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Is it Safe for Me to Fly?

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'Is it Safe for Me to Fly' seems like a simple question. But who is Me, what is Safe, and why is there a reason for focusing on Fly? Is the underlying question: 'Are the people responsible doing everything they should to make flying safe?' Good questions – so what are the answers?

First, let us put some limits on the questions. The questions are about somebody flying as a passenger, not as a pilot or other aircrew. Next, restrict the flights to ordinary operations between airports. This takes out things like adventure aviation and tourism sightseeing, eg around mountains, where the risks might well be higher than for ordinary flights. Third, do not include security aspects – obviously a real problem, but involving different kinds of decision process.

Some people would never even think that the flying safety questions were sensible ones to ask. A sizable proportion of people have some kind of phobia, with intense, persistent fear of something, often with unpleasant physical symptoms. Fear in itself is not necessarily an irrational response – sensible mice are fearful of cats. A typical psychologist or psychiatrist would say that the fear shown in phobia, as distinct from a superstition or aversion, is a panic or anxiety disorder, the product of unnatural or illogical functioning of the brain. Social phobias are fears about social situations, eg giving a talk. Specific phobias are fears of a single specific thing, eg spiders, heights. At the top of the list is agoraphobia, where somebody fears leaving home or their personal haven.

Fear of flying is sufficiently widespread to justify world conferences. The 3rd International Conference on Fear of Flying was held under the auspices of the International Civil Aviation Organization (ICAO) in 2007 [http://www.icao.int/icao/en/atb/meetings/2007/ff07/Documentation.htm], with several dozen contributors. Bor & Foreman, and de Zeeuw & van Gerwen are interesting summary presentations. The latter suggest that about a third of the population feels some kind of anxiety about air travel. Perhaps the main reason that air travel affects so many people is that it ticks so many different phobia boxes: heights, enclosure, crowds, death, lack of control, etc. There are many different kinds of therapeutic treatment for fear of flying, usually involving some combination of education, exposure and desensitisation. These try to help people get into an appropriate emotional state. But showing people tables of comparative accident statistics and trends does *not* appear to be a major component in resolving the problem.

So, assuming the Me of the question does not have a phobia, what is Safe? Without going into definitions yet, safe means not suffering damage from being an aircraft passenger: neither death nor injury. Absolute safety is not possible in an imperfect world. Safety has to refer to some high, but achievable level of performance, ie the risks of death/injury are very small. This leads to targets for safety performance which have words such as acceptable and tolerable attached to them. The arguments then focus are what are reasonable – but challenging – targets for safety.

Society's attitudes to safety play a big part in assessing what is acceptably safe. But aviation safety culture has changed, because society's safety culture generally has changed dramatically. Biographies of the Wright Brothers tell us that the first passenger death was in 1908: Thomas Selfridge, the heaviest passenger so far carried. Orville Wright was the pilot, crash investigator (the cause was a stress crack in the propeller), and aircraft designer. It was a test flight for the USA's Army. There does not appear to have been an accident investigation or government inquiry.

The first airliner mid-air collision was in 1922, with seven people dead. It happened in Beauvais, north of Paris. The aircraft were on the London-Paris route flying towards each other in bad weather – and following the various roads and rail lines too accurately. But the point to note is that in Flight magazine – the widely read UK aviation magazine – the accident report was only a few paragraphs at the bottom of page 7. Today, there would be massive media coverage, and some combination of public inquiry and thorough accident investigation, eg see the UK Air Accidents Investigation Branch (AAIB) reports at http://www.aaib.dft.gov.uk/home/index.cfm.

The growth of air transport as an ordinary transport mode for travellers has been dramatic. Figure 1 shows ICAO data from 1950 to 2006. The Figure also shows that passengers also tend to fly longer distances: a revenue passenger-kilometre (RPK) means a paying passenger flies one kilometre. Historically, RPKs have been doubling about every eight years – although the current oil price shock makes continued growth less likely.

In the context of this huge increase in traffic, what has been the safety record? Figure 2 is from Aviation Safety Network statistics and covers the same period as Figure 1. This chart shows deaths of aircrew or passengers. The average number of deaths a year is about 1,200. The number per year is roughly constant over the whole period – compare the growth illustrated in Figure 1. In general, aviation safety uses deaths as the indicator of safety, rather than some combination of deaths, serious injuries and other injuries, probably because of the inherent difficulty of weighting injuries and deaths. The survivability of an air crash is very dependent on its circumstances, eg if it is over water or involves fire. Many aviation safety initiatives are concerned with improving survivability. For example, see the 2001 NTSB report and the AAIB report on the1985 Manchester takeoff accident crash, with its fire, smoke and evacuation problems – which led to a major Cranfield University research programmes.

