Aircraft Accidents and Safety

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ADAC
Aircraft Design & Consulting

Causes of Aircraft Accidents

Accidents by Cause						
Cause	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**Total**
Pilot Error	60%	55%	54%	60%	60%	**58%**
Mechanical	21%	16%	18%	15%	18%	**17%**
Sabotage	5%	11%	11%	8%	9%	**9%**
Weather	6%	5%	6%	6%	7%	**6%**
Other	8%	13%	11%	11%	6%	**10%**

http://www.planecrashinfo.com/cause.htm

Significant Accidents

- DH Comet fatigue failure
- Lockheed Electra wing failure
- BAC111 tab-operated elevator
- VC10 engine fratricide LHR (plus other engine failures)
- Turkish Airlines DC-10 out of ORY
- Tenerife 747 collision
- UA DC-10 at SUX
- AA DC-10 at ORD
- JL 123 rear pressure bulkhead
- A320 at Airshow
- AF 447 over South Atlantic
- Colgan Air Dash 8
- Euralair 363 at Kazan Int'l
- Concorde at CDG
- A400M at Seville Airport

Pilot error
Operation or maintenance error
Airframe or engine design error

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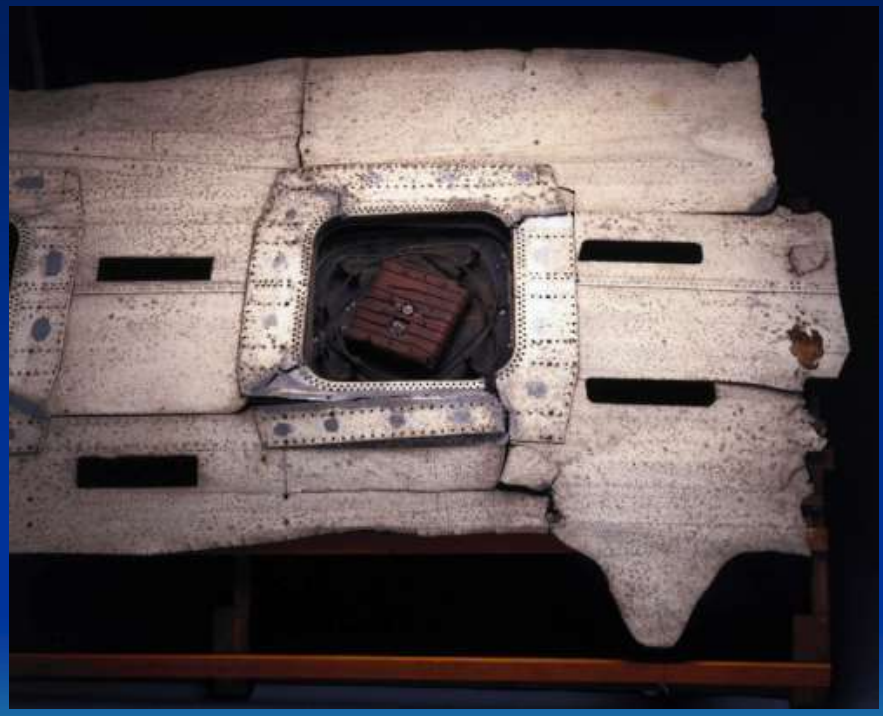
Comet 1 Accident Investigation

- 1954.01.10
- Fatigue failure of frame of escape hatch
- Explosive decompression of fuselage
- Crashed into Mediterranean off Elba
- Fatalities: 29 pax, 6 crew

