

PREVENTING RUNWAY COLLISION

WHAT I HAVE TRIED TO DO

by Tzvetomir Blajev

.....

A RUNWAY INCURSION, AND NOT PEEING IN YOUR PANTS

by Professor Sidney Dekker

.....

LEARNING FROM EXPERIENCE

by Captain Ed Pooley

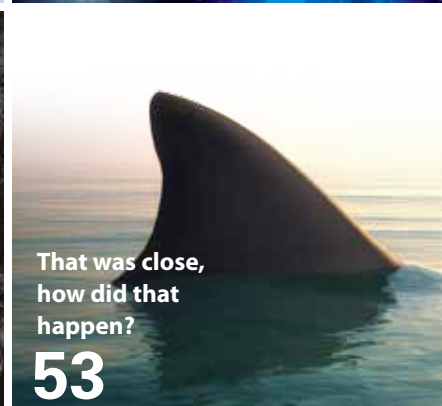
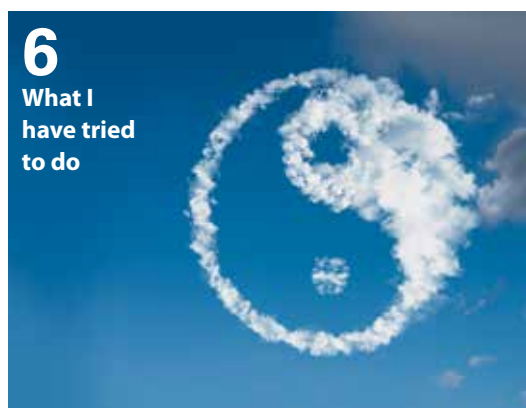


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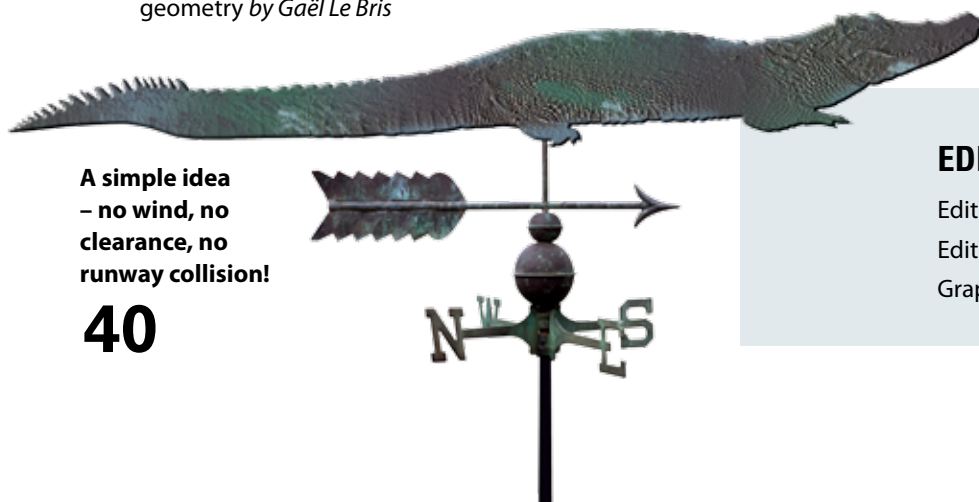
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CONTACT US

The success of this publication depends very much on you. We need to know what you think of HindSight.

Do you find the contents interesting or boring?

Did they make you think about something you hadn't thought of before?

Are you looking forward to the next edition?

Are there some improvements you would like to see in its content or layout?

Please tell us what you think – and even more important, please share your difficult experiences with us!

We hope that you will join us in making this publication a success.

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SKYbrary DOWNLOAD

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EDITORIAL TEAM

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Dear readers,

Traffic in Europe is growing again, with 40% more flights expected by 2035; however, the number of airports and even runways in Europe is hardly growing at all. This means that airports are becoming busier and there is ever-increasing pressure to maximise runway throughput and to make airports more efficient. It also means that essential maintenance of the existing airport infrastructure has to be fitted in around operations.

All of this potentially increases the risk of runway incursions – which are widely considered to be one of the most important safety concerns for aviation. Nowadays, we think that several things have to go wrong for there to be a major accident, given the safety nets we have in place and the layers of redundancy in aviation. However, it can take only one incorrect or misheard instruction for a potential high-speed collision to occur.

There are some fascinating articles on the subject in this edition – not just looking at the causes but also at how we can make runways safer, as well as more efficient. As ever, there is no single solution. Part of the response needs to be based on the human factors involved, learning from both negative and also positive incidents. Part of the response needs to address the operational procedures in place at individual airports, especially at times when unusual things are happening, such as works or maintenance.

Technology can also play a role here. SESAR has developed and validated new tools for controllers¹ and Remote Towers may have the capability of displaying information next to the aircraft on the screen. An article in this issue describes the new runway safety lights being evaluated at Paris Charles de Gaulle, which are a good example of how we can start to strengthen the safety nets in this crucial area.

However, technology can only take us so far and complex systems will not be appropriate for every airport. Dangerous runway incursions can just as easily occur at relatively quiet airports where vigilance and respect for procedures will continue to be our primary defence.

The European Action Plan for the Prevention of Runway Incursions is a useful guide to best practice for everyone involved – not just flight crews and controllers but also drivers of airside vehicles and even designers of airport lighting systems. The current edition (from 2011) is due to be updated so please do share your experiences – both good and bad – so that we can all improve safety on the runway.

The Director General




FRANK BRENNER

has worked in Air Traffic Management for his entire career. He has been Director General of EUROCONTROL since 1 January 2013.

Since taking up his functions at EUROCONTROL, he has initiated the development of a Vision and Strategy, including the development of Centralised Services as part of the SESAR deployment concentrating on how to support controllers with new technology which increases safety.

Before joining EUROCONTROL, Frank Brenner was General Manager Operations for FABEC, Vice Chairman of EUROCONTROL's Performance Review Commission and a member of the Performance Review Body. Trained as an air traffic controller, he has held a number of posts at DFS including Head of ATM Operations, Director of Operations at the Business Unit for Aeronautical Data Management and Director of DFS's Control Centre Business Unit. operational posts.

¹- Conflicting ATC Clearances (CATC) and Conformance Monitoring Alerts for Controllers (CMAC)

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PREVENTING RUNWAY COLLISIONS

THE SINGLE OPERATIONAL ISSUE

ADDRESSED BY
THE 5TH ANNUAL SAFETY FORUM

PRESENTED BY
**THE FLIGHT SAFETY FOUNDATION, EUROCONTROL AND
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WHAT I HAVE TRIED TO DO

It was the beginning of November 2012. The conference hall in Santiago looked more like a stadium. One could barely see empty seats and participants were still entering. I saw Paolo who, after the death of his son in an aircraft accident, quit his job and joined in the work of the Flight Safety Foundation. Paolo also saw me and made his way around some people to reach me and started speaking with his throaty voice "Ciao Tzvetomir, such a success – the whole of South America is here. You know, you have saved many lives, just that you and the people you saved will never know it."

In the beginning of 2004 I was tasked to facilitate "Safety Information Sharing and Safety Improvement" for EUROCONTROL. A number of products emerged from this work – Safety Alerts, Safety Action Plans and Toolkits and, a little bit later, SKYbrary. Another product was also envisaged, a magazine style of publication which would communicate ATM safety knowledge and debate to both pilots and controllers in an easy to read style.

We launched HindSight in 2005 and you are now reading the 24th edition of it. Twice a year our editorial team tries to assemble a special publication for you. A publication that attempts to respect two important guiding principles for what can and what cannot be published. What I call here The Yin and The Yang of safety.

