at times**



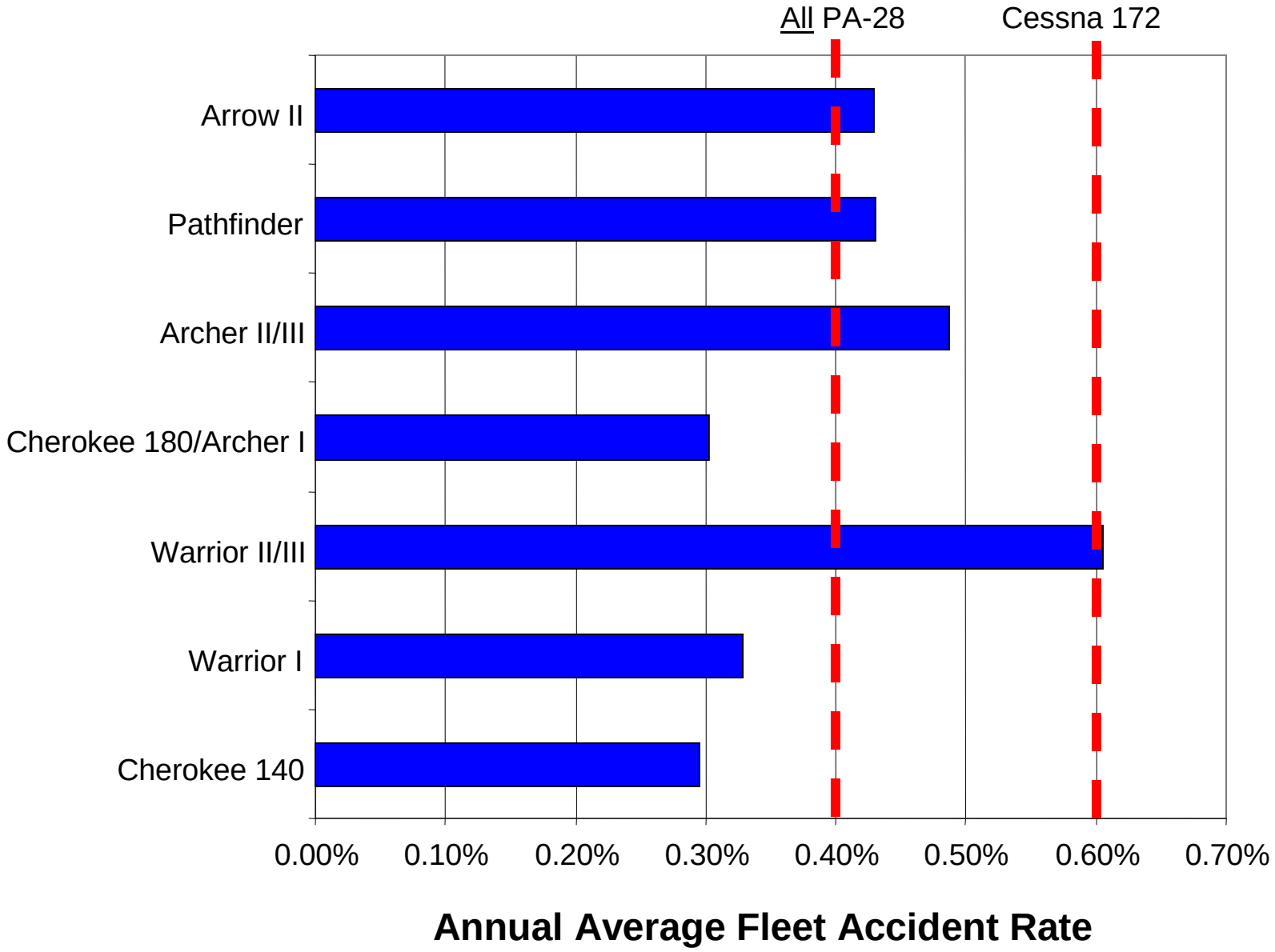
Overall Accident Rates



Terminology Note

- **"Fleet Annual Accident Rate":**
  - **Average number of accidents in a year, divided by the average number of registered examples over the same 10-year period**
  - **Does NOT take number of hours into account**
- **"Fatality Rate"**
  - **Percentage of accidents that resulted in fatalities**