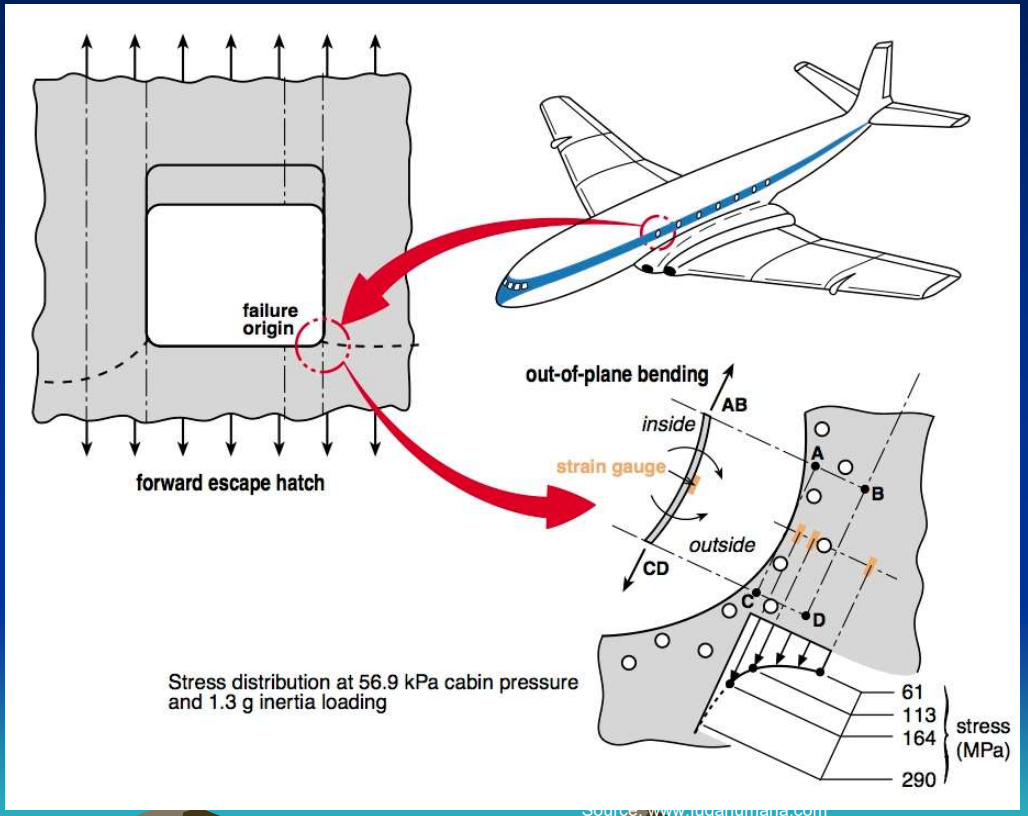


Source: www.greatwen.com

© 2013 Anthony P Hays

Accident Investigation

- Fatigue stresses along line between window and rivet hole



Source: www.luganumana.com

Lockheed Electra Wing Failure

- 1959.09 and 1960.03
- At cruise, wing failed at root
- Each aircraft had suffered from heavy landing
- Loose engine mounts resulted in whirl mode flutter
- Solution: strengthen engine mounts and wing root skins

Source: San Diego Air and Space Museum

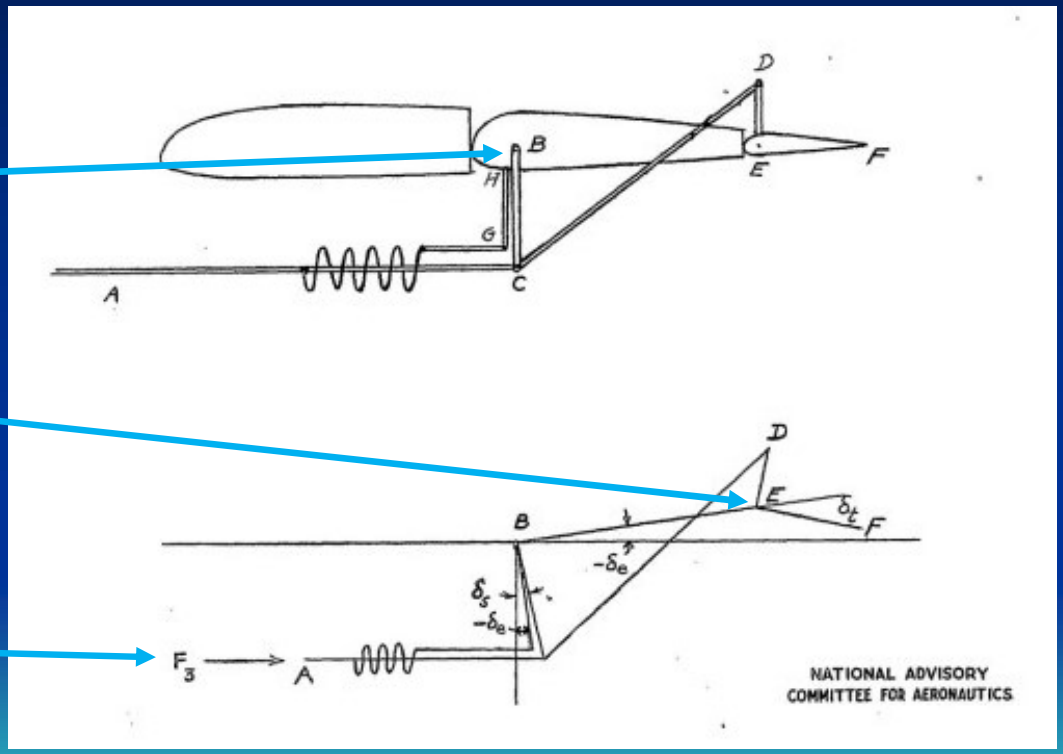
BAC111 Prototype Crash

- 1963.10 stall testing
- Fatalities: Chief test pilot Mike Lithgow + 6 crew members
- Unrecoverable deep stall
- In part due to tab-operated elevators
- Installed stick-shaker to reduce probability of entering stall conditions

Source: www.fugahumana.com

BAC111 Tab-operated Controls

- Main control surface is freefloating
- Tab operates in opposite direction to control surface
- Pilot's input forces reduced



Source: NACA RB L4P07

DC-9 Comparison

- DC-9-10 also used tab operated elevators and ailerons
- Longer variants had hydraulic boost in trailing-edge down position
- MD-80 has hydraulically-powered elevator