The Yang

This is the rational, logical, engineering point of view. Safety is achieved by a predefined structure of safety barriers. The barriers are sometimes redundant and sometimes support each other. You can invest in a rigorous stop-bars safety policy which will prevent an incorrect entry to the runway protected area or you can consider implementing Runway Status Lights to provide autonomous alerting to those who may be directly affected by a potential runway conflict that the runway is occupied.

In this way, in order to prevent runway collisions, we need a structure of safety functions which prevents runway incursions, prevents runway incursions to result in a runway conflict and ultimately to prevent a runway conflict leading to a runway collision.

Talking about safety structure and functions, in HindSight we particularly try to share with you the positive experiences of those who have

developed and implemented new procedures or systems and can tell us what improvements these brought. Learning from good and bad, we also try to outline real incident and accident scenarios and investigate with you what information these failure stories tell us about the effectiveness of existing safety protections.

In sharing with you the technical part of safety, we "censor" only if the information about the standard procedures is misleading. We try to promote a healthy and constructive discussion with arguments based on facts and disagreements being a matter of opinion.



Tzvetomir Blajev
Editor in Chief of HindSight

The Yin

Of course, safety cannot be only explained by the structural design of safety protections. There is much more to human and systems behaviour than just the rational de-construction of safety functions, training, compliance with procedures and reliability of equipment. People working in aviation and influencing safety come with their social and personal identities; they can be big or small cogs in the “safety machine” but they are more than cogs or nodes in the network; people are also carriers of an identity which influences and is influenced by their working environment. In other words, there are strong cultural issues in the way we “do things around here”.

We try avoiding talking too much about safety culture directly in HindSight but instead aim to become part of this culture. We try to find those story-tellers and meaning-shapers that challenge and make explicit our underlying assumptions on how things work or don't work. Our shared underlying assumptions, created slowly over the years, almost sub-consciously built in our daily life, are in fact our safety culture.

Case studies, “camp fire” stories, comments and discussions have, as we hoped, over time continually given you someone else's cleverness that can enrich your understanding and maybe challenge your assumptions. Or they can cultivate an ethical dilemma. On the one hand, use of the

construct “situation awareness” when investigating past runway collision cases where it may be more a label of the symptoms than the underlying reasons. On the other hand it can be a useful system design guide to help maximise the ease of runway conflict detection and interpretation by controllers, pilots or vehicle drivers.

When we share with you the stories we try to avoid emotional conflict on a personal level.

The Yin and Yang are seemingly opposite and mutually exclusive. But this is only at a superficial level. They are part of one and the same story about safety; it is just the point of view that may be different. Apart from the structural, constructivist point of view and the safety culture point of view there is also another perspective – the perspective of power and interests. I can proudly reveal that over the 12 years of HindSight production we have only had two partially successful attempts for “political” influence. Once we removed the statement that “using stop bars will not solve all your problems” and once we removed the name of an aircraft operator.

I have made this overview of HindSight because with the next edition it will have a new Editor-in-Chief. I am very confident that with Dr. Steve Shorrock in command, HindSight will be in very good hands. So my final Editorial is my report to you as a reader on what I have tried so far. I felt a responsibility to give my best to reduce the risk to peoples' lives and to contribute to a cause I strongly believe in.

Paolo is not anymore with us. But his words are still with me and are reward enough for what I have tried to do.

Enjoy reading HindSight! ☺



My first love in flying has always been gliding. I soloed when I was 14 years old, off the winch in a wood-and-fabric sailplane. Since that day, I have flown lots of other things (many of them much, much bigger, and indeed with engines), but gliding remains my first love.

A RUNWAY INCURSION, AND NOT PEEING IN YOUR PANTS

by Professor Sidney Dekker

I am currently in the role of Chief Flight Instructor (CFI) at a club on the other side of the ranges from where I live. We operate from a CTAF council airfield with a paved runway, some 1750 meters long. To get the gliders airborne, we use a Piper Pawnee, one of those old crop-dusting planes with a 235 horsepower six-cylinder engine.

In reality, though, we don't operate from the runway. Like many gliding operations the world over, we take off and land on the grass beside the runway. This has various reasons: one is that gliders can't move under their own power (because they have none, except motorised gliders...) so they tend to take up space on an active runway and need to be pushed off by hand. Another reason is that the grass is wider than the paved runway, so you can line up gliders for takeoff and still have space next to them to land. Landing on grass is also a lot kinder on the tyres.

Toward the end of a nice day not long ago, with high cloud and almost no wind, I had just landed with my own glider (yes, on the grass). No other gliders were waiting to take off anymore: people were done flying for the day. But they were still coming in. I'd heard that another glider was in the circuit behind me. I got out of the cockpit, pulled my glider to the side of the grass and watched the other glider turn from base onto final. At that moment, the

tow plane, which had been parked to the side of the grass as well, started up. With not much delay, it lurched forward and taxied out in front of the glider on final approach. I heard repeated calls from the glider pilot, directly addressing the tow plane, but to no avail. The tow plane kept on taxiing along the grass parallel to the runway, past me and toward the hangars where it was going to be refuelled and parked. The glider that had been on approach (a go-around is impossible, for obvious reasons) had squeaked to the side of the tow plane to find a place to land, still on the grass. The paved runway was not in use at the time.

As CFI, you are responsible for the safety of operations. It is at moments like these that I feel that my ideas and writings, that my books and arguments, are being put to the test like never before. That is, of course, the beauty and credibility of being operationally active when writing about safety in aviation (and, incidentally, the beauty of a publication like this one, as most people who write in it are operationally active and often in positions of responsibility). This means that it's not just talking about stuff: you actually have to *live* what

you talk about. You have to walk that talk. At least if you don't want to pulled apart by cognitive dissonance, or some ethical conflict inside your own head.

Because what I wanted to do, was to run out to the tow pilot, and give him a royal talking-to. What on earth was the idiot thinking? Didn't he look out? What about not hearing the calls of the other glider pilot? Was he even qualified to drive the darned thing? You know the sorts of reactions you can have in a situation like that.

I restrained myself. How many audiences, I thought, have I counselled in not engaging in peeing-in-your-pants management? That is the kind of management where you are so upset, or so concerned, that you feel you really need to go, you really need to do something now, *now*. And so you do it. That is like peeing in your pants (not that I speak from personal experience, at least not before conscious age, but I have three kids...). It's like peeing in your pants because you feel really relieved when you do it. *Aaaah*, the feeling of letting go (again, this is judging from how



my kids occasionally looked when they were young). But it is also like peeing in your pants, because of what happens shortly after.

What happens shortly after is that you start to feel cold and clammy and nasty. And you start stinking.

And, oh by the way, you look like a fool.

That's what peeing-in-your-pants management does to you. Makes you feel relieved, but only for a short while. Then you feel nasty and dirty and you look like a fool.

PROFESSOR SIDNEY DEKKER

is Professor and Director of the Key Centre for Ethics, Law, Justice and Governance at Griffith University, Brisbane, Australia. Author of best-selling books on human factors and safety, he has had experience as an airline pilot on the Boeing 737.



So what did I do instead? Well, I happen to have written a couple of books on this, so I should know, right? Again, knowing and applying are two different things. But here I went, thinking to myself standing there next to my glider in the honey-coloured light of the setting sun. The starting assumption (and I really needed to convince myself of this) is that people don't come to these activities to deliberately do a bad job. What they did made sense to them at the time, given their goals, their knowledge and their focus of attention. If human errors show up, then these are consequences of issues much deeper in the system. They aren't causes of trouble; they are the result, or one expression of trouble that was already there.

So the tow pilot had the best intentions. What he did must have made sense to him, otherwise he wouldn't have done it. Others might do this sort of thing too. As responsible for the safety of the operation, I had to find out why. Ultimately, the question that I needed to answer was this: *what* was responsible for this event to occur, for this runway incursion to happen? I had to avoid asking *who* was responsible. Because that, after all, would lead to a quick and false answer. The tow pilot, of course! He should have watched out more. He should have tried harder. He should not have lost (oh good grief) his situation awareness...