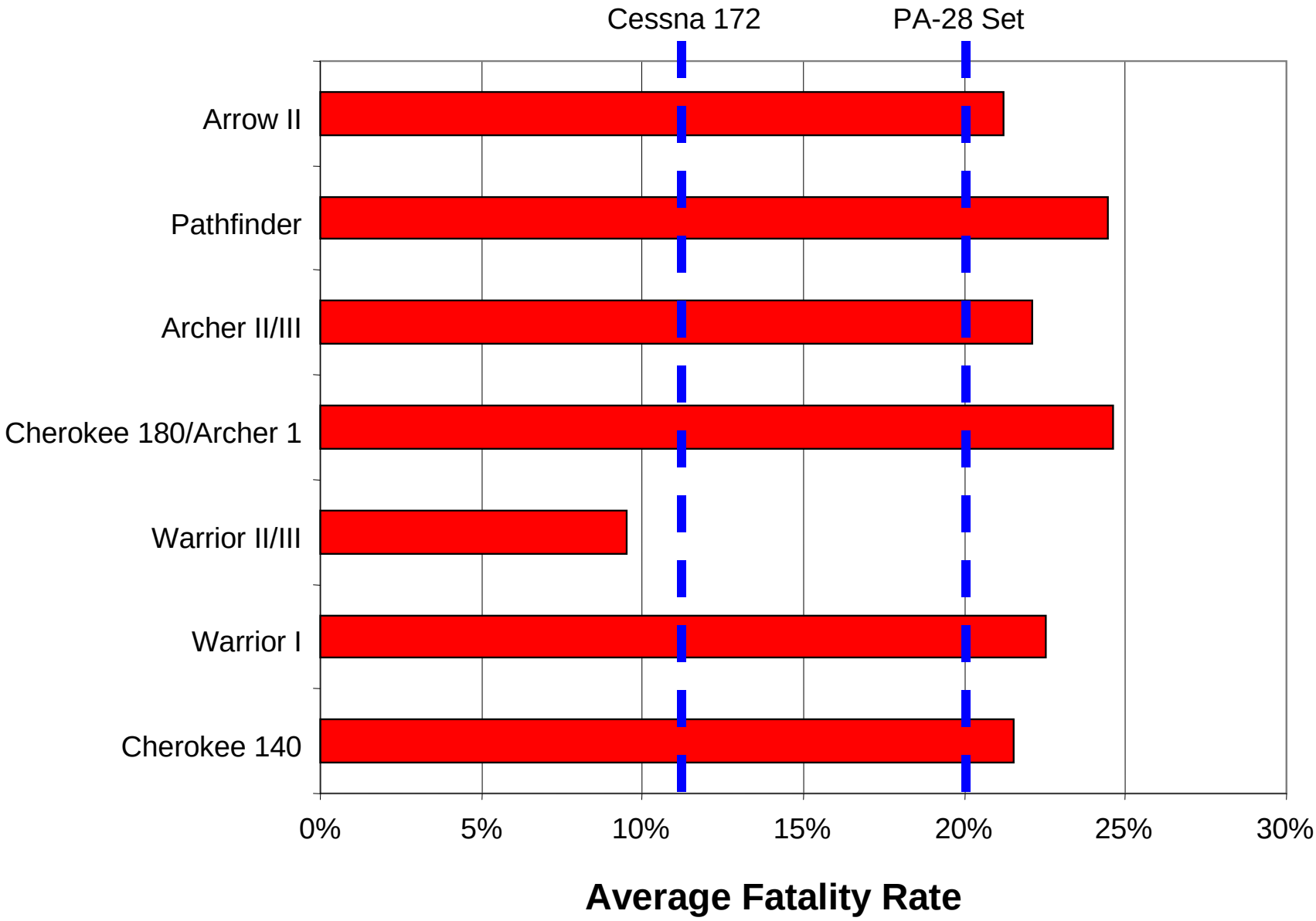
PA-28 Fleet Accident Rate



Fleet Rate Summary

- **Fleet accident rate is about 2/3rds that of the Cessna 172s!**
- **"Yes, but the Cessna 172 is used as a trainer!"**
  - **Surprisingly, the PA-28 group was involved in training accidents <u>at a nearly identical rate</u> (~30%)**
  - **Almost half the Warrior II/III accidents were during training**