Source: wikipedia

Uncontained Engine Failure

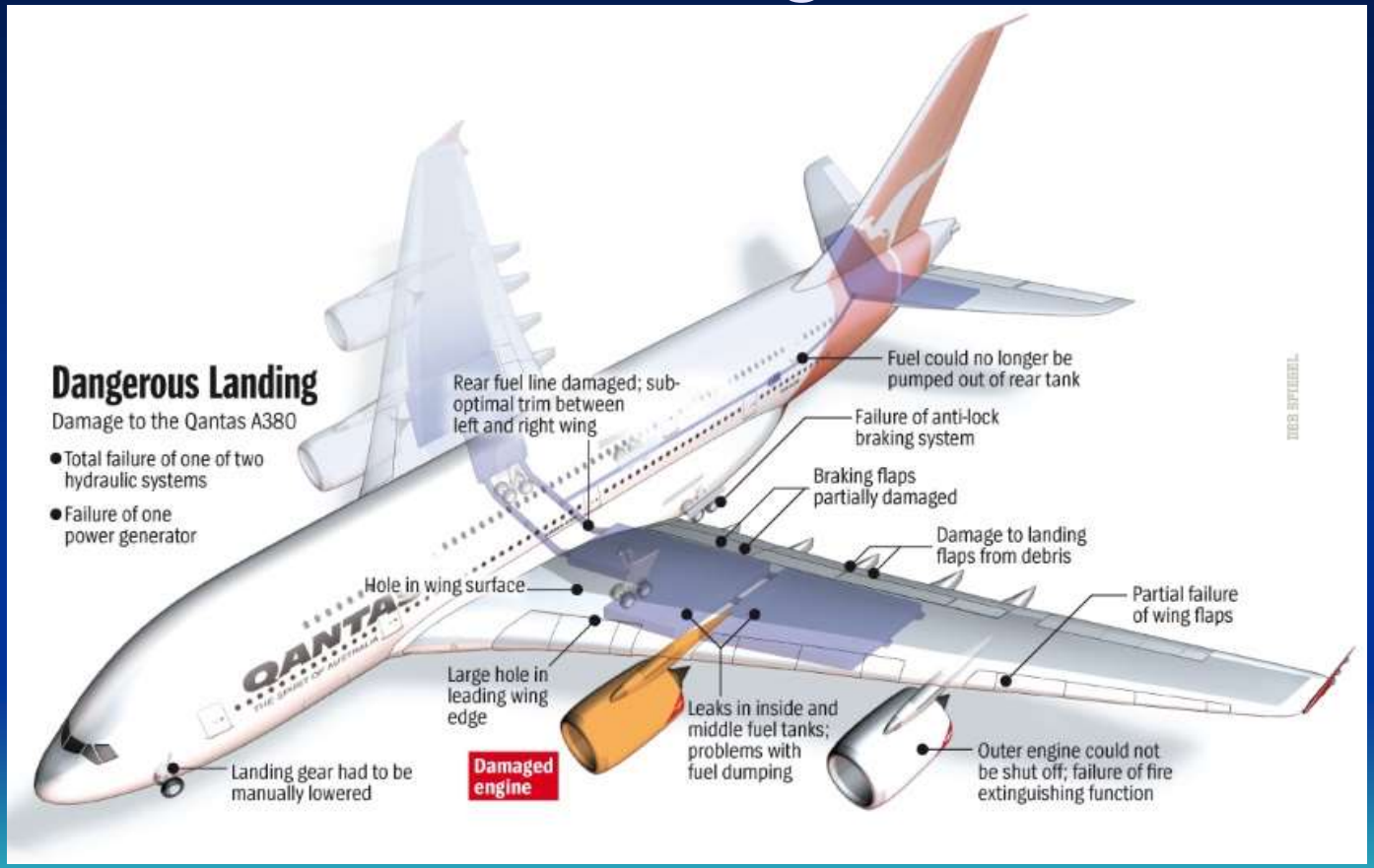
- 1969.11
- BOAC Super VC-10
- # 3 engine LP turbine failure after takeoff from LHR
- # 3 parts damaged # 4 engine, also shut down
- Returned to LHR with overweight landing

Source: http://www.vc10.net/History/incidents_and_accidents.html#Engine Disintegrates

Uncontained Engine Failure

- 2010.11.04
- Qantas flight QF32 LHR-SIN-SYD
- A380 with 4 x RR Trent 900 engines
- Improperly manufactured oil feed line leaked, cause oil fire on #2 engine IP turbine, turbine failure
- Crew: Captain, 1st officer, 2nd officer + two check pilots
- Took 50 minutes to evaluate systems failures

Uncontained Engine Failure

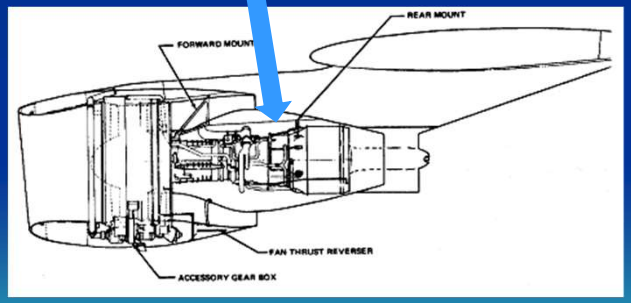


Uncontained Engine Failure

- DL275 DTW-NRT 2011.10.23
- Failure occurred soon after takeoff
- Most parts passed downward and outward
- Pylon also overstressed