Aviation safety improvements are the product of extremely good ideas about what to do, but the main ingredient is a massive amount of operational learning and hard grind in getting things to work. Figure 3 sketches some of the key safety components of the current aviation system. All of the technologies and warning systems on the left and right hand sides were decades in development. The creation of the system's safety defences in Figure 3 has used both top-down approaches – ie to try to 'design out' risks – and bottom-up learning – ie to try to prevent a similar future accident.

For example, an aircraft taking off from Heathrow crashed in Staines in 1972, killing all of its 118 passengers and crew. The AAIB found that, during the climb, the lift devices on the aircraft wings had been set incorrectly, which led to an irrecoverable deep stall. The lead pilot had undiagnosed coronary artery disease, with evidence of a possible silent heart attack. The analysis of the accident produced recommendations about aircraft operating procedures, crew training, cockpit resource management (ie ensuring that the pilots worked effectively together), cockpit voice recording (to aid post-crash investigations), and more detailed medical examination arrangements. All of these led to changes, and these are now embedded in the structures sketched in Figure 3.

More recent aviation accidents provide new kinds of insight, in particular about organisational and policy issues. On 1st July 2002, two aircraft collided over Überlingen on Lake Constance, and all 71 people on the aircraft died. In system safety terms, the Überlingen tragedy was a very complex accident, with accident investigators and researchers identifying a large variety of significant causal factors, including policy on the use of collision avoidance equipment, air traffic control centre staffing arrangements, the risks posed by engineering work, etc.

Do the world statistics on aviation safety paint the full picture? No, they do not. Table 1, using International Air Transport Association (IATA) data, presents statistics on aircraft hull losses in the world's regions as a rate per million flights. A hull loss means the aircraft was totally destroyed or damaged beyond economic repair, so it is a sensible indicator of aircraft operators' safety performance in the different regions. (It has limitations as an accident severity metric, as an ageing world fleet and the economics of repairs could tend to mean that less severe accidents become hull losses.) The first point to stress is that these rates derive from a statistically small number of events, the rates for the individual regions typically being based on no more than three or four accidents. Assuming something like a Poisson distribution of the number per year, there will be large variations in the rate for each region from year to year. Second, there are strong indications that the rate for Africa is markedly higher than the average: note the numbers in bold italic font, which are those that are more than twice the world average in that year. Improving the safety of operations in Africa is a high priority for IATA, ICAO and other safety organisations.

So, the world safety record shows major improvements over the years, and Europe's record is better than the world average. But suppose the Me of the original question is from the UK/Great Britain. Obviously, UK/GB is part of Europe's safety record, but how does aviation compare with other transport modes? Table 2 is a reduced version of the DfT's latest 'Modal comparisons' statistics (from its Table 1.7). It shows that, over a ten-year period, air transport has a better record than other modes. But there is a danger of hubris here – one bad aviation accident would change the statistical picture markedly – so the sensible conclusion must be that air transport is about as safe as rail and bus/coach travel, measured on a passenger kilometres basis.

Other transport modes, in which passengers may not be carried on a commercial basis, generally have a worse GB safety record than air, rail and bus/coach. The bottom part of Table 2 shows the comparable car and motorcycle statistics: worse for cars and much worse for motorcycles. Note that these two cover both driver and passenger casualties. It is in the nature of phobias that people suffering from fear of flying are often quite content to travel by car, although it is several times riskier.

Having scanned Table 2, coming across Table 3 – taken from the latest Rail Safety and Standards Board (RSSB) Annual Safety Performance Report – is a surprise. In the first column of Table 3, the 0.0 rate of Table 2 for air transport has turned into a 0.1 for airlines. This is not, however, one of those school algebra paradoxes that proves that 0 = 1. The basic idea is that comparisons need to use a long-term average for fatality rates, ie a Synthetic Estimate. This is to take account of the fact that accidents are rare and a typical airline accident results in many more deaths than a typical rail accident.