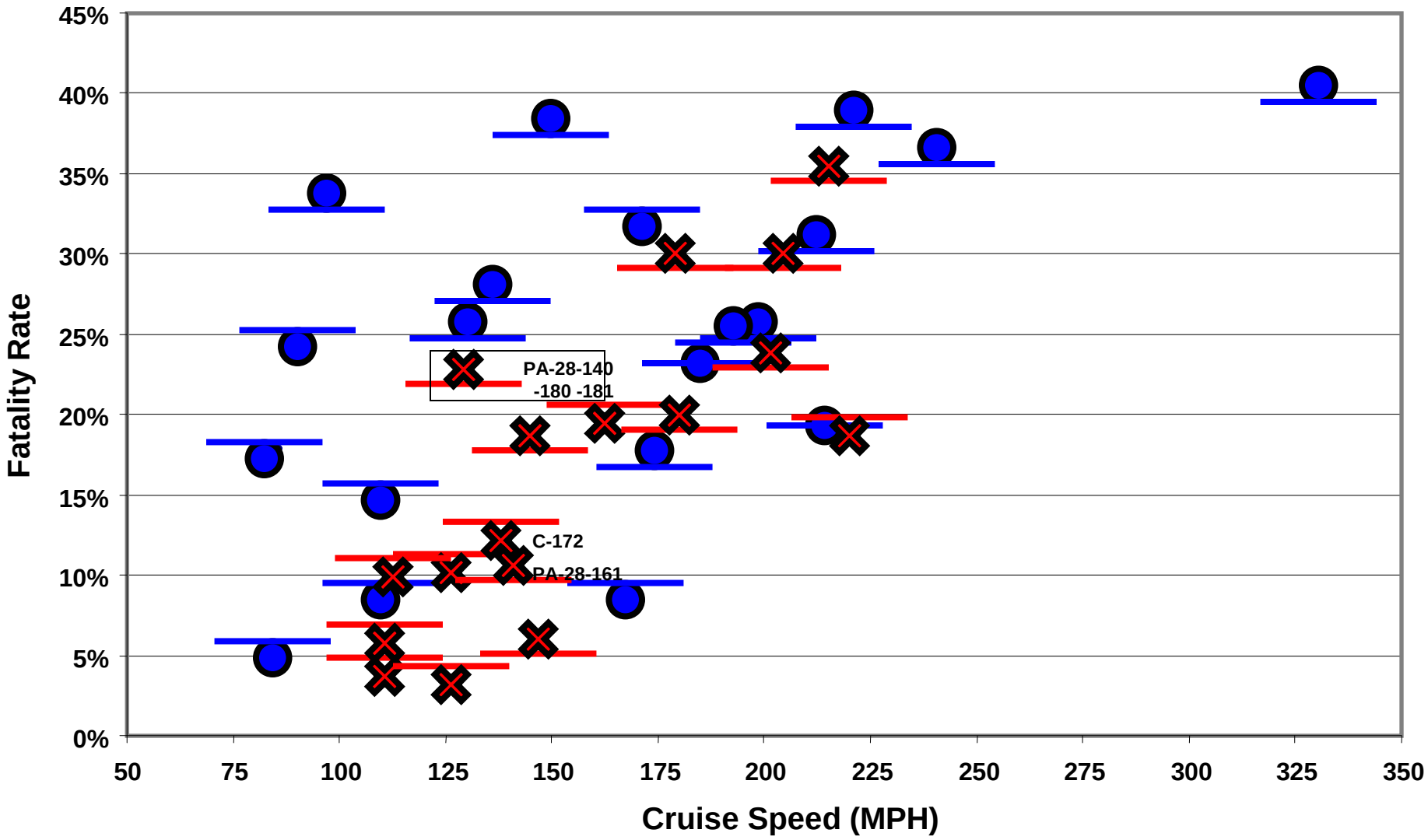
Fatality Rate



Why is the Cessna 172 Rate Lower?

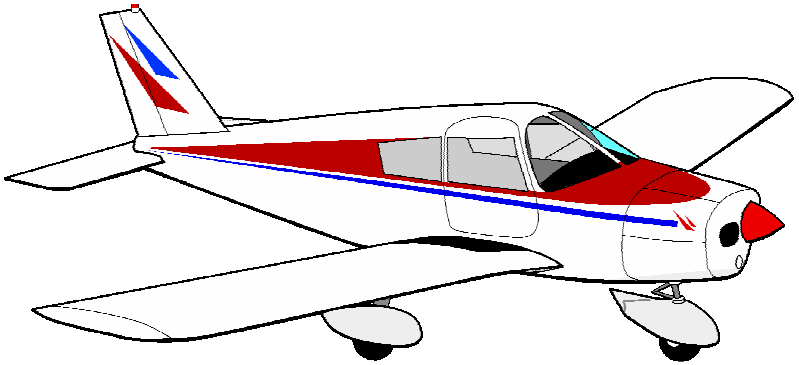
- **Energy in a crash is related to the square of the speed at impact**
  - **But speed ranges for the most-common PA-28s are about the same as the 172**
- **Note that the Warrior II fatality rate is a bit less than the Cessna 172**
  - **Training accidents are generally low-speed affairs**
- **My work with homebuilts led to a theory that wing position has strong effect on survivability**
  - **High wing places solid structure above occupant's heads**

Wing Position and Fatality Rate

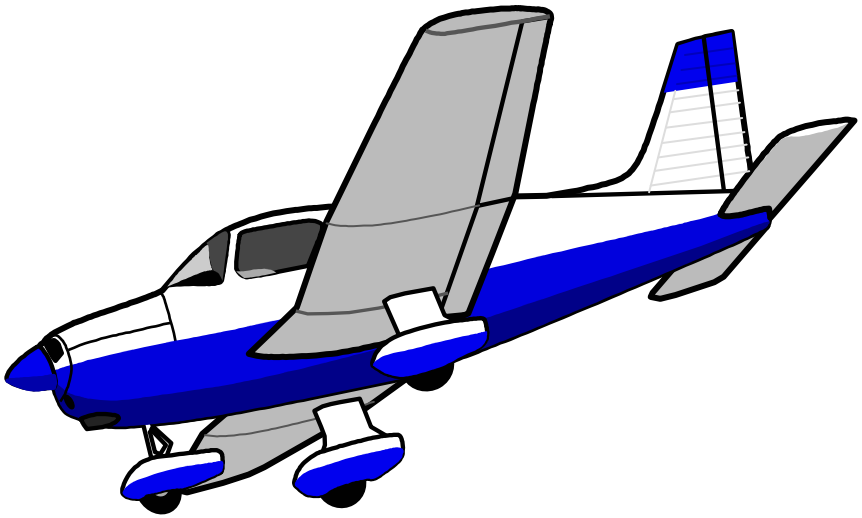


Fleet/Fatality Rate Summary

- **Training accidents affect both the fleet rate and the fatality rate**
- **The PA-28 sample used has an almost identical percentage of training accidents, but its fleet rate is about 1/3rd lower than the Cessna 172**
- **However, the fatality rate is almost twice as high as the 172**
  - **<u>May</u> be due to less occupant protection in low-wing aircraft**
  - **Only way to prove it would be an injury survey**