Uncontained Engine Failure (con’td)

- A few parts damaged inboard aileron and underside of wing
- Would like to locate core ahead of front spar

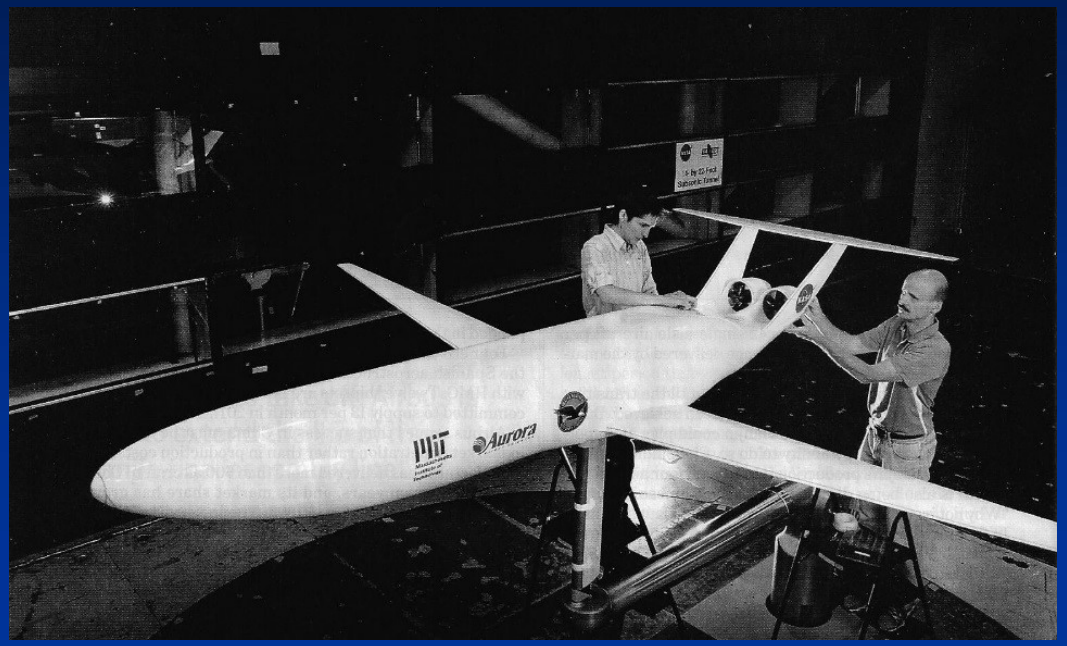


Source: www.adg.stanford.edu

Uncontained Engine Failure

- 2017.09.30
- #4 engine
- No significant damage to aircraft
- CDG-LAX over Greenland
- Engine Alliance GP7200 (GE/P&W)
- Looks like fan disc failure

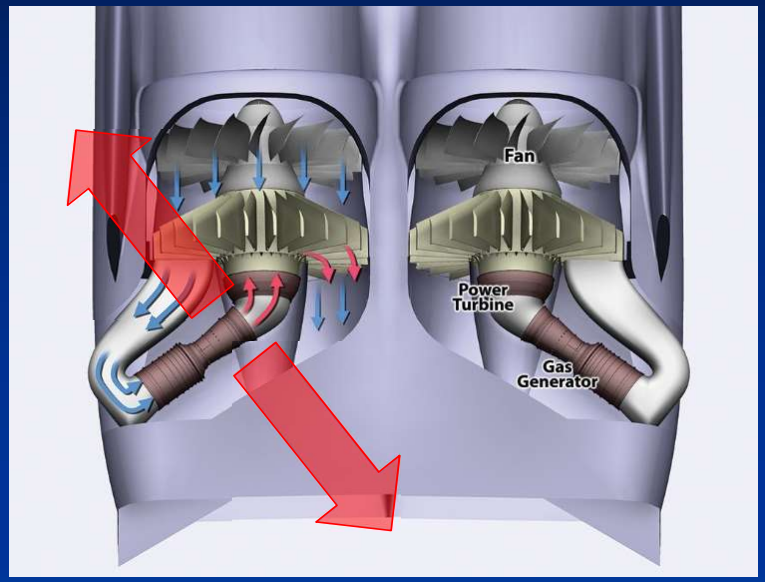
NASA/MIT D8 Double-bubble Fuselage and NFL Wing



Source: Aviation Week

NASA/MIT D8 Double-bubble Fuselage and NFL Wing

Turbine debris



Gas generator reversed (similar to P&W PT6)

Turkish Airlines Flight 981

- 1974.03.03
- DC-10 climbing out of Paris-Orly
- Cargo door not fully latched (baggage handler didn't speak Turkish or English)
- Door opened explosively
- Decompression deformed cabin floor
- Rudder & elevator cables jammed