RSSB advise that the airline calculation has six stages:

1. Estimate worldwide fatality rates (per flight hour) 2002-04 for jets, turbo-props and business jets.
2. Estimate 'unadjusted' UK fatality rate per flight hour using proportions of jets, turbo props and business jets in UK large aircraft fleet.
3. Adjust for UK's better than average safety record by using Developed World – European, North America & South West Pacific – rather than World data
4. Adjust for ongoing safety improvements
5. Convert from flight hours to passenger flight hours
6. Convert from passenger flight hours to passenger km

RSSB's report carefully notes some of the caveats and biases involved, eg the greater likelihood of weather and communication problems in many other countries, the lack of high ground near UK runways, and a greater use of landing aids at UK airports. The methodology is rational – but it is a bit strange that the calculation of UK/GB risks never actually involves examining specifically UK or GB accident data.

Table 3's other columns, estimating the relative safety risks using other metrics, are also interesting. Statistical reports frequently use RPK for transport safety estimates, but is it the best basis for a safety metric? Using hours as the denominator makes rail appear much better than airlines. Assuming the RPK-based rates are the same, this is simply because air travel is faster than rail travel. If the traveller's objective is to get from A to B, the risk of death in an accident would be the same for the two modes, supposing very similar distances travelled.

Using an Hours-based metric produces some odd results, even when the focus is on a single transport mode. Suppose that UK rail travel had continued to have the kinds of speed restrictions imposed after the 2000 Hatfield accident. If these added 25% to the time for every journey, but had no other effects, then the Fatality Risk per Hour in Table 3 would reduce by 20%. Thus, the number of deaths a year for exactly the same journeys would be unchanged, but the Fatality Risk per Hour would be better, thanks simply to a slower service. At the other end of the spectrum (and apologising for any humour in what is a grim topic), replacement of rail travel by a Star Trek-like Transporter that moved people to their destination a million times faster, but without any increase in the risk per journey, would be appalling in Fatality Risk per Hour terms. 'Per hour' metrics *do* have value if the focus is on providing a safe service over time: for example, safety performance of an air travel control organisation is usually measured by the rate of accidents and/or incidents per 10 million hours.

Table 3's final column shows a huge difference between airline and rail safety – the average length of a journey generates the difference. But sensible comparisons have to be like-for-like: there is not much value in matching the 22 minute rail journey from Watford to Euston with a flight from Heathrow to San Francisco. For essentially the same journey, eg London to Manchester, the most suitable comparison is fatalities per RPK, as recognised by RSSB: "From the user's perspective, the risk from using a mode of transport can be assessed on the basis of fatalities per traveller kilometre. In theory, this allows him/her to compare the risk from undertaking the same journey using different modes."

So, the answer to 'Is it Safe for Me to Fly?' sketched here is generally positive. Aviation safety improvements over several decades, with huge increases in traffic, are substantial. Aviation's achievements match or better other modes of transport. But further safety improvements can be delivered. The question: 'Are the people responsible doing everything they should to make flying safe?' will always need to be asked. This naturally leads to the question 'How much should be invested in transport safety?' – discussed in Andrew Evans' research.

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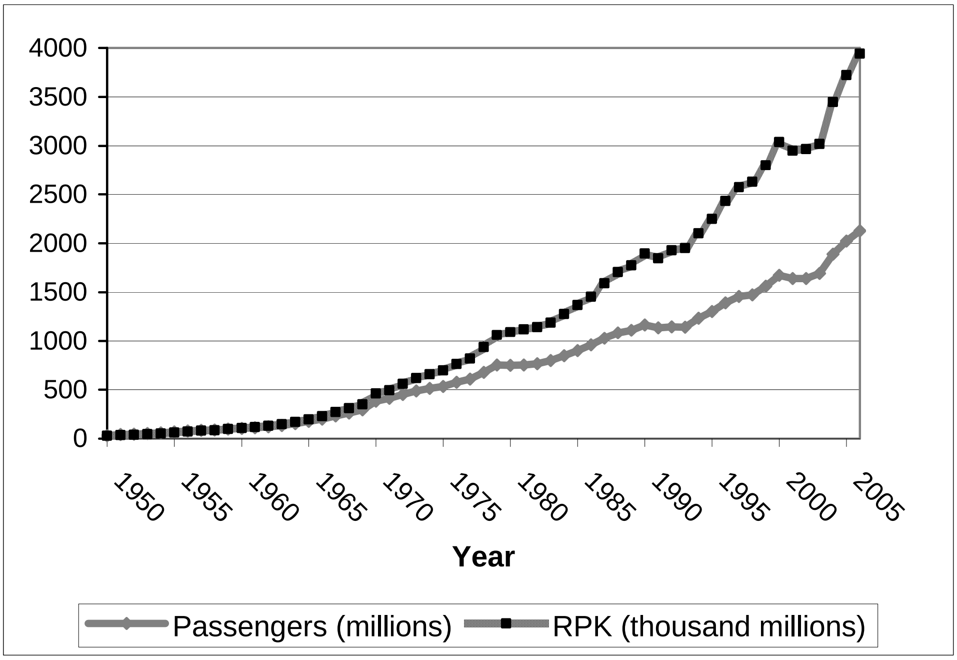