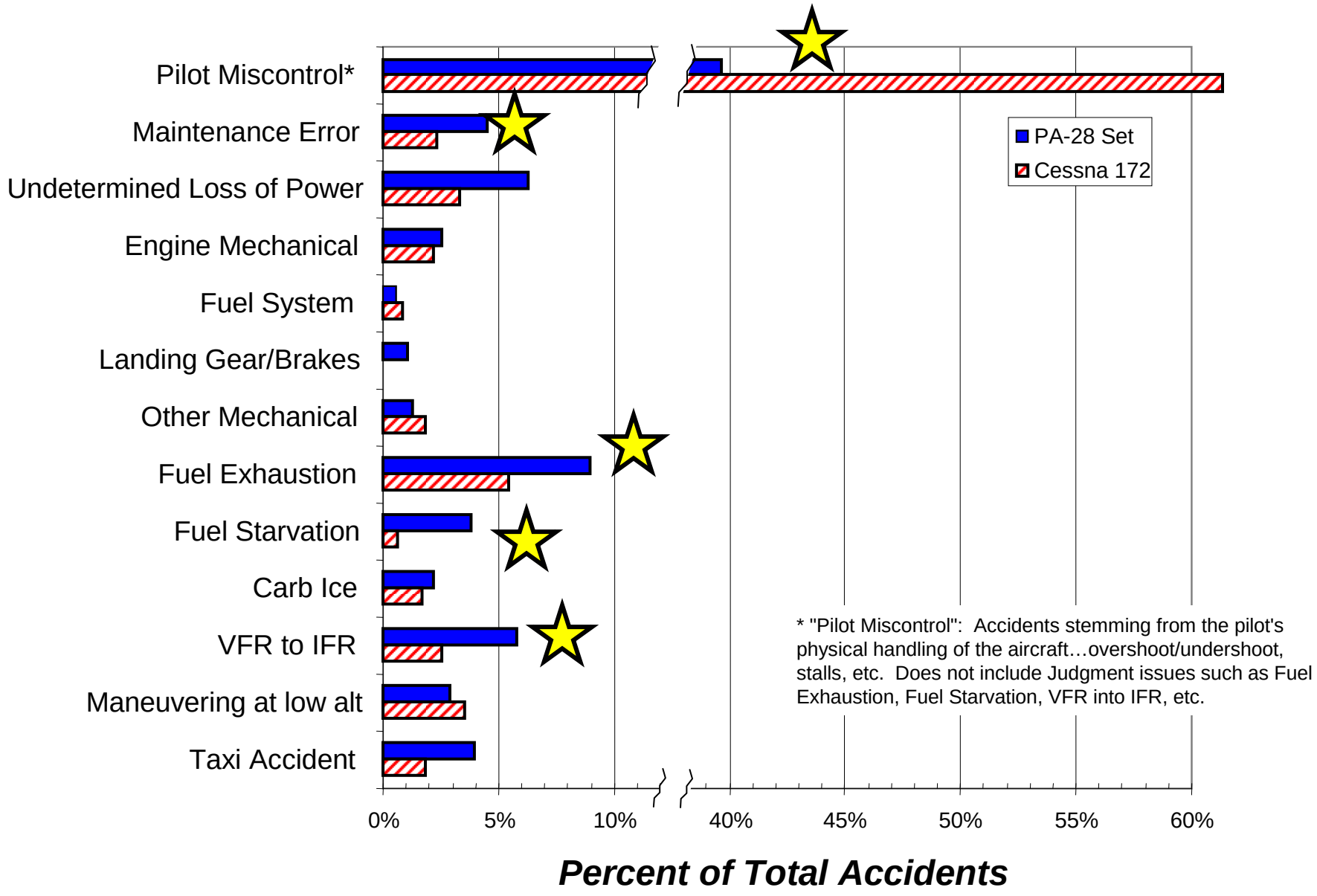
Cherokee Accident Causes



Analysis Process

- **Convert NTSB reports to database, including:**
  - **Date and location**
  - **Pilot qualifications**
  - **Type of operation (Personal, Instruction, etc.)**
  - **Aircraft total time**
  - **NTSB ruling of the cause of accident**
- **Read full narrative of each accident**
  - **Probable Cause often leaves out significant clues**
- **Enter my own estimation of the cause into database**
  - **"Initiator"**
- **Repeat ~560 times for Cherokees, ~1100 times for Cessna 172s**
- **Compare & Contrast**