By Steve Fitzgerald - Gallery page http://www.airliners.net

Turkish Airlines DC-10 involved in accident

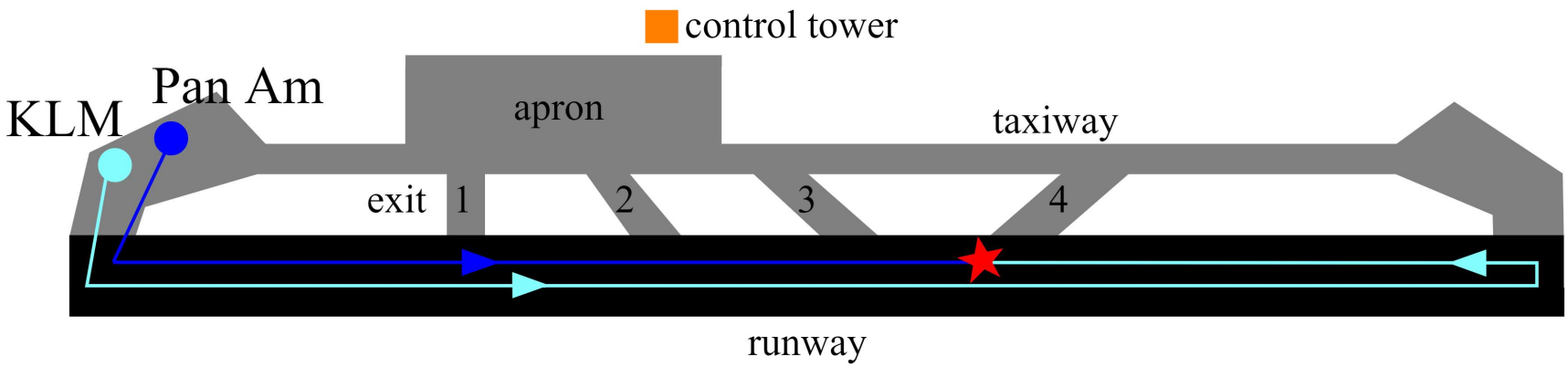
Tenerife KLM/PanAm 747s

- 1997.03.27
- Total of 583 deaths (largest no. of deaths in single accident)
- Terrorist incident in Gran Canaria resulted in traffic diversion to Tenerife
- Aircraft occupied taxiway

Source: Wikipedia

KLM 747 involved in accident

Tenerife KLM/PanAm 747s



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- Single runway with parallel taxiway. Dense fog
- KLM captain tried to take off without explicit clearance
- Initiated philosophy of CRM

Tenerife KLM/PanAm 747s

- First officer warned captain of lack of TO clearance
- KLM 747 hit rear of PanAm aircraft as it turned off runway onto taxiway
  - All pax on KLM 747 died
  - 61 pax on PanAm 747 survived
- Recommendations
  - Use standard phraseology in ATC communications
  - Incorporate CRM into crew training (the captain should heed the advice of others)

DC-10 Accident at ORD

- 1979.05
- AA 191 ORD-LAX
- Rear engine mount overstressed when re-installing engine

DC-10 Accident at ORD

- Ruptured LE slat hydraulic lines
- Slats on port side retracted
- Without slat, below V_S on port side only
- Added mechanical lock to slat mechanism

JAL Flight 123

- 1985.08.12 Haneda to Osaka
- Total of 520 deaths (largest single-aircraft accident) with 4 survivors
- Explosive decompression of aft pressure bulkhead (improperly repaired by Boeing)
- Lost all hydraulic pressure + vertical stabilizer
- Flew for additional 32 minutes
- Death toll exacerbated by delays in rescue

JAL 747 involved in accident at ITM

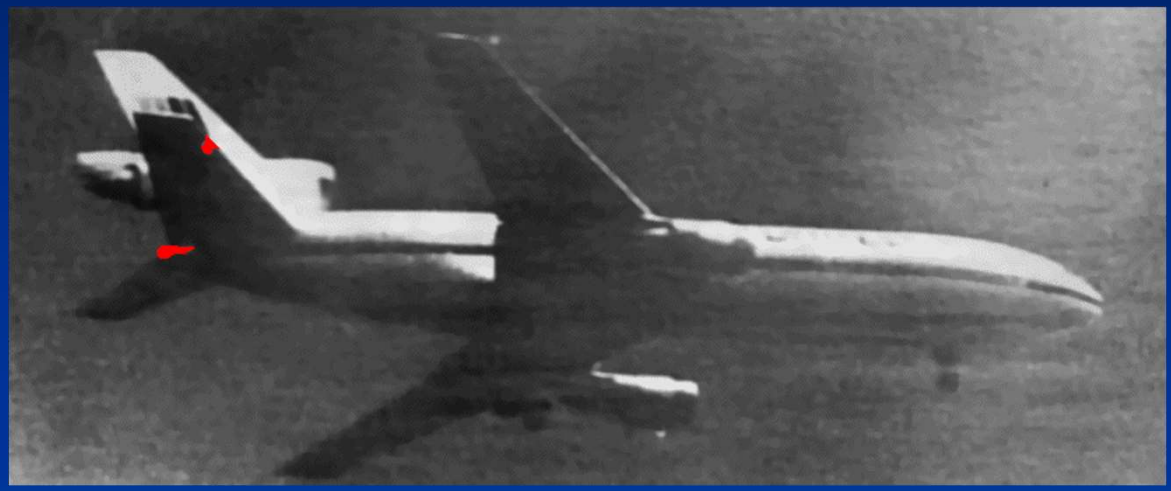
A320 Accident at Mulhouse-Habsheim Airshow