Right. Try that, and see how far it gets you in your next investigation. No, I needed to find out *what* was responsible. To answer that question, you need to go *up and out* in your thinking. Don't just go *down and in* and ask the tow pilot what on earth he was doing. No, you need to set the event in a larger context, connect the actions of those involved at the time to other activities, processes and actions, many of which stretch out in space and time beyond those few people, beyond that afternoon.

I won't bore you with the details, particularly because a CTAF airfield doesn't have ATC (which is the whole point of CTAF). So some of you might wonder what this whole fuss is about after all (just get a controller in to sort out the mess!!). If we were, however, to start far away and high up, you can already start to discern the conditions of possibility for an event like this one. Airports in the country where this happened are funded Federally, built at State level and operated at Council level. Sometimes they are also regulated federally, but the extent of that depends on whether the aerodrome is 'registered.' It is possible to have an unregistered aerodrome, from which federal regulation can wash its hands. So lots of levels of government are involved (or sometimes not). Depending on where you are on the political spectrum (i.e. how libertarian or not), this is either a

good thing or a bad thing. Next, the country's AIP. It turns out that glider operations are not specified in it as taking place from the grass besides the runway. The first time anybody might discover gliders in that spot is when they show up at the field, or watch pictures on the club's website. The first can be a bit too late; the second is not an 'official' source of operational information. So in bureaucratic reality, we don't operate from grass at all. Or shouldn't. Or may not. Or can't. Yet we do – in reality, that is.

Then the tow plane. There's an injunction against starting the engine with the radio switched on. There are good electronic reasons for that, which are way outside the scope of this column. So first you start up (which involves toggling the separate magneto systems and various other buttons). And that's where it gets typical, of course (in the Don Norman/James Reason errors-in-a-sequence sense). Once the engine is running, you can taxi. Your goal is achieved: you can now move the plane under its own power. So you move. Why engage in any other actions? Like switching on the radio? Then it is the end of the flying day, so there's no more movements, right? And you are going to stay off the official manoeuvring areas of the airfield, because you'll just stay in the grass beside the runway. So it isn't actually necessary to use the radio there – or at least you could argue as much.

Which brings me to the crunch: according to the AIP, this isn't even a runway incursion. Because it isn't a runway. In practice, yes. On paper, no. I didn't react. I learned later that day that the glider pilot and tow pilot had spoken to each other, and were deciding how to put in an official incident report.

So next time, when someone does something you really find idiotic, obviously dangerous or unnecessarily risky, remember: don't pee in your pants. Find out why it made sense to them. Think up and out, not down and in. Ask *what* is responsible, not *who* is responsible. **5**

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 1977¹...



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 aircraft² 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 flight 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 collision³ 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 1998⁴ 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 beginning⁵. 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.

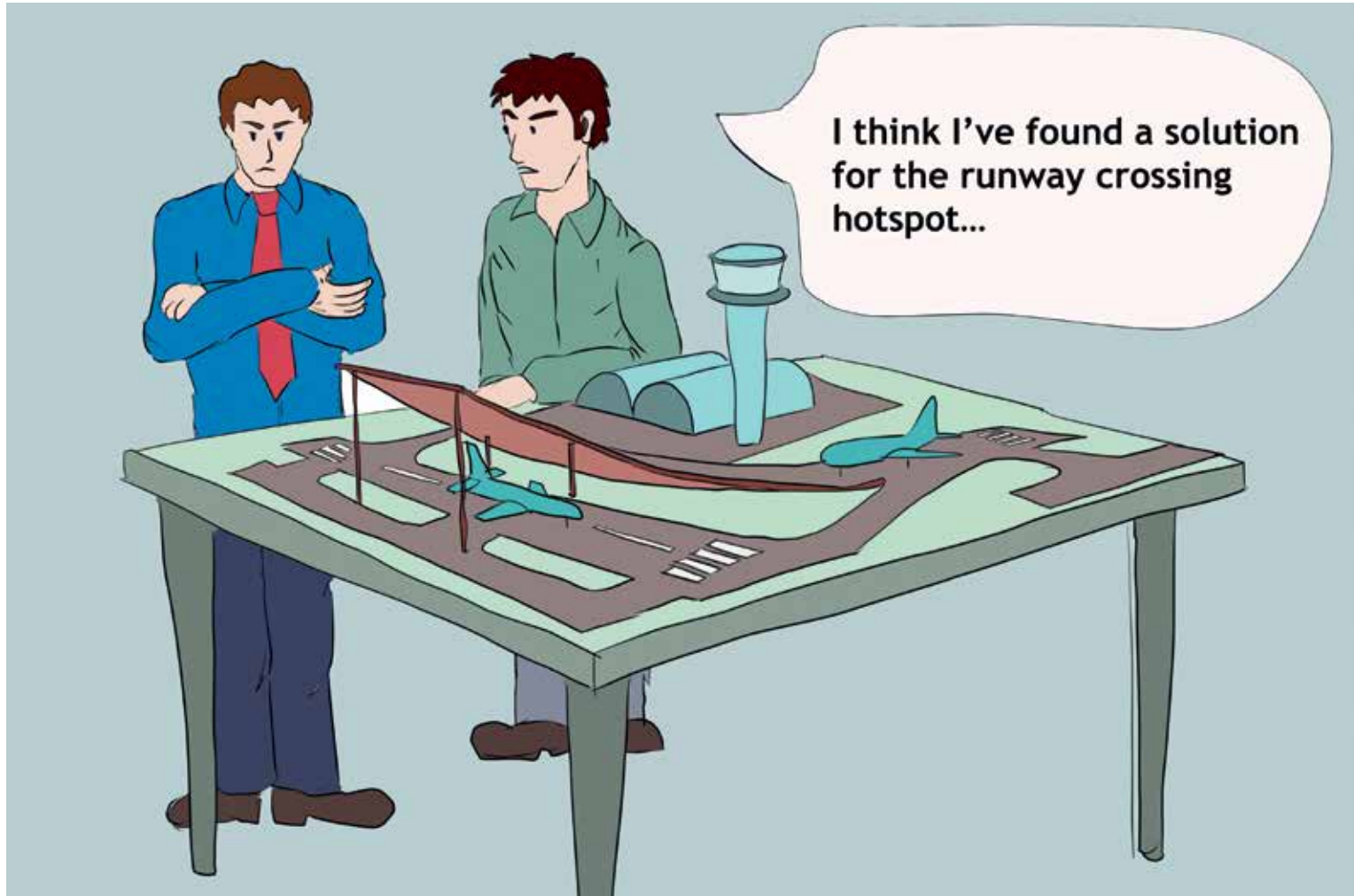
Operations with intersecting active runways bring another form of collision risk. There are two main variants and most but not all of these end up as near misses, albeit sometimes very close and involving premature rotation, delay in rotation or an abandoned take off by one of the aircraft involved. 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 out⁶. 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 2010⁷, 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 II 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) System⁸ 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. **S**

8- see [http://www.skybrary.aero/index.php/Runway_Status_Lights_\(RWSL\)](http://www.skybrary.aero/index.php/Runway_Status_Lights_(RWSL))

9- see [http://www.skybrary.aero/index.php/Final_Approach_Runway_Occupancy_Signal_\(FAROS\)](http://www.skybrary.aero/index.php/Final_Approach_Runway_Occupancy_Signal_(FAROS))

THE MISSED OPPORTUNITY

by Bengt Collin

it should be understood that all the details in this story are, purely fictional and any similarity to real incidents, persons or meetings is unintended.