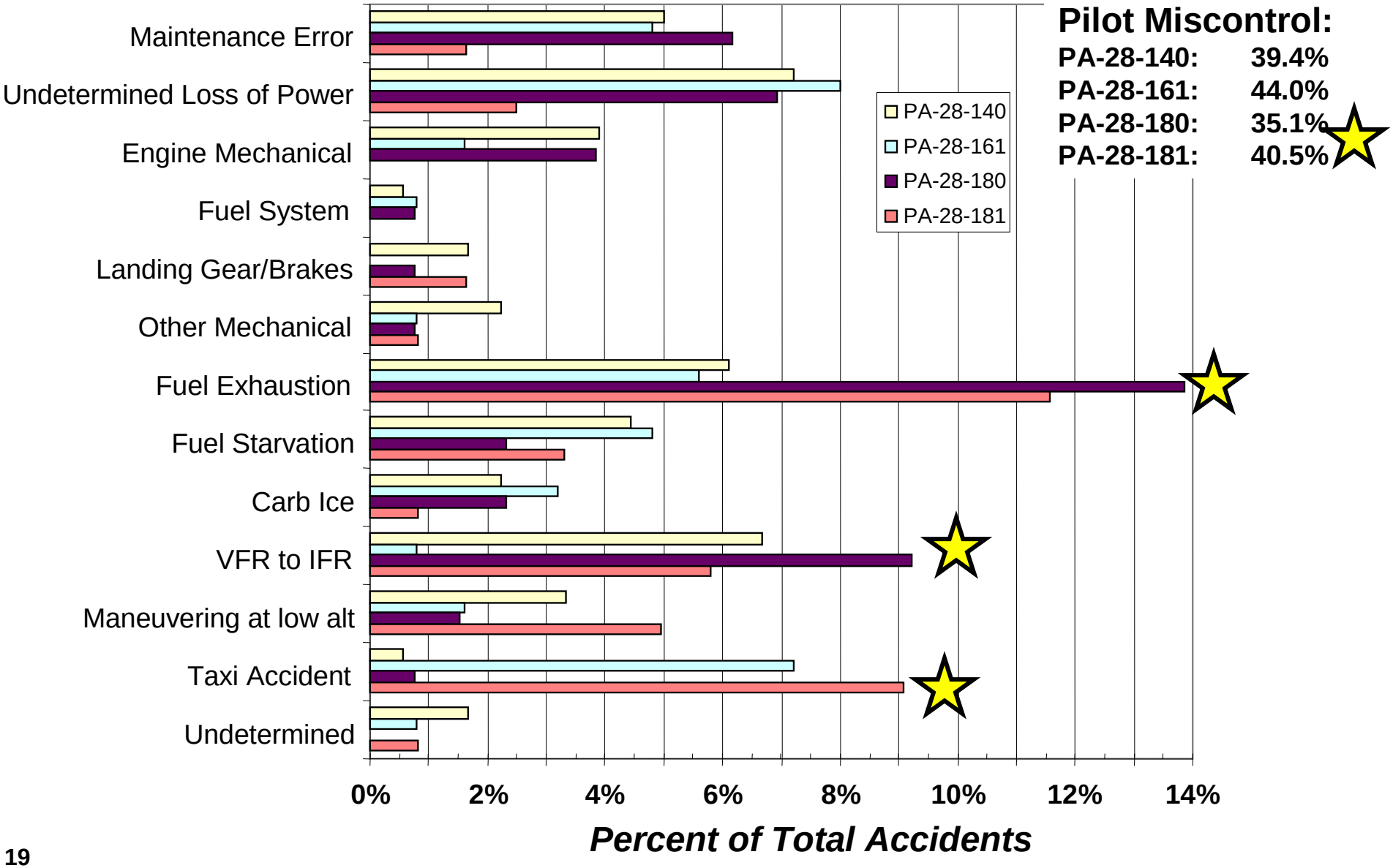
Guess Which One is Pilot Miscontrol?



Key Points in Causes

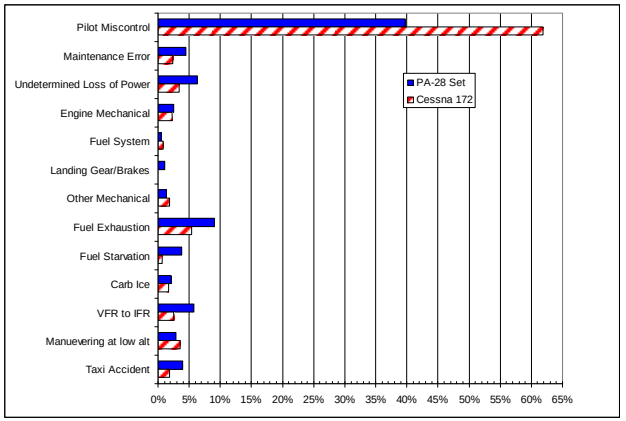
- **The PA-28 set has a "Pilot Miscontrol" rate ~1/3rd lower than that of the Cessna 172**
  - **Again, both types have the same percentage of training accidents**
- **The #2 cause of Cherokee accidents: Fuel Exhaustion!**
- **PA-28 Set has an accident rate due to Fuel Starvation five times higher than the 172!**
  - **The good news: Fatality rate for Fuel Exhaustion/Starvation is low (11%)**
- **Add up all pilot-related errors:**
  - **PA-28 set: 62%**
  - **Cessna 172: 76%**