- 1998.06
- Failed to climb after low pass
- Crashed into trees
- 130 pax, 3 died
- Pilot flew too low, too slow
- Climb prevented by α-limiter

Source: © MilborneOne

UA 232 Accident at Sioux City

- 1989.07.19
- By chance, had two check pilots in cockpit
- Fan disc failure of #2 engine



Airplane on approach to SUX (damage highlighted)

UA 232 Accident at Sioux City

- Caused failure of all three hydraulic systems, resulting in loss of most aerodynamic control
- Used differential thrust for yaw control
- Example of successful CRM
- Unable to correct upset from cross-wind gust on final approach
- Of 296 aboard, 111 killed, 185 survived
- Partial solution: install hydraulic fuses (isolators)

AF Concorde Accident at CDG

- 2000.07.15
- Engine wear strip from previous t/o on runway
- Concorde tire disintegrated, debris hit fuel tank
- Overpressure ruptured fuel tank
- During 27 years in service, 7 major wheel or tire incidents resulting in significant damage
-

Source: NY Daily News

Air Transport Pilot Licence

© Tom Lunieski https://www.jetphotos.com/photo/6228181

Business Week 2019/02/18

- 2009.02.12 Colgan Air Bombardier Dash-8 crashed at Clarence Center, NY.
- NTSB found probably cause to be “the captains’ inappropriate response to the activation of the stick shaker…”
- Prompted stricter pilot licensing requirements, and revised testing procedures

https://en.wikipedia.org/wiki/Colgan_Air_Flight_3407

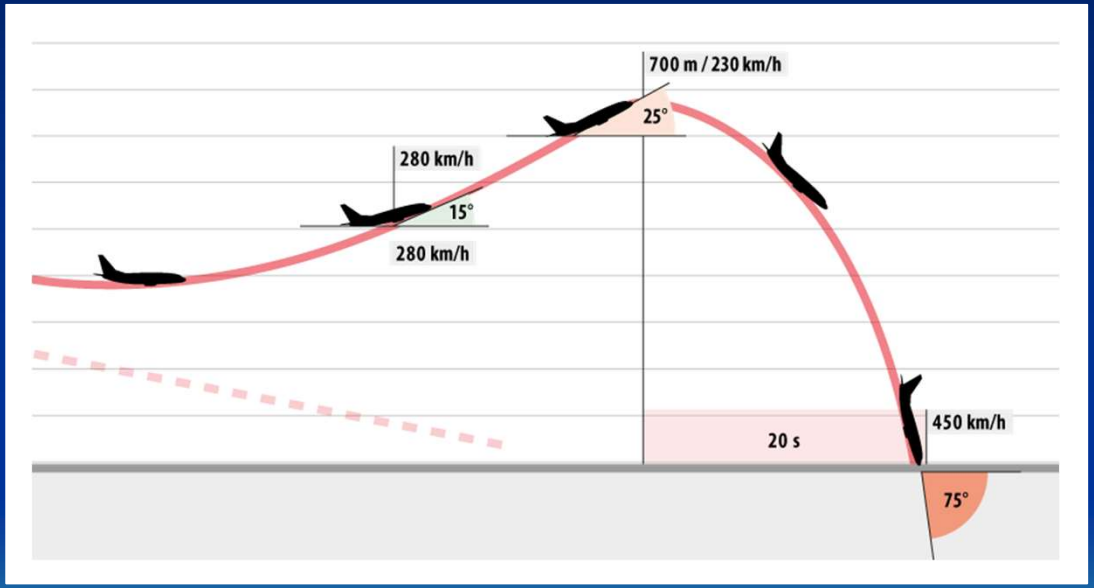
AF 447 GIG-CDG

- 2009.06.01
- Icing on pitot tubes caused autopilot to disconnect and loss of airspeed indication
- Pilot-Flying (PF) inadvertently stalled aircraft, but failed to recognize it
- Aircraft descended to water in stalled condition

Source: Wikimedia

Tatarstan 363 at Kazan Int'l

- 2013.11.17
- B.737-500
- Lack of crew training for go-around
- Pilot may have misinterpreted sensation of acceleration for that of climb