The first accident

"Taxiing to gate two niner, Braxy 555". It was late in the evening, cold weather, unlimited visibility; he could see the stars above, it was indeed a nice evening. "Is it first left, I've never parked here before", the Captain asked his First Officer whilst gently slowing the aircraft down. "This map is at a very small scale, it's difficult to see all the details", he added by way of explanation. "I think so, the gate is next to gate thirty, just follow the green taxi lights to the left and pass behind the aircraft parked on gate thirty". The First Officer pointed with his left arm in front of the Captain to make his statement even clearer. "The people are waiting for us at the gate", the Captain commented. Just before commencing the relatively sharp left turn onto their gate, they felt a light contact with something.

From the Final Report accident one

"Since taxiing behind gate three zero is prohibited and is a potential risk of collision, we recommend clearer markings on the ground and a better description of the route in the AIP".

The Tower Manager

She had breakfast at six thirty as usual, black coffee and toast. Following a quick glance in the morning paper – Pia still preferred the paper version rather than the electronic one – she started planning her day. At the top of the agenda was a meeting with the CEO for the service provider she was employed by. Then, after lunch, her nightmare, the monthly meeting with the union representatives. She had scheduled lunch with the new airside manager for the airport, should be nice. He had started his job only a fortnight ago, she had to remember to be polite and be interested on his background.

The morning meeting with the CEO

"I have read the report on the accident outside gate twenty nine". The CEO leaned back in his black office chair. "To be honest I don't think you need to do anything at all Pia". "But the recommendations are there, I had a quick chat with one of the investigators, he recommended us to investigate if the taxiway centreline lights could be switched on and off, like at Heathrow you know", Pia replied. "The incoming aircraft was following an incorrect line of lights" she continued. "Forget about it, why should we do that?" Ollie, the CEO looked serious. "Let's be realistic, this single accident didn't hurt anybody, it is paid for by the insurance companies, it doesn't cost us anything". "But we have an increasing number of runway incursions too" Pia replied. "Don't over react Pia, perhaps more training is the solution instead". It was a quick meeting.

Lunch

"Nice to meet you Andrew and thank you for having time to talk to me so soon after you started, you must be very busy". Pia smiled at Andrew, he smiled back, she was good looking in her new black dress. They were sitting in her favourite restaurant for business meetings; not visited that often though, her budget being very tight. They were overlooking one of the aprons. "What did you do before starting your work at the airport?" "I managed a truck company", Andrew replied and added "almost the same thing as running an airport". "Interesting, I'm sure you will find several possibilities to use your experiences in your new job", Pia said and smiled at Andrew again.



BENGT COLLIN

formerly worked at EUROCONTROL HQ as a Senior Expert involved in operational ATC safety activities. Bengt has a long background as Tower and Approach controller at Stockholm-Arlanda Airport, Sweden

The afternoon union meeting

To say that the relation to the controllers union was superb, was the overstatement of the year. They were sitting in a warm meeting room in the ground floor of the tower building. Outside it was raining and beginning to get dark. The union representative, Chris, explained that "the controllers would not accept the use of the stop bars for legal reasons". He continued "If a controller forgets to re-activate a stop bar after it been switched off and an incident or even an accident occurs, legal action could be taken against the controller. We cannot accept that. Full stop". She didn't expect that and had nothing to say really. She was seriously considering changing job. There must be better possibilities elsewhere. "We will stop using the stop bars by tomorrow, any questions?"

The second accident

"We just follow the lights behind gate thirty and make the left turn to our gate" the Captain explained to her First Officer. "Are you sure we can pass behind that aircraft, it seems like it's parked a bit away from the gate", the First Officer replied. "Just to be sure, we'll divert slightly to

the right, you are right, it's not really at the gate, is it"? They could feel the small but distinct impact of the tail of the parked aircraft as it touched their left wingtip.

Recommendations following the second accident

"As with the previous accident at the same location, we recommend that the instructions in the AIP should be improved. We also recommend, based on this accident and other reported diversions from cleared routes leading to runway incursions, that the airport to investigate the possibility of being able to activate only relevant taxiway centreline lights.

The follow up meeting at the airport

"I just can't understand this recommendation", he had already started the discussion before sitting down at the table. Andrew looked relaxed in his red pullover and blue jeans, she could notice some grey spots in his large beard. "If someone makes a mistake it's their fault" he continued. "For example, if a truck driver was speeding, they had to pay the fines, not the company". "But comparing a speeding truck driver with an accident, actually two accidents plus a number of runway incursions is not relevant, is it?" Pia tried to stay calm. "Please explain to me why we should invest money in something we have no involvement in" Andrew quickly replied. At that very moment Pia finally decided to quit her job. Ansi, the secretary opened the door; "Can I water the plants?"

The phone call from the airline

"Good morning Andrew, welcome to your new position, may I take the possibility to bring up a problem we have?" The representative from the major airline at the airport went straight to the point without the usual small talk. "We are having problems navigating around the airport. For our many sub chartered pilots it's very challenging". "What is challenging, don't you have a map?" Andrew to late realised it perhaps was not the best answer. The airline representative didn't react, he just ignored Andrews comment. "Even I almost caused a runway incursion last week, all this

work in progress is disruptive, we can't follow the usual routes. And why have you stopped using the stop bars?"

"I have nothing to do with that, it's a Tower decision". They should train the pilots better he thought, it's not my problem, but he didn't say it.

In the Tower

It was dark, fog prevented the controllers from seeing the ground. "Could you hand me the coffee please Brent", the ground controller asked as he turned away from his HMI. He had only two aircraft on his frequency, he instructed one of them to contact the runway controller for the departure clearance, the other was an inbound international carrier, no conflicts. He started drinking his coffee, relaxing after a busy period.

"I almost switched on the stop bar at the runway entrance, I'd forgotten that they all should be off at all times" the runway controller Ken said to Brent. "I think it's a stupid decision by the Union to instruct us not to use the stop bars" Ken continued. "Ken, why is it dark here and not in China, I don't understand why it's not night at the same time everywhere". Ken completely ignored Brent's question, he normally did. "ABC123 wind calm, runway one eight cleared for take-off".

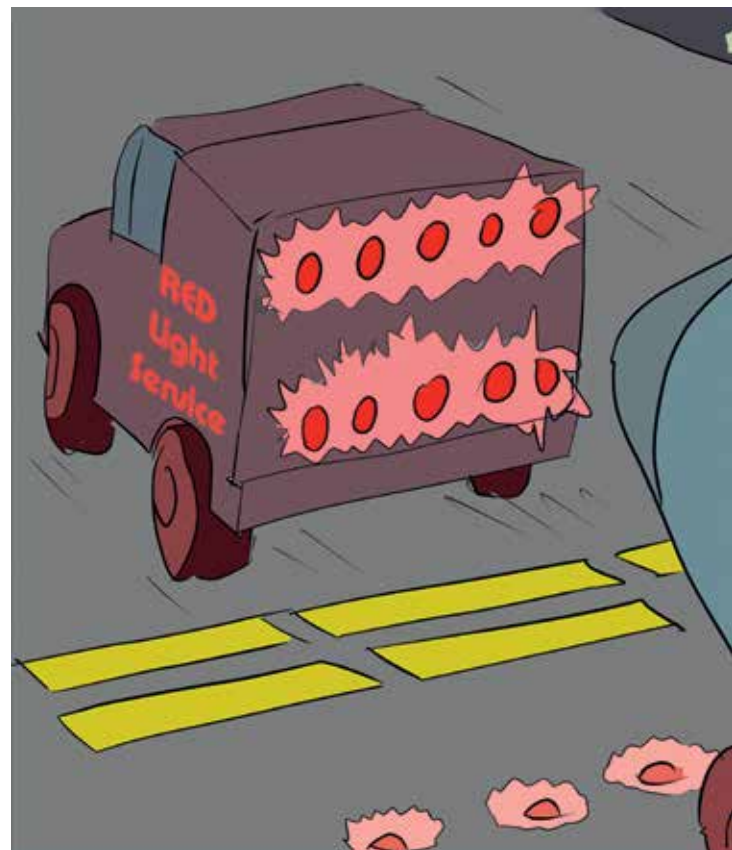
On the Flight Deck

"It's really difficult to navigate around this airport and the fog doesn't make it any easier". The Captain followed the green lights ahead, to his left and right he could see the green lights on other taxiways, it was green lights everywhere. Because of work in progress on the inner parallel taxiway, they were now following the outer taxiway, which he had never used before, instead. "Could you please check the taxi chart, I guess we should continue straight ahead, or is it slightly to the left"? While the

First Officer examined the chart, the Captain continued taxiing slowly straight ahead, unaware of the runway ahead. He wasn't sure of their position, should he stop? The visibility was very low, he could see only a few green lights ahead, it should be ok. At the same time another aircraft, a few hundred metres to the north, started its take-off roll southbound.