Comparing the PA-28 Set



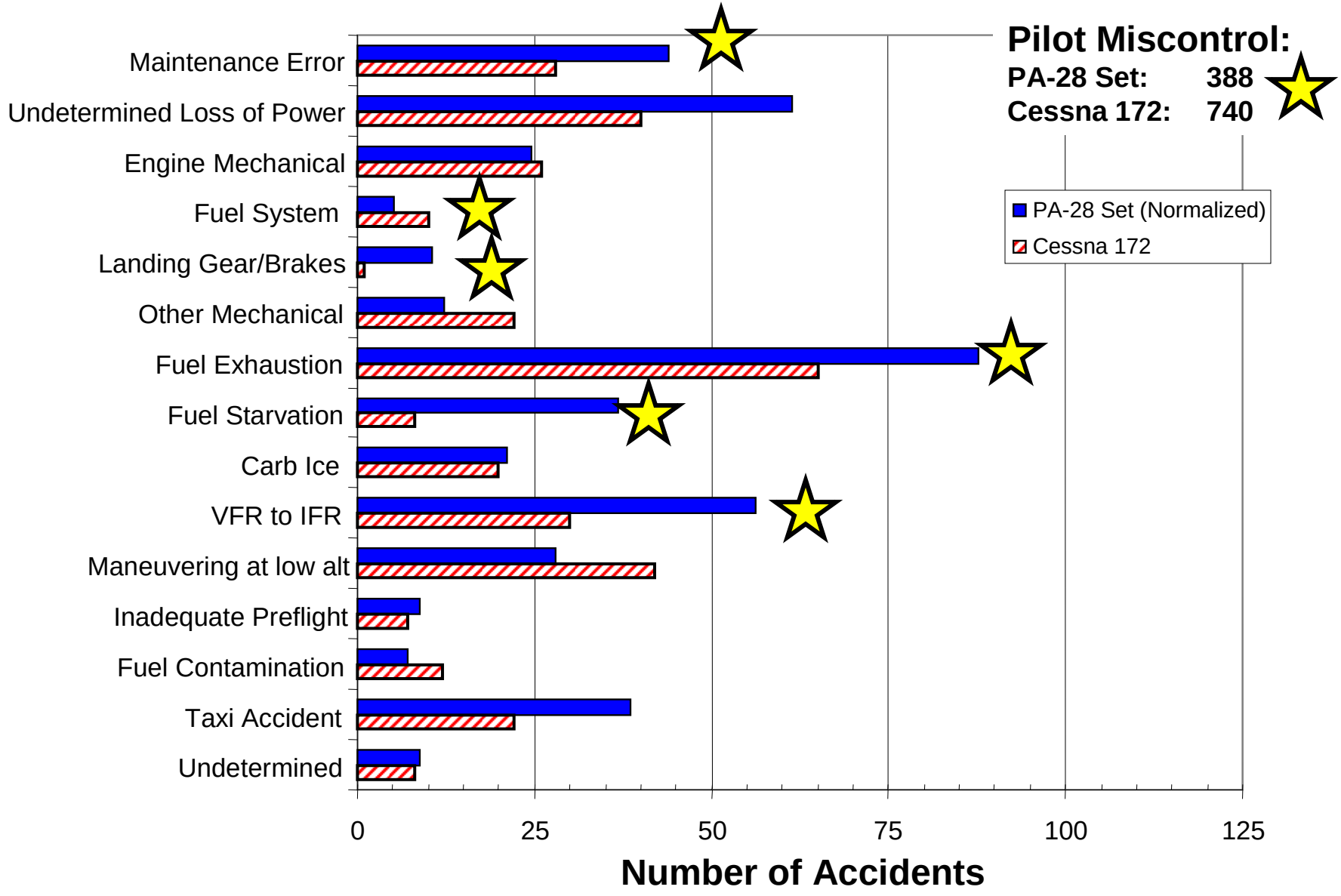
The Problem With Percentages

- **Comparing accident causes by percentages is a bit deceptive**
  - **If one parameter is higher, the others must be lower**
    - **Has to still add up to 100%!**



- **Better approach is to compare the raw numbers of accidents**
  - **But if the numbers of aircraft don't match, the comparison of meaningless**
- **Let's <u>normalize</u> the number of accidents between types**
  - **Compute the number of accidents they would have had if the fleet sizes had been the same**
    - **Multiply PA-28 Set accidents by 1.75**

Normalized PA-28/Cessna 172 Comparison



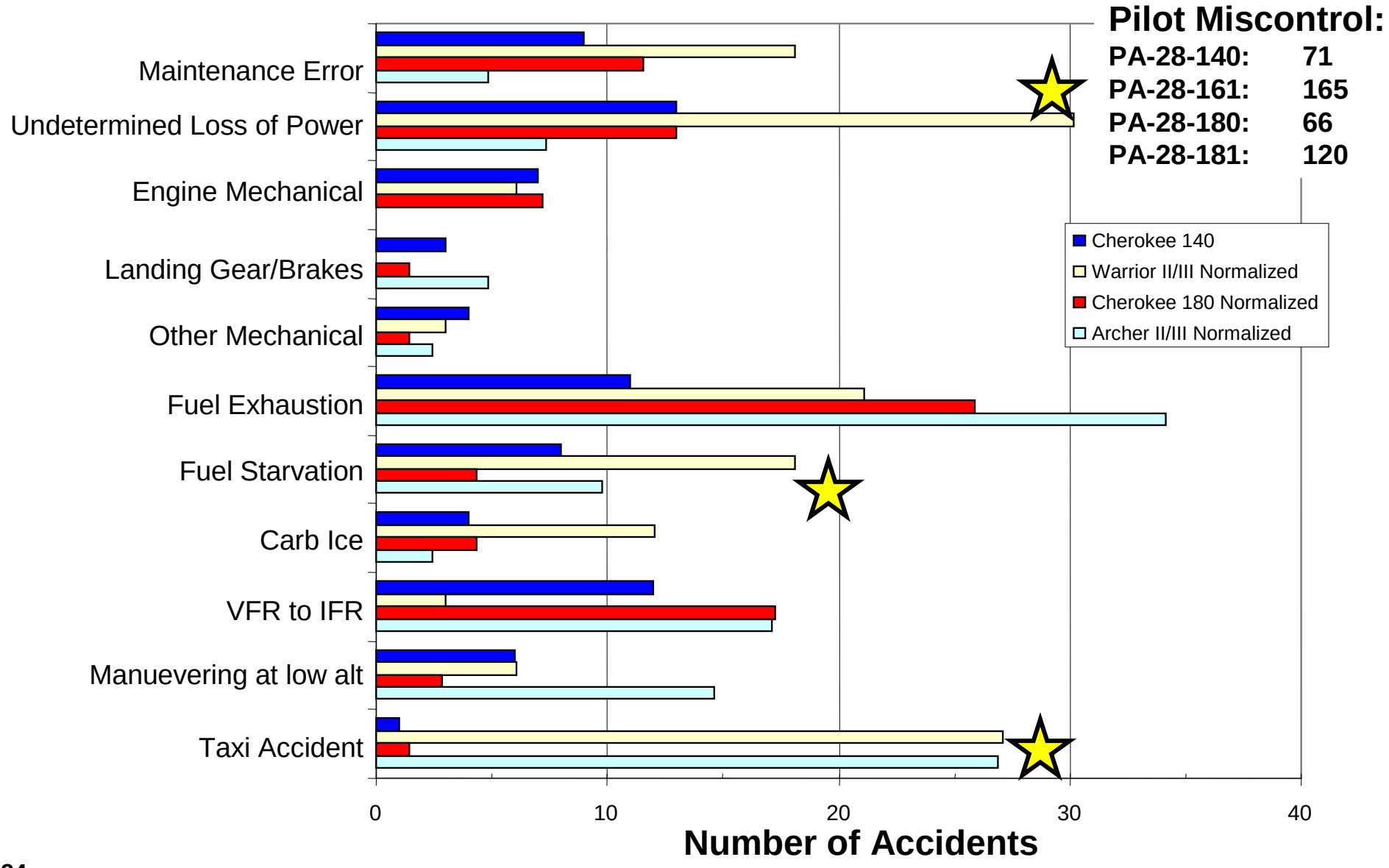
What Does It Mean?