Source: © MilborneOne

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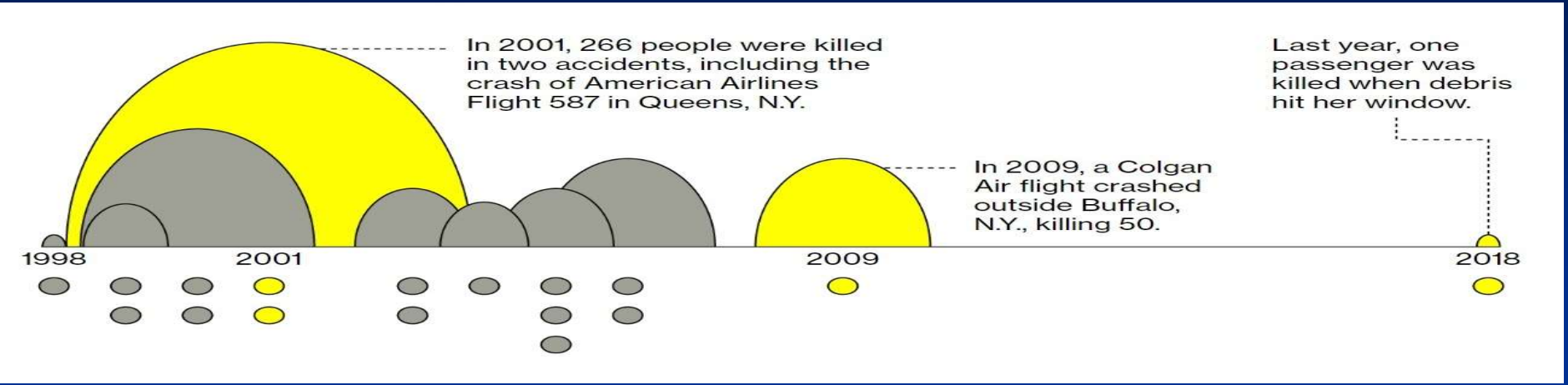
A400M Accident at Seville

- 2015.05
- Pre-delivery test flight
- Engine torque calibration data accidently wiped on software load
- FADEC stopped operating
- No warning until 400 ft AGL

Source: © MilborneOne

Deaths on U.S. Passenger Airlines



Business Week 2019/02/18

- At least 1,500 hours total flight time, 500 hours cross-country, 100 hours night, 75 hours instrument
- At least 23 years old, instrument rating, able to read, write, speak and understand English

- Rigorous written exam
- Good moral character
- Other ratings typically required (e.g., instrument, multi-engine)

https://en.wikipedia.org/wiki/Pilot_certification_in_the_United_States#Airline_transport_pilot

Comparative Accident Fatalities

Type	Deaths per billion		
	Journeys	Hours	km
Bus	4.3	11.1	0.4
Rail	20	30	0.6
Van	20	60	1.2
Car	40	130	3.1
Foot	40	220	54.2
Water	90	50	2.6
Air	117	30.8	0.05
Pedal cycle	170	550	44.6
Motorcycle	1640	4840	108.9
Space Shuttle [10]	104477611.9	441897.6	16.2

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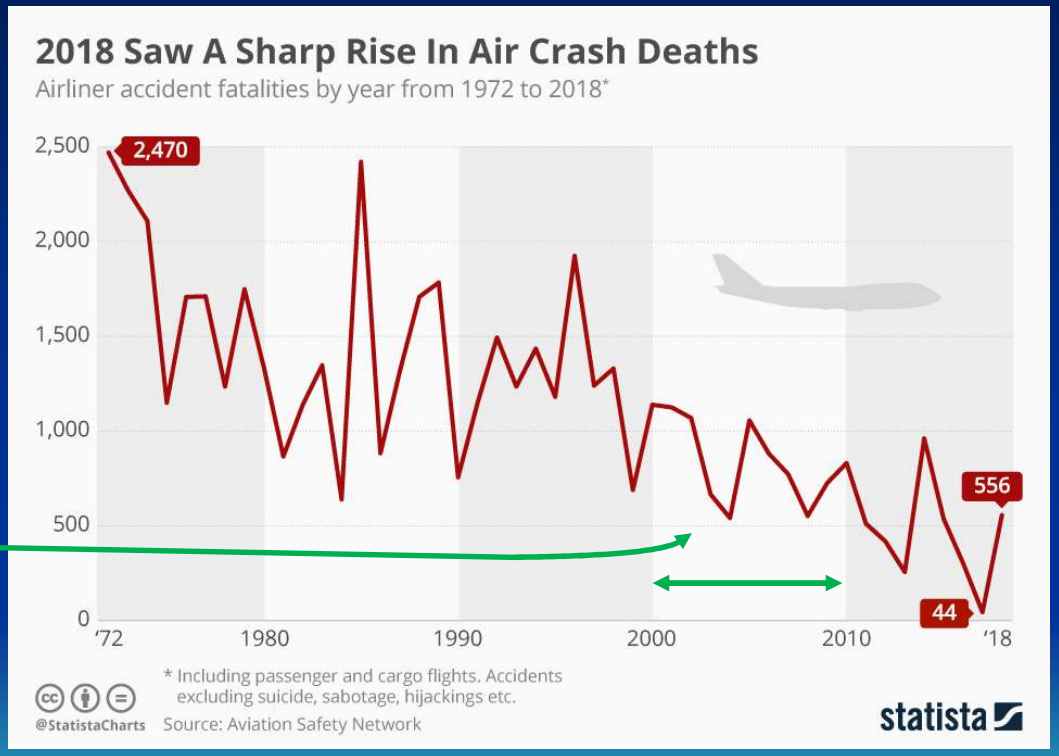
Data for U.K., 1990-2000

https://en.wikipedia.org/wiki/Aviation_safety

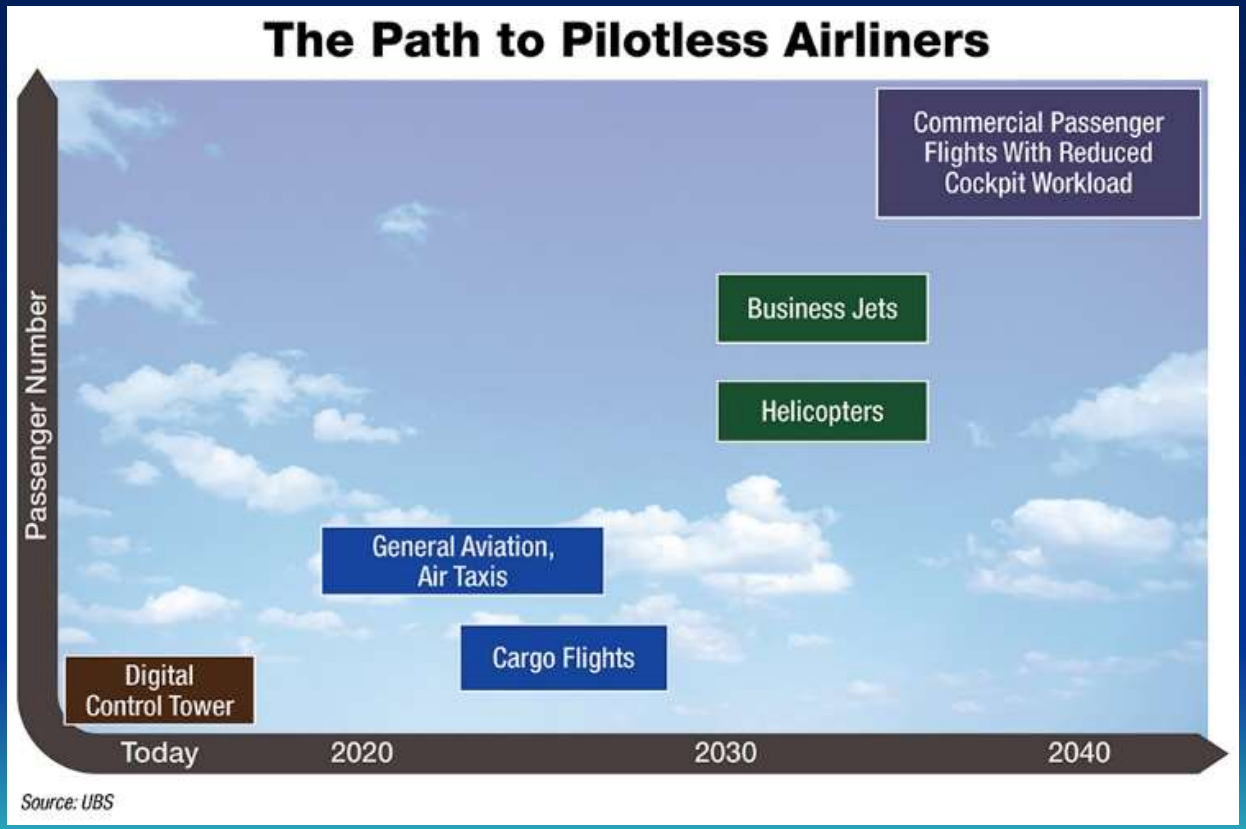
Airliner Accident Fatalities

In the U.S., between 2000 and 2010, 0.2 deaths per 10 billion pax miles (compare with driving for which 150 deaths per 10 billion pax miles).



https://www.forbes.com/sites/niallmccarthy/2018/01/02/2017-was-the-safest-year-in-the-history-of-commercial-air-travel-infographic/#47eb01cf60d4

Pilotless Aircraft



http://aviationweek.com/commercial-aviation/opinion-pilotless-commercial-aircraft-likely-2020s-2030s

Pilotless Commercial & GA Aircraft

According to UBS potential annual savings:

- > $26B in pilot-related cost savings for airlines that UBS covers
  - Up to $3B for bizjets
  - $2.1B for civil helicopters
- $1B for flight optimization (~1% of carriers' fuel bill
- $3B saving for insurance and pilot training
- Revenue increase for increased utilization

Conclusions

- Most accidents due to pilot error
  - Often inadequate crew training for unusual or upset conditions
- Mechanical failure ranks second
  - Maintenance, repair, overhaul
  - Design
- Compared with other modes of transportation, fatal accident rate usually ranks low

Thanks for your interest