KAPITEL 11

Probabilistische Risiko-Analyse

Paul Marks of the New Scientist has a couple of good recent articles on the volcanic-ash problem for commercial aviation, one from today and one from last week.

I talked about a simple calculation of this risk in my Risk course this morning, since it is topical, it shows practical issues well, and it fits in about an hour's lecturing (with anecdotes). It seems that few people want to or can perform an elementary risk calculation about flying in the volcanic ash from Eyjafjallajkull. Here goes. It's very crude, but still leads to some insight.

Let us classify first the outcome categories per flight. I choose four:

1. No damage
2. Engine needs thorough inspection and cleaning
3. Engine needs major overhaul
4. Engines stop in flight.

All of these have happened. 1 to the majority of recent airline flights, 2 to a couple of Ryanair planes, and to the Finnish F-18s that had an encounter on April 15 , the day before the first ban, reported here previously, 3 to the (in)famous NASA DC-8 (at a cost of $3.2m, so one reads), 4 to Eric Moody on the famous BA 747 in 1982.

One can almost directly read off the severity from these. Let us consider units to be equivalently pounds or euros or dollars.

Severity of events (event classes) 1-4

1. 0
2. 10^4 to 10^5
3. 10^6 to 10^7
4. If a catastrophe is caused (i.e. the airplane does not succeed in making a dead-stick landing on an airport) then 10^8–10^9

It is curious that these four categories fit so crudely but neatly into powers of 10, covering the range.

So the risk is (the old De Moivre definition from 1711):

probability(1).severity(1) + probability(2).severity(2) + probability(3).severity(3) + probability(4).severity(4) In fact, this is only a crude estimate of severity, since if some engine is found to be damaged, then all engines on all airplanes flying into or from those airports that engine flew into and around those routes that engine took will have to be inspected as well, and that might run into the hundreds. This calculation does not take account of these knock-on effects.

Using severity(1) = 0, the risk per flight then lies between

10^4 x prob(2) + 10^6 x prob(3) + 10^8 x prob(4)

and 10^5 x prob(2) + 10^7 x prob(3) + 10^9 x prob(4)

(using the factors of ten associated with the severity ranges) Consider your average intraeuropean flight, say Air Berlin flying Paderborn-London Stansted. Boeing 737NG, let's say 150 people on board (this is an overestimate), paying €100 per seat (actually, it's lower, and much of that is airport tax). Your revenue for the flight is at most €15,000 (and a lot less if you take out airport tax). So your expected value of loss, the risk, above, must be less than this if you hope to do better than by not flying. So your decision criterion is

10^4 x prob(2) + 10^6 x prob(3) + 10^8 x prob(4) < 15,000 if you take the lower estimate of risk, and

10^5 x prob(2) + 10^7 x prob(3) + 10^9 x prob(4) < 15,000, that is

10^4 x prob(2) + 10^6 x prob(3) + 10^8 x prob(4) < 1,500 if you take the higher.

Let us take the lower estimate. You can handle a cleaning event without much trouble, but you had better be sure, to break even, that you have at most one chance in just over 60 flights of an overhaul event, and only one chance in just over 6,000 flights of an engine-out event.

Given what was known on April 16th about outcomes (for example, that the Finnish engines might be trashed), I wonder how much of what we heard from airline chiefs complaining about not being able to fly was political manoeuvring for government handouts to "compensate"them for being forced to do what a risk analysis would have told them to do anyway?