- **Really looks like the PA-28 Set is easier to handle than the Cessna 172**
  - **Number of Cessna 172 miscontrol accidents almost double!**
  - **Remember, the same rate of training accidents**
- **Looks like the PA-28 Set is more prone to errors made during maintenance**
  - **Smaller fleet size, perhaps mechanics aren't as familiar**
  - **However, this could merely reflect the diligence of Piper Corporation reps involved in investigations**
- **Higher VFR to IFR accidents probably reflect greater use as traveling aircraft**
  - **"Gethomeitis" is more prevalent if it's a significant distance**

Normalizing Within the PA-28 Set

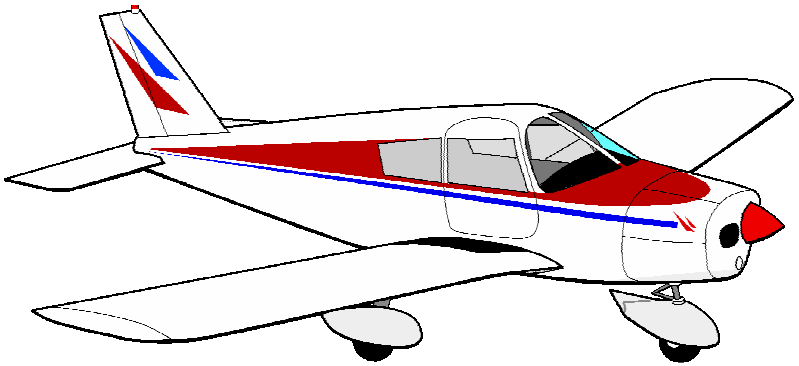
- **Can do the same mathematical trick to compare the four airplanes in the PA-28 Set**
- **Average Fleet Sizes, 2001-2010:**
  - **PA-28-140 (Cherokee 140): 6127**
  - **PA-28-161 (Warrior II/III): 2033**
  - **PA-28-180 (Cherokee 180/Archer I: 4256**
  - **PA-28-181 (Archer II/III): 2509**

Normalized Comparison

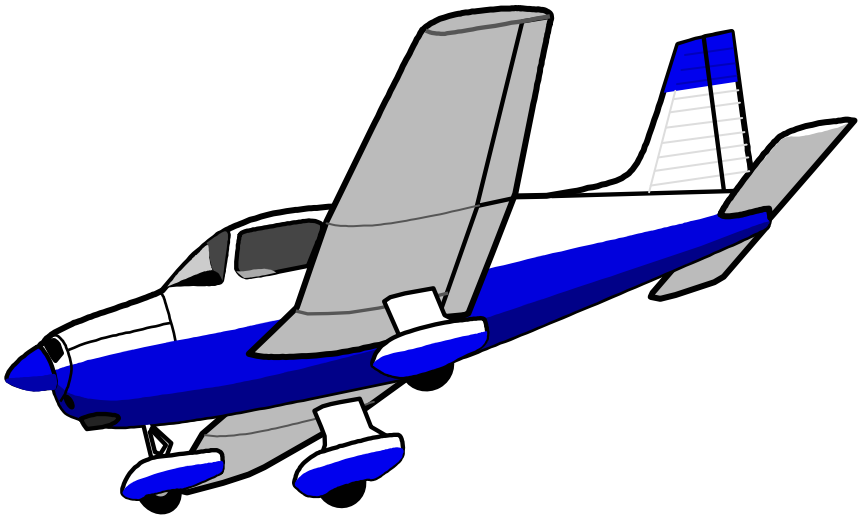


Pilot Miscontrol:

PA-28-140:	**71**
PA-28-161:	**165**
PA-28-180:	**66**
PA-28-181:	**120**



Mechanical Failures



Mechanical Failures Involved in Cherokee Accidents

	Total	Mechanical	Engine Internal	Fuel FWF	Controls	Gear/Brakes	Propeller	Other	Carburetor	Ignition	Fuel (Airframe)	Oil System
All	556	60	17	10	7	6	5	4	4	3	2	1
Cherokee I40	180	24	7	4	4	3	2	0	3	0	0	1
Warrior II/III	125	11	3	3	0	0	1	2	1	1	0	0
Cherokee I80	130	18	7	3	2	1	1	1	0	1	2	0
Archer II/III	121	6	0	0	1	2	1	1	0	1	0	0

Summary Columns

Includes both Initiator and Secondary Causes

Individual Summaries

Engine Internal (17)

