LEARNING FROM EXPERIENCE

by Captain Ed Pooley

As you read this edition of HindSight, we will be approaching the 40th anniversary of the aircraft accident which has, to date, killed more people than any other – the collision between two Boeing 747s on the Island of Tenerife in the Canary Islands in 1977[1]...

1- see http://www.skybrary.aero/index.php/B742_/_B741,_Tenerife_Canary Islands_ Spain,_1977

This accident, like all other runway collisions, has its origins in human error, in this case by the commander of the KLM 747 who began take off without clearance in visibility that precluded seeing that the other aircraft was still backtracking the same runway – and may well have been below the minimum permitted given the NOTAM'd inoperative runway centreline lighting. The evidence of the investigation indicated the KLM First Officer working the radio knew that there was no take off clearance but in the circumstances he found himself in felt unable to challenge his very senior and highly experienced colleague. Even when the Flight Engineer attempted to alert the Captain to the fact that the radio transmissions which they had just heard indicated that the other 747 was still on the runway, he got an emphatic 'put-down' from the Captain, apparently confident that he did not need help from his crew colleagues.

Since then Captains like this one have thankfully largely disappeared, although I did encounter a few with similar tendencies early in my own flying career. Helped by the Tenerife collision, we gained CRM and embraced the concept of an aircraft commander as a leader accountable for aircraft safety but working with team support of at least one other crew member. We entered a new era in which we began to accept and deal with human factors seriously for the first time. In this respect the chances of a repeat of a collision of this primary origin are very much reduced – but of course never eliminated.

Fourteen years later, a much bigger and always busy airport, Los Angeles, saw another runway collision between two passenger aircraft[2] which also resulted in the destruction of both aircraft and killed 34 people. This time it was in good visibility at night and followed controller error. A Boeing 737 was cleared to land on a runway on which a Metroliner had already been cleared to line up and wait at an intersection a little over 700 metres from the runway threshold. Since then, both the competency monitoring of and support tools available to FAA Controllers have improved a lot – as both needed to given the situation at many busy US airports at that time. And the FAA design dispensation which meant that the tail-mounted anti collision beacon on a Metroliner which was not visible from the 737 fight deck has since been modified – although not to the satisfaction of the NTSB.

Actual runway collisions involving transport aircraft, especially between two in-service transport aircraft are rare events. But as the 2001 Milan Linate collision[3] between an MD 87 taking off and a Cessna Citation which crossed a red stop bar into the path of the other aircraft in daylight but in thick fog killing all on board both showed, it is speed which is the factor to fear. CRM had arrived on the flight deck of the MD87 but the operating standards achieved by the pilots of the small aircraft which was involved, the like of which often share runway use, were certainly far below acceptable and even the legality of the flight questionable.

Another scenario which nearly led to a disaster at Amsterdam in 1998[4] is towing an aircraft across an active runway when there was an insufficiently rigorous procedure for controlling such runway access. On the day concerned, the TWR Visual Control Room was in cloud but that didn't stop the runway controller assuming that a Boeing 747-400 under tow and not working his frequency had vacated the runway before they gave take off clearance to a Boeing 767-300. Fortunately, the runway visibility was enough for the 767 crew to see the other aircraft in time to stop before reaching it.

The lessons from this event may or may not have since been learned at Amsterdam but they have certainly not been at Jakarta's second airport. On 4 April this year, a Boeing 737-800 taking off at night in good visibility and in accordance with its clearance collided with an ATR42-600 under tow without lights which had begun to cross the same runway 850 metres from its beginning[5]. Despite last minute avoiding action by both parties, with the 737 at around 130 knots at impact the two aircraft sustained "severe damage". Fortunately, the airframe contact was between the 737 left wing and the left wing and empennage of the ATR 42 and the fuel-fed fire which broke out in the 737 did not reach the fuselage. No lesson learned from Amsterdam 1998 though, just as then the towing vehicle was communicating with an assistant controller on a different radio frequency. And it's worth noting that an aircraft under tow is likely to be slower moving and less capable of last minute collision avoidance manoeuvring than a taxiing aircraft.

Operations with intersecting active runways bring another form of collision risk. There are two main variants and most but not all of these end up as near misses, albeit sometimes very close and involving premature rotation, delay in rotation or an abandoned take off by one of the aircraft involved. The first scenario has both runways as the

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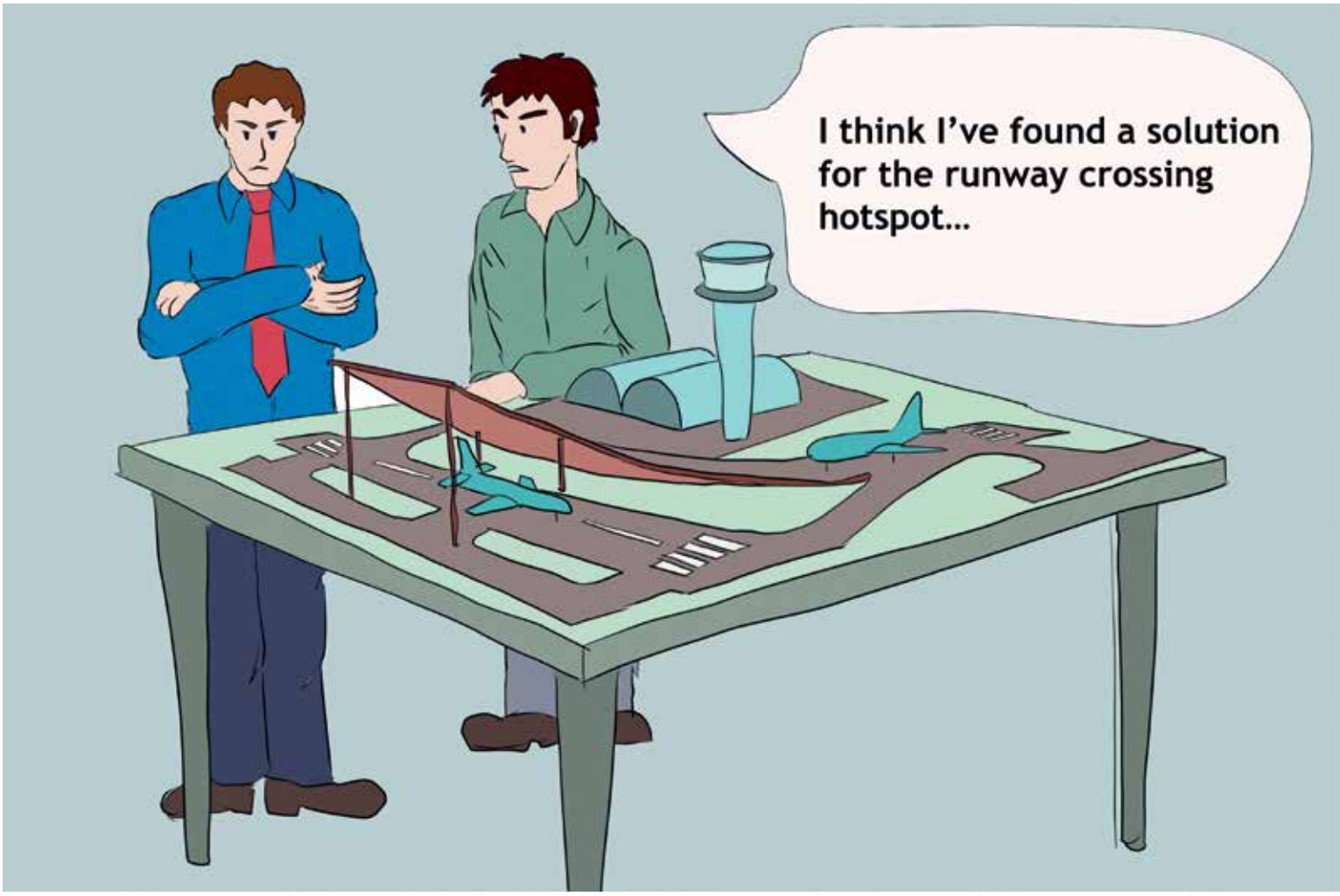
2- see http://www.skybrary.aero/index.php/B733_/_SW4,_Los Angeles_CA_USA,_1991
3- see http://www.skybrary.aero/index.php/MD87_/_C525,_Milan_Linate,_2001
4- see http://www.skybrary.aero/index.php/B763_/_B744,_Amsterdam_Netherlands,_1998
5- see http://www.skybrary.aero/index.php/B738_/_AT46,_Jakarta Halim_Indonesia,_2016



direct responsibility of a single controller and the other has separate controllers for each runway. In the USA, liaison between runway controllers has often been a problem whereas this side of the water, the single controller case such as that for intersecting runways 16 and 28 at Zurich has proved difficult to sort out[6]. For similar reasons, many near misses – but few actual collisions – involve aircraft crossing an active runway in order to get to their intended take off runway or from their landing one to parking. Conflict during a taxi crossing of such a runway can have its origins in either controller or pilot error.

An actual collision between a vehicle on an active runway and an aircraft at high speed is rare – but in thick fog at Luxembourg Airport in 2010[7], a Boeing 747-400F making a daylight landing off an ILS Cat 3b approach made superficial contact with a van parked in the Touch Down Zone which one of the pilots saw just before impact. Both the landing aircraft and vehicle runway access clearances were valid but the vehicle had received its clearance on the GND frequency whereas the aircraft had received theirs on the TWR frequency. Lastly, there is the 'simple' incursion case – again with many, many near misses of varying severity but only rare actual collisions – where an aircraft awaiting departure taxis onto the expected runway either having received and accepted a conflicting clearance but failed to follow it or having misunderstood a previously accepted clearance. It is clear whilst pilot error is often involved, the interface between TWR and GND controllers is often involved too.

Now what can we learn from the range of risks exemplified so far and the bigger picture of which they are part? Well, all collisions or near-collisions are founded on at least one (and usually only one) human error. That error will have had a context but it will also have had consequences. A lot of effort has been and continues to be put into trying to prevent errors that might – or might not – become the initiating factor in a runway collision and there is still much to be done. But because we can never entirely eliminate human error in setting up this risk any more than we can for other risks, I want to focus instead on how to mitigate its ultimate consequences, the risk of a runway collision where at least one aircraft is moving on an active runway at high speed.

The first requirement is an accurate assessment of airport-specific risk which is free of who is responsible for addressing that risk. The second requirement is processes, procedures and/or equipment which will be effective in preventing high speed runway collision. That is not necessarily the same as preventing runway incursions even though that in theory will solve the collision risk. I make the distinction in order to advocate a top down approach to risk rather than just a bottom up one. There are many Safety Management

6- see the findings of one of the more recent investigations at: http://www.skybrary.aero/index.php/A320_/_A320,_Zurich_Switzerland,_2011
7- see http://www.skybrary.aero/index.php/B744_/_Vehicle,_Luxembourg_Airport,_Luxembourg_2010

Systems out there which get lost in often irrelevant detail and loose sight of the ultimate risks and the priority that managing them demands. Airport users rightly assume, but don't always get, an equivalent level of operational safety.

Of course, the ultimate defence against traffic conflict on the ground is an alerting system based on projected ground tracks/flight paths which is independent of cause and communicates its alert directly to those who will be affected – pilots and drivers. Ideally, this would be a bit like the TCAS ll solution to airborne collision and the alert would be accompanied by guidance on what to do. In reality, we are not yet in sight of that but we do have something which is almost as good – the combination of a Runway Safety Light (RWSL) System[8] and the Final Approach Runway Occupancy Signal (FAROS)[9]. Whilst this FAA-sponsored combi-system ticks most of the boxes and will surely address the runway collision risk at the major US airports where it is being installed, it is very, very expensive and in its present form is only likely to be adopted at busy and complex airports. Some of you may be familiar with Europe's pioneering partial trial of the RWSL element for the main (inner) northerly runway at Paris CDG.

But all is not lost. Airports differ greatly in their complexity and traffic levels and so the route to effective top-down risk management will differ greatly. Incidentally, it is worth noting that there seems to be considerable circumstantial evidence that a disconnect between complexity and traffic levels may, in itself, be a source of avoidable runway collision risk. Where they are well matched, the opposite often appears to be true. Take the world's busiest single runway airport, London Gatwick, for example, where risk bearing runway incursions have long been almost non existent despite 55 movements per hour on a mixed mode runway.

In looking at high speed runway collision risk, it is clear that in all cases, the chances of it are much greater if low visibility and, to a lesser extent, the hours of darkness prevail. There is absolutely no doubt that visual conspicuity has averted many, many potential collisions. It is also generally true that risk is much higher if the situational awareness of those at direct risk is compromised by a failure to have all runway occupancy communications taking place on a single radio frequency and in a single language.

Beyond that, there are a whole set of potential risk factors that could and should be comprehensively assessed at individual airports. All of the following, not placed in any order of significance, have been relevant in the past and may well be in the future too:

- the absence of a process or system to monitor compliance with clearances.
- the absence of a check on the compatibility of all clearances currently valid.
- intersection take offs, especially if permitted from access primarily installed for the rapid exit of opposite direction landing aircraft or any runway intersection which requires less than a 90° turn onto the runway.
- the absence of ground and airborne radar or an equivalent display of traffic positions and tracks available to a runway controller.
- where the crossing of an active runway is necessary on the way to the take off runway or after landing.
- the simultaneous use of intersecting active runways occurs unless wholly effective control procedures are mandated.
- there is mixed mode runway operation.
- pilots are unfamiliar with the airport concerned.
- 'follow the greens' is in not used at least at night and in low visibility conditions.
- all runway access is not controlled using lit red stop bars operated using strict procedures.
- the runway longitudinal profile is uneven to the extent that a clear view along the length of a runway at surface or near surface level is not possible.
- vehicles permitted to operate airside beyond the ramp area with only one qualified driver on board.
- the procedure for runway configuration change is not adequate or adequate but not always applied as required.
- the procedure for the handover of runway controller positions is inadequate or not followed.
- the procedures for supervision of trainee controllers are inadequate or not followed.

In providing that not necessarily comprehensive list, I do not seek to diminish in any way the concurrent importance of aircraft operator procedures reflecting runway collision risk management at the generic or, where considered necessary, the individual airport level.

Finally, I have one important safety recommendation on this subject. Whilst it is important to understand risk at one's own airport or in one's own aircraft operation, a high speed runway collision or a near risk of it is such a rare event that it is essential to find time to look beyond your direct concerns at what is happening elsewhere.

8- see http://www.skybrary.aero/index.php/Runway_Status_Lights_(RWSL)
9- see http://www.skybrary.aero/index.php/Final_Approach_Runway_Occupancy_Signal_(FAROS)