Figure 1. World Airline Passenger Traffic (source ICAO)

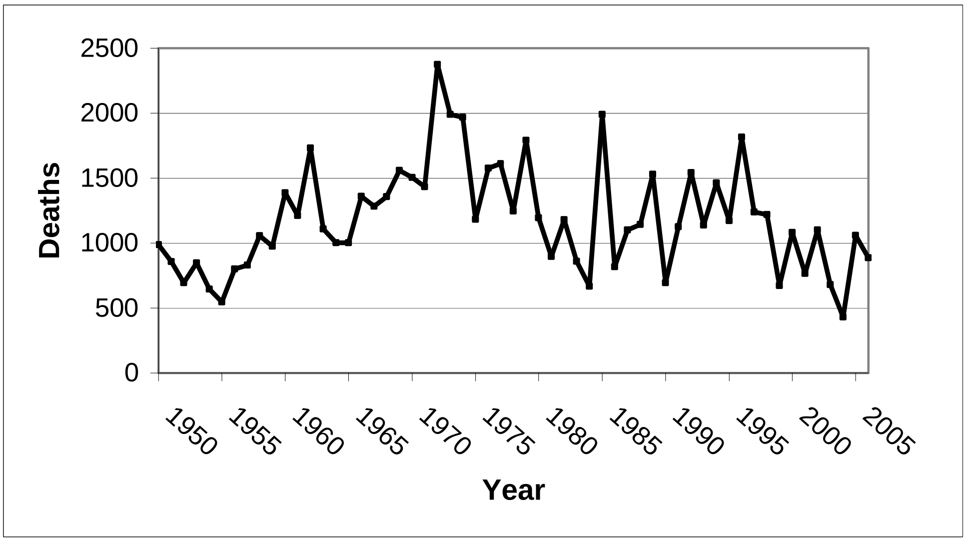

Figure 2. World Airliner Deaths by Year (source ASN)