Valve	Valve Lifter	Connecting Rod	Crankshaft	Cylinder	Piston	Muffler
7	2	2	1	3	1	1

Fuel Firewall Forward (10)

- **8/10 due to faulty maintenance (MX) - mostly disconnected/loose lines**
- **One due to failed mechanical fuel pump (coinciding with electrical failure)**
- **One vapor lock**

Controls (7)

- **MX: Two cases of a cracked vertical stabilizer and the unapproved maintenance modification to the rudder**
- **Two case of binding/jamming throttle control**
- **MX: Disconnected throttle at carburetor**
- **Sheared mixture cable**
- **Disengagement of the left control wheel from the control column (manufacturer error)**

Gear/Brakes (6)

- **Three fatigue cracking of the upper torque link attach lugs**
- **Stress cracking of gear**
- **Excessively worn brake pads and rotors**
- **Spongy brakes (pilot elected to fly)**

Accidents Related to Maintenance Mistakes

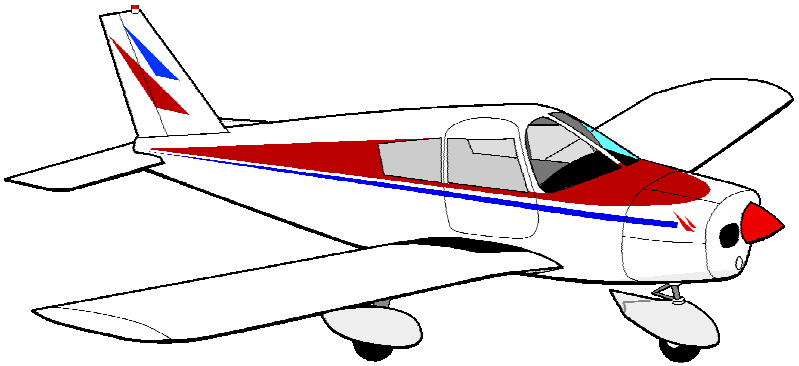
Mistakes Made

Procedures Not Followed	Inadequate Inspection	Unapproved Mod	AD/SB not complied with	Unqualified Mx	Misapplied Placard
14	5	3	3	1	1

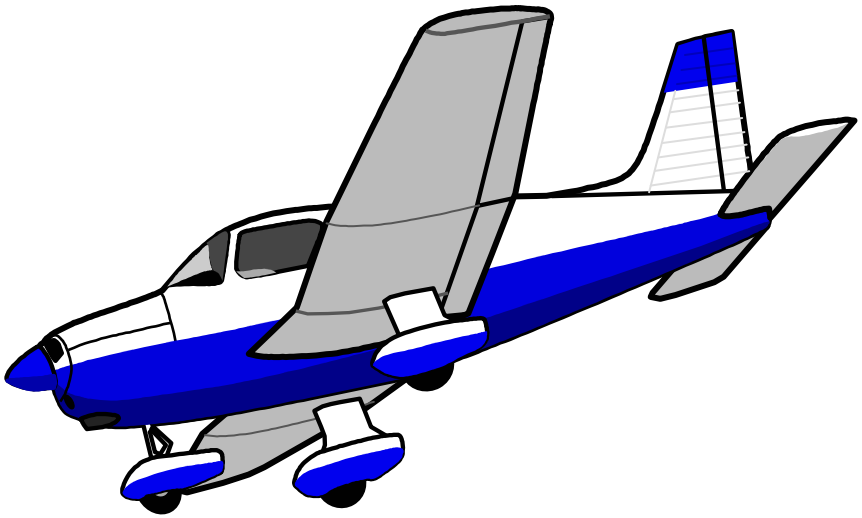
- **"Maintenance Mistakes" are not necessarily made by an A&P**
  - **Owner modifications**
  - **Owner not complying with ADs and Service Bulletins**
- **"Procedures Not Followed" may be an indication of lack of PA-28 experience/documentation**

System Affected

Fuel FWF	8
Engine Internal	3
Carburetor	3
Controls	3
Prop/Spinner	3
Fuel (Airframe)	2
Ignition	2
Gear/Brakes	1
Other	1



Wrap-Up



Summary

- **While the "Pilot Miscontrol" rate for the PA-28 Set is lower than for Cessna 172s, it is still *four times higher* than the next-highest accident cause**
- **That second-highest cause is fuel exhaustion**
- **Mechanical failures seem to be happening somewhat more often, especially associated with maintenance failures**
  - **Could be affected by parts availability**
  - **Could just be age…**
- **Most-common maintenance errors are related to fuel line attachment/routing in the engine compartment**
  - **Find a mechanic that knows your aircraft!**
- **One quarter of all PA-28 accidents start with an engine failure…are you ready?**

The Fault Lies Not With the Stars...

- **Pilots can't usually can't blame anyone else for an accident**
  - **Even if it's the maintainer's fault, it's still our heinies on the line….**
- **Statistics predict the aggregate, not the individual**
  - **Just because ~1 in 250 Cherokees will crash this year, DOESN'T mean <u>you</u> have a 1 in 250 chance of an accident!**
- **Minimize your exposure by controlling risks**
  - **Stay current!**
  - **Manage your fuel (9% of all PA-28 accidents are fuel exhaustion)**
  - **Pick your weather (25% of pilot error accidents involve strong winds)**
  - **Avoid VFR into IFR Conditions (6% of accidents)**
  - **Learn to manage the Cherokee's fuel system (4% of all accidents)**
- **Use the resources out there**
  - **WINGS program**
  - **Owner's Group support**