The third accident

On television in another country
Following yesterday's accident involving an aircraft from one of our international carriers, the airline has made the following statement: "We understand that following two previous accidents at the same airport plus a number of reported runway incursions there, the authorities had already recommended a review of the use of the airfield guidance light control system. This has, to our knowledge, not been initiated. We will of course wait until the preliminary investigation report is released, but we will be ready to pursue legal action against the airport if this information is correct". S



CASE STUDY COMMENT 1

RADU CIOPONEA

The proletariat cause:
Unions versus Management. Or is it?

Here we go again. How and why have we arrived at a point where the management and the unions completely and utterly lack the basic understanding of the safety implications of their decisions? The CEO dismisses the safety recommendations, effectively rendering useless a time-honoured system and a legal obligation, the airside manager is running a garage, and adding insult to injury, the Unions "protect" their members by interfering with what is a strictly professional, safety-critical activity. What it's interesting is that none of them seem to be concerned about safety, yet all of them must know better. I'm also taken aback by how easily ATCOs would simply follow the decision of the union not to use the stop bars. I'm not sure where in

the certification process, the safety case or the procedure design the Unions are included. I also wonder how a Union can overrule an internal procedure which is also a legal obligation on which they have no competence or authority. And then, whose responsibility will it be when non-usage of the stop bars is determined to have been a major contributor to an accident? Would a "the Unions told me so" excuse stand scrutiny, let alone be accepted as a defence in Court?

For sure, this is an imagined case. Or is it? It may well be, but it's surely not unrealistic. Something like this may soon come to an airport near you. Something like this may already be unfolding at an airport near you. The silver lining in this entire story is that costs are carefully being kept under control so we can all fly CheapAir to that sunny destination wearing only flip-flops and the 10kg small backpack allowed for free in the cabin. But the small drift into failure that happens all around us, the posturing of the Unions concerned with everything that would make a good political case, the managers that are pressed by Boards, shareholders and mindless politicians to keep costs down and their bonus up... all this may end up in smoke one day. Quite literally. And then the blame game will start with Unions and management once again

RADU CIOPONEA

is an aeronautical engineer with nearly 25 years in ATM, having held an ATCO license in his home country after which he joined EUROCONTROL as a safety specialist. He worked on safety matters for the past 18 years in areas like Just Culture, safety performance or safety management tools. He supports European and non-European ANSPs in their SMS and in his free time he likes fly gliders and powered aircraft. Safely.

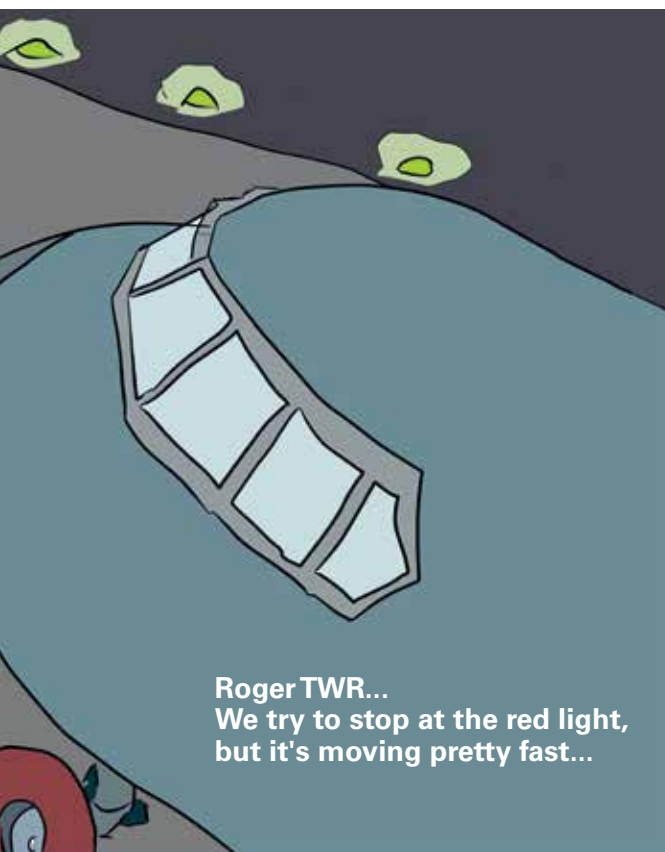


united in a mutual finger-pointing exercise, promptly remembering that they are supposed to be antagonistic.

Last but not least, I'm sure Pia must've looked pretty in her black dress. I'd submit her role there was supposed to be more than representing the Fashion Channel though. While I fully realise how difficult it is to fight stubborn and narrow-minded management, particularly when Unions also work against basic common sense, simply considering a job change is perhaps not the best way of action? And if that is what she wanted, why delay? Leave without delay and let someone more competent and/or more determined ensure the safety of that place. She didn't. She may have to do it now. Not on her own terms, though. But in any case, the Union will be there, shoulder to shoulder, to defend her. So will the CEO. Or will they?

A RECOMMENDATION

Safety costs money, whether to implement, maintain or improve. It's as simple as that. When savings must be made, when policies must be applied or when personal issues intervene, safety must not take a back seat, lest it backfires and leads to an incident or accident. At that point, all cost, policy or personal issues will take on a whole new meaning. Yes, safety is expensive, but these are monies wisely spent and must continue to be spent for the long term survival of our industry and customers. Quite literally. Savings, policies and personal priorities should always heed safety priorities.5



Roger TWR...
We try to stop at the red light,
but it's moving pretty fast...

CASE STUDY COMMENT 2

CAPTAIN ED POOLEY

We hear rather a lot about 'Collaborative Decision Making' but a decision to do something is not a collaboration, it is the responsibility of the owner(s) of the problem. The specific problem here appears to be an airport taxi system which is deficient to the extent, in the first instance, that one particular taxi route is not clear enough to pilots to preclude repetitive routing error. So who owns the problem here?

First, we must decide on the cause(s) of the problem. Is it "the pilots" (and if so who are they, just the ones who 'messed up' or potentially all the pilots who work for the same operators or potentially all pilots who use the airport) or "the inadequate guidance on taxi routes provided by the airport operator"?

On the evidence available, whilst it might be a very good idea in the short term for the operators who employ the careless pilots to raise awareness of the obvious risk and for ATC to provide an explicit caution with every clearance through the problem area given to visiting pilots, there is a limit to this. It is really no more than holding action pending some permanent improvements in taxi guidance where it has gone wrong in the same place more than once. So the real problem owner in my assessment is the airport operator. They need to devise an enduring fix and, before finalising it, make sure it is the right one. It needs to

be appropriate to all pilots, especially the ones whose perspective is rarely available – the pilots of non-based operators. Of course on their very first visit to a new airport, pilots can be expected to be pretty cautious and are, by and large, unlikely to make too many assumptions about which way to go if it's not completely clear. Faced with doubt on this first encounter, they are likely to stop and check with ATC. On subsequent visits however, their confidence in ground operations at the no longer entirely unfamiliar destination can be expected to increase and it would not be unusual for it to do so without recognising all the 'gotchas' unless their operator destination brief has highlighted them.