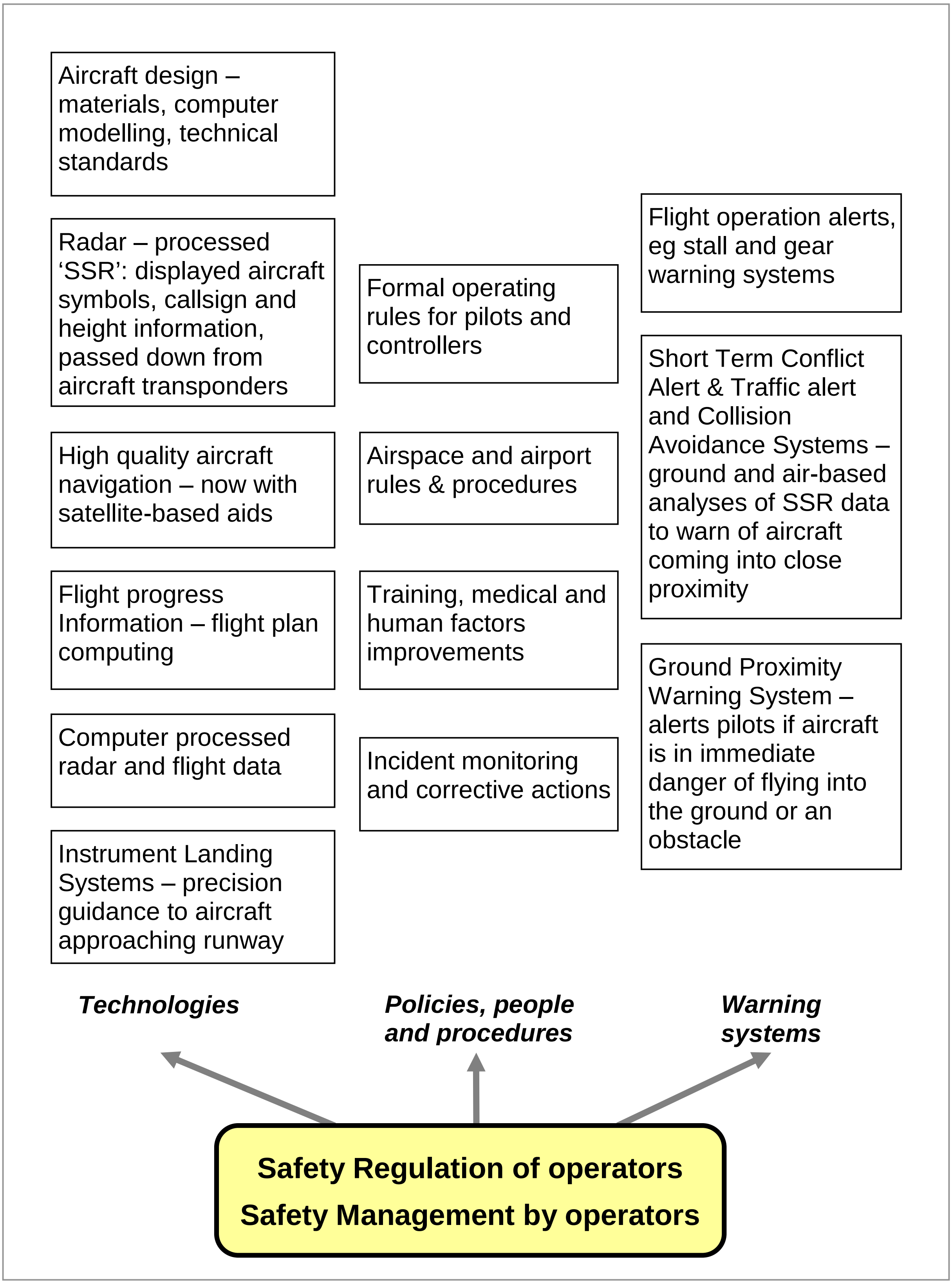

Figure 3. Some Key Aviation Safety Components

Region	2005	2006	2007
Africa	***9.21***	***4.31***	***4.09***
Asia Pacific	1.00	0.67	***2.76***
Russia & CIS	0.00	***8.60***	0.00
Europe	0.33	0.32	0.29
Latin America	***2.59***	***1.80***	***1.61***
Middle East & North Africa	***3.84***	0.00	1.08
North America	0.19	0.49	0.09
North Asia	0.00	0.00	0.88
World	0.76	0.65	0.75

Table 1. Regional accident rates – Hull losses per million flights, Western Jets - IATA and non-IATA, rates > twice World figure shown in bold italic. (source IATA)

Mode	Category	1996-2005 average
Air [1]		
	Killed	0.00
	KSI	0.00
	All	0.03
Rail [2]		
	Killed	0.4
	Injured	15
Bus/coach		
	Killed	0.3
	KSI	11
	All	184
Car [3]		
	Killed	2.7
	KSI	31
	All	317
Motorcycle [3]		
	Killed	111
	KSI	1360
	All	5176

Table 2. GB Passenger casualty rates by mode: 1996-2005. Per thousand million passenger kilometres (source DfT)

Notes

KSI = Killed or seriously injured

All = Killed, seriously and slightly injured

1 Passenger casualties in accidents by UK registered airline aircraft in UK & foreign airspace

2 Passenger casualties involved in train accidents and accidents occurring through movement of railway vehicles

3 Driver and passenger casualties

	Fatality risk per 10^9 traveller…		
	km	**hours**	**trips**
Railway	**0.1**	**5**	**4**
Airline	0.1	76	290
Bus/coach	0.3	6	3
Car	2.6	100	36
Cycle	32.0	380	120
Pedestrian	36.0	150	40
Motorcycle	110.0	4,300	1,900

Table 3. Synthetic Estimates of UK modal fatality risk using different metrics (source RSSB)

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