Then we come to the second quite separate problem, that of whether ATC are going to make use of the newly-installed lit stop bars to help prevent pilot-caused runway incursions and the consequent risk of collision on the runway. Here, we find that the owner of the problem is ATC

and that the controllers trade union is playing with safety. Trade Unions can be a very effective contributor to a service delivery business or they can forget the need to avoid unilateral action which is clearly in conflict with the essential requirement for the highest practicable operational safety standards. Any concerns they have should always be taken first to the employer and the latter must constructively engage to resolve concerns raised. Of course even better, the employer should pre-empt problems with any proposed change by proactively engaging with the trade union well ahead of that change. It is not clear whether that happened here but the tacit inference is that it did not. And whilst this is a matter for the ANSP to sort out in the first instance, they are probably a service provider to the Airport Operator and therefore ensuring that the benefit of the investment in stop bars that they have presumably paid for is realised is ultimately also the Airport's responsibility.

A RECOMMENDATION

There are lessons here for all four organisations – the airport operator, the ANSP, the aircraft operator and the controllers' trade union. To this list, I am going to add the Safety Regulator who issued the airport operator with their licence and must thereafter oversee the performance of the licence holder. Since the airport operator appears unwilling to recognise the need for 'aggressive' action on both aspects of taxiing safety, I will choose the safety regulator for priority attention. They need to 'police' the use of the airport operating licence they have issued so that the conditions for safe operations are met. The current preference for 'Performance Based Regulation' is compatible with intervention in the face of inaction. S

CAPTAIN ED POOLEY

is an Air Operations Safety Adviser with over 30 years experience as an airline pilot including significant periods as a Check/Training Captain and as an Accident/Incident Investigator. He was Head of Safety Oversight for a large short haul airline operation for over 10 years where his team was responsible for independent monitoring of all aspects of operational safety.



CASE STUDY COMMENT 3

MIKE EDWARDS

There are three issues within the Case Study that spring to mind, all of which can be filed under a general ethos of “Safety is somebody else’s responsibility”.

The three illustrative points in the story are:

- Ground collisions passing behind Stand 30, which is apparently already prohibited.
- Refusal to use stop bars in case we forget to switch them on/off leaving us open to individual liability.
- Reluctance to spend money on something seen as “not my problem”.

The recommendation with regards to passing behind Stand 30 was to have clearer ground markings and amend the AIP. This recommendation came from the ANSP’s investigation and follows the line of “not our problem”. Clearer ground markings, so that is placed on the Airport Authority and a better description in the AIP, so that is also on the Airport Authority.

There are two weaknesses with this recommendation. Firstly, there is no justification or description of the problem. What is wrong with the ground markings? What is wrong with the description in the AIP? Demonstrate how it would fix the problem? Secondly, and perhaps more importantly, there is no action on the ANSP. If passing behind Stand 30 is prohibited, why is it being allowed to happen? There is a potential recommendation here on the ANSP to be more directive and

precise in taxi clearances. Prevention of the outcome by making it almost impossible to be initiated, for example, aircraft shall not be routed via X and Y if Stands Z are occupied.

For years many aerodromes have had vehicular traffic crossing their runways, or their undershoots, controlled by traffic lights that are switched from green to red and back to green by the Tower Controller. Did we ever think, we are not going to use the traffic lights in case we forget to switch them back to red – no. Today we are told to be scared of liability and litigation. The temptation is to turn inwards. The ATC Union’s refusal to use stop bars did not consider the possible consequences – “not our problem”. We are reliant on whoever it is that we think owns the problem to know about it and understand it. Has anybody ensured that knowledge and understanding exists? – “not my problem”. Just Culture and Corporate Liability should and must shield staff from individual legal action for unintentional errors of perception, memory and action.

The term “Corporate Liability” brings us to the third issue – why spend money on somebody else’s problem. Accidents are rarely caused by one and only one factor. Many players can be brought into the mud as legal personnel seek to maximise or



MIKE EDWARDS

was until recently Head of Safety Investigation at NATS (the UK Air Navigation Service Provider). He held this role for 7 years and prior to that he was Head of Investigation at London ACC. He had been an ATCO at Edinburgh and Heathrow before becoming the manager of all student controllers and then a Supervisor at London Terminal Control. He holds a PPL with Group B rating.

spread liability. It will become your problem. Pretty much everything comes down to money. On the front line it is primarily about not killing your customer (thus keeping your job) and secondly getting him or her to their destination the same day. At Headquarters it is about protecting the Company and the Investors. Risk Management and Cost/Benefit are the buzz words. Proactive safety costs, but how do you define the benefit? There is an old saying that if you think safety is expensive, try having an accident. Some time ago a Safety Director was asked to justify the cost of the Safety Department, the SMS and the raft of expensive recommendations from “Safety”. The Company lawyer intervened saying that if the Company became involved in legal action, the more he could demonstrate the excellent safety culture to the Court, the less the liability would be. A demand for 10m euros compensation could easily be reduced to 500k euros. Insurance with a 20 year positive position!

A RECOMMENDATION

All stakeholders in operational safety should promote an ethos of “what can I do to help?” rather than one of “not my problem”. Even if this is primarily led by protecting ones’ own rear end, everybody wins. S

STOP

HOLD POSITION!

by **Captain Conor Nolan**

It was mid-afternoon at a busy northern European hub airport. The crew of a departing aircraft were sitting waiting, with engines running, for permission to commence taxiing to the departure runway. The airport is considered a complex one for ground movements and multiple aircraft were manoeuvring from the ramp area out onto the taxi-way system for departure, with lots of R/T chatter. Concerned at the delay in receiving taxi clearance, and already thinking about the knock-on effect of any delays to on-time-performance for the return leg, a degree of frustration began to build in the cockpit.

The aircraft entered the traffic flow and reached a point on the route where they would normally expect a handover to Tower frequency. On this occasion they were told to hold position, switch to Tower and monitor the frequency. They did so, and listened as other aircraft were given priority in the line up sequence. The crew felt that they were being disadvantaged and denied their proper place in the queue, based on their estimation of who had called in what order, and the length of time they had been already waiting.

As they waited in the queue, the Commander repeatedly tried to engage the Tower Controller in debate. The Commander requested an explanation as to the logic behind the sequencing of aircraft, asserting that it was inappropriate. The Tower Controller tried to avoid getting involved in the debate, concentrating instead on managing the traffic flow, issuing line-up, take-off and landing clearances to the numerous aircraft in the traffic pattern. The failure to engage in a discussion with the outbound crew only served to increase the levels of frustration, now reaching a point where it was becoming a threat of distraction. The crew felt they had lost their place in the departure sequence despite ATC assurances to the contrary. The Tower Controller pointedly avoided answering the repeated transmissions, until such time as he could no longer avoid engaging with the affected crew, with instructions to line up. By this time the level of frustration had reached a point where inappropriate



CAPTAIN CONOR NOLAN

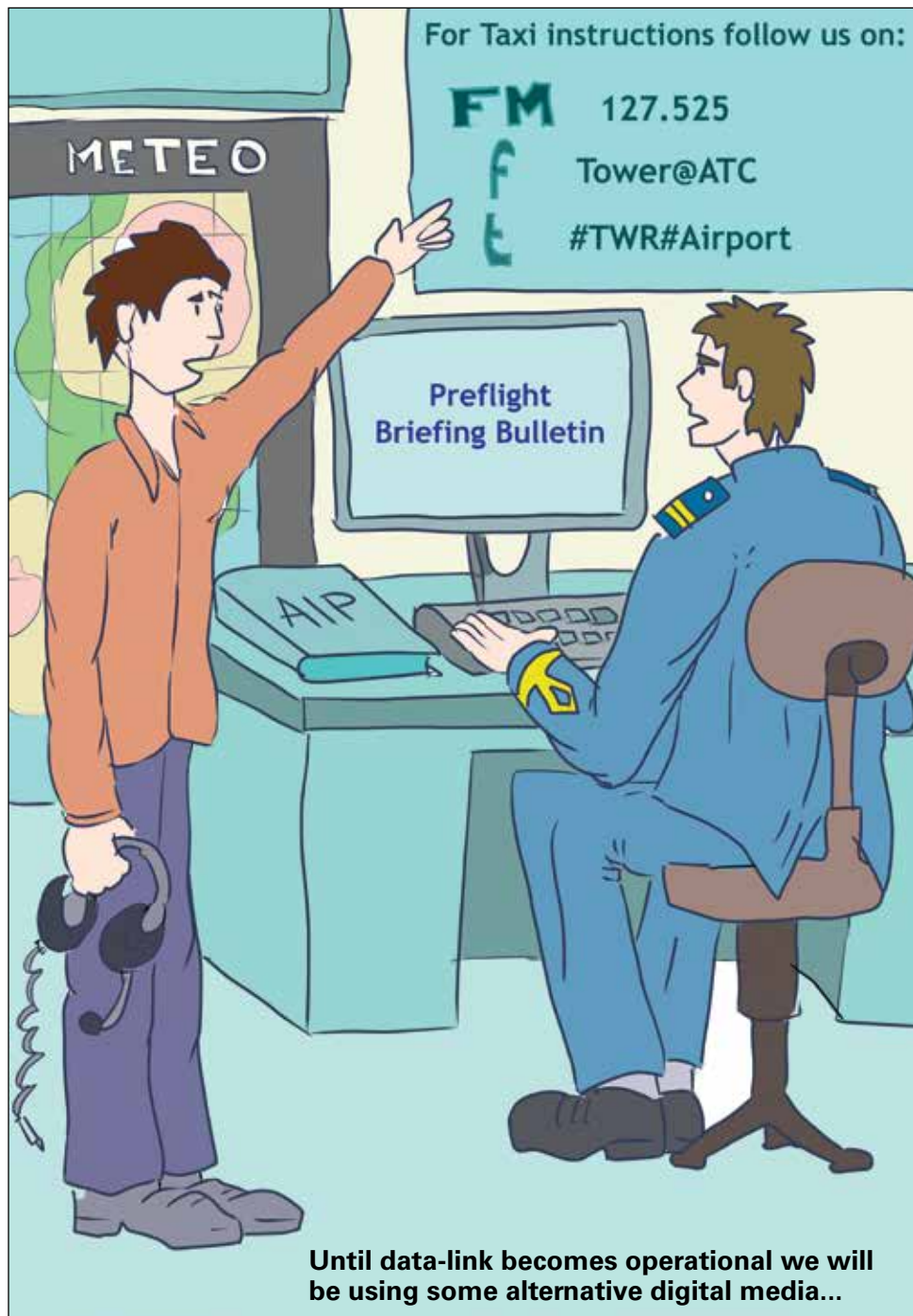
is an A330 Captain and Corporate Safety & Resilience Manager with Aer Lingus in Dublin. A pilot since 1989, he previously served as Director of Safety with Irish ALPA, and joined the Aer Lingus Safety team in 2008. Conor is also a member of the Board of Governors of the Flight Safety Foundation, and a member of the IATA Regional Coordination Group for Safety & Flight Operations.



words were said by the pilot to the Controller, immediately prior to lining up and departing.

Unknown to that crew, who took off and switched frequency to the Area Controller, they had left behind a very distracted and quite upset Tower Controller, whose concentration had been badly affected by the turn of events. As the next landing aircraft approached the runway rapid exit taxi-way, he shifted his attention to the next aircraft in turn at the holding point. Failing to notice that in fact the arriving aircraft had missed the turn-off, he cleared the next departing aircraft to line up and take-off....

Thankfully, the other pilots in the holding bays were sufficiently aware of what had occurred just moments earlier, and there was a collective call to ensure that the departing aircraft did not commence take-off. On this occasion visibility was good, in daylight, and the majority of other operators were locals accustomed to the local dialect and controllers. They were well tuned to recognise that the exchange



was inappropriate and poised to intervene when they saw the Controller's error. On another day, in poor weather, with visiting pilots waiting in the holding bays, the outcome might have been different.

The Tower Controller was relieved by an associate and the rest is history. Reports were filed, investigations conducted and in the spirit of Just Culture, the outcome was that lessons were learned by all involved and these were shared to help others benefit from this experience. This story serves to illustrate how critical the attention and concentration of all involved in runway

operations is to preventing runway incursions. No matter how frustrating a ground delay may be, it is never acceptable to challenge the Controller over the airwaves. File a report, call them on the phone later, and by all means seek an explanation (or let your Company follow it up), but when in the cockpit or at the console, always make sure to stick to the task at hand, namely maintain R/T discipline and situational awareness in the ground environment. And for Controllers, you may know why the sequence must be so, but spare a thought for the pressures pilots are under to maintain OTP, and if you can help by explaining in a quiet moment, it might go a long way to helping everyone keep the wheels turning. 5

RUNWAY COLLISION PREVENTION

A FIRST FOR EUROPE!

by **Jean-Marc Flon,**
Thomas Tritscher
& Arnaud Guihard

RWSL – Runway Status Lights – is a newly installed system intended to improve airport safety by indicating to pilots when it is unsafe to cross, enter or take off from a runway. It has been deployed on runway 09R/27L at Paris-CDG in a joint initiative of the airport operator Groupe ADP and the French ANSP the DSNA. Operational evaluation began on 28 June 2016.



**JEAN-MARC
FLON**

is General Manager Air Traffic Services at Paris CDG where his responsibilities include oversight of Approach and Tower Control as well as Apron Management. Earlier in his career, he was a controller at Chambéry, Paris Orly and Nice, during which time he was active in the French Air Traffic Controllers' Association including serving as President.



**THOMAS
TRITSCHER**

is an operational air traffic controller TWR and APP at Paris CDG Airport. He also part of the division in charge of tuning and defining the DSNA systems used at the airport, and is particularly in charge of the deployment process of RWSL at CDG.



**ARNAUD
GUIHARD**

is an engineer graduated from Arts et Métiers Paris Tech. As manager in the Paris – Charles de Gaulle Airport Airside Division he is responsible for lighting systems. His scope includes airfield ground lighting (AGL), apron floodlighting, control & monitoring and power supply networks.

The principle of an RWSL system was initially imagined and developed in cooperation between the FAA and the MIT Lincoln Laboratory as part of an ongoing effort to explore new technology in the face of concern in the FAA at the continuing prevalence of serious runway incursions. Between 2005 and 2009, part of the system was tested at Dallas/Forth Worth Airport (KDFW), Los Angeles (KLAX) and San Diego (KSAN). In respect of what had been developed in the USA, EUROCONTROL decided in 2008 to create a workgroup to evaluate the possible use of RWSL

in Europe. In parallel, the “Local Runway Safety Team” of Paris-CDG studied the possible deployment of RWSL and Groupe ADP and DSNA were persuaded that the implementation of the system on the inner runways could be a great step forward in preventing runway incursion.

RWSL is an automatic and autonomous advisory back-up system designed to prevent and reduce the severity of runway incursions. The implementation on the field consists of 2 types of lights:



The Runway Entrance Lights (RELs) at each holding point of the northern inner runway 09R/27L, consist of a series of red in-pavement lights spaced evenly along the taxiway centreline from the holding line to the runway edge, plus one placed near the runway centreline.



The Take-off Hold Lights (THLs) consist of two double rows of red in-pavement lights each side of the runway centreline, grouped into sets at each potential line-up point on the runway.

RWSL uses both primary and secondary surveillance radar to dynamically turn on/off lights which directly indicate runway occupancy status to pilots or vehicle operators.

The main purpose is to improve airport safety by indicating when it is unsafe to cross, enter or take off from a runway.

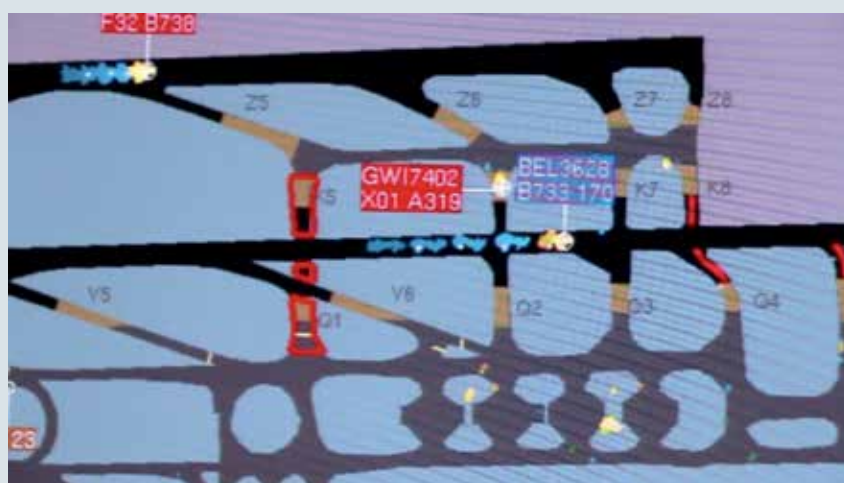
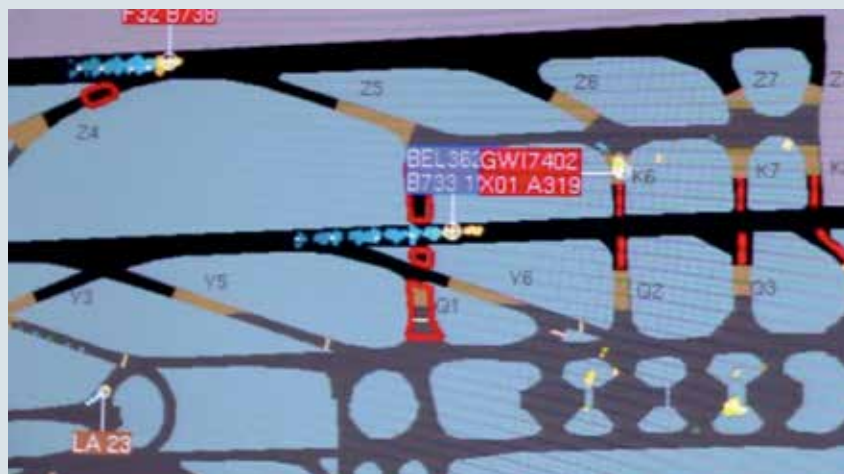


On the A-SMGCS display in the Tower, activation of the lights is shown to the controller so that they are immediately aware.

The development of RWSL for Paris-CDG has faced a range of challenges, particularly in the coordinating its implementation with the A-SMGCS system and in terms of human factors issues.

The system as originally defined is intended to work autonomously using the ground movement situation provided by the A-SMGCS. During the development RWSL had to be adapted to the available radar system and its input sources. Although 'AVISO' – the CDG A-SMGCS – was well developed and efficient enough to provide a ground situation display to controllers, the precision needed to make RWSL operative was a step further. However, eventually, after considerable effort by the development team, this was achieved.

The safety case has been developed in coordination with EUROCONTROL. The human factor aspect was also a challenge to overcome. As explained, RWSL signals consist only of red lights conveying to the pilots the danger of entering or crossing the runway, or taking-off. The extinction of the lights has no meaning, and green lights aren't turned on once the reds are off. The crews have to fully understand the meaning of the lighting system and must not assume that the lights going out means they then have a clearance to enter the runway or to take-off. This is a key point in the process of the implementation of RWSL, as those lights are the only information given to the pilots. If their presence or absence were to be misunderstood, hazardous situations could be created by the system, in a completely counterproductive manner. To establish this understanding, Groupe ADP and DSN have used all means of communication at their disposal to reach the maximum number of pilots who may operate to Paris-CDG: letters to the airlines, aeronautical publications and especially working closely together with the two main user airlines, Air France and



EasyJet. A training session to the system with four scenarios has been developed with the direct support of EUROCONTROL presenting animations for raising Runway Users awareness about RWSL operational principles (<https://www.eurocontrol.int/runway-status-lights-rwsl-fr>).

RWSL has already proved its value. On 22 August, an Airbus A340-600 on runway 09R was cleared for a rolling take off while it was still on its way to the holding point. One minute later, an Airbus 319 had vacated the outer runway 09L after landing. Unfortunately the controller – due to a misunderstanding of the actual situation – cleared that aircraft to cross runway 09R, on which the A340 was taking off. The RWSL red lights turned on in front of the A319, and the crew reacted as intended by stopping their aircraft before the runway contrary to the clearance they had received. The system prevented its first runway incursion at Paris-CDG that night. **S**



UNDERSTANDING OF RUNWAY SAFETY, YOU MUST:

RETURN^{OF} THE JEDI



BY **DR ANNE ISSAC**

OUR UNDERSTANDING OF INCIDENT INVESTIGATION AND THE ASSESSMENT OF ASSOCIATED CAUSAL FACTORS, PARTICULARLY IN THE AERODROME ENVIRONMENT HAS HAD MANY DEVELOPMENTS. RATHER LIKE THE STAR WARS FILMS, WHICH APPEAR IN NO PARTICULAR ORDER, RUNWAY SAFETY EVENTS ALSO OCCUR IN RANDOM SEQUENCE...

ANNE ISAAC

leads the Human Performance development work in the pilot/controller interface in NATS, UK. She gained her PhD in Cognitive Neuropsychology at Otago University in New Zealand. Her previous work has been in the development of incident investigation tools and techniques in European ATM, the introduction of TRM into the ATC environment and the introduction of Day to Day Safety Surveys techniques into NATS. She has written several book chapters, academic papers and the book *Air Traffic Control: the human performance factors*.



One way of attempting to understand how the complexities occur is to unpick the event in chronological order. The Joint Error Development of Incidents [JEDI] methodology was initially developed in Europe and has been refined within NATS to broaden the skills of incident investigators and enhance the depth of understanding of the causal factors associated with ATS incidents. This is achieved by looking closely at the context within which the assessed causal factors occur. Put simply, rather than a collection of causal factors, the JEDI methodology works through the timeline of an incident, identifying the 'pivotal' moments at which an incident may have been either prevented completely or the severity of the event reduced.

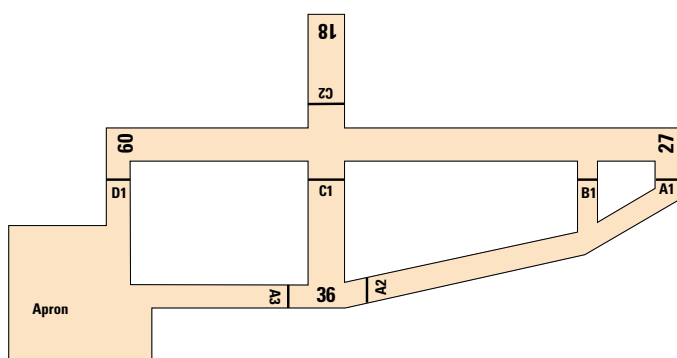
One thing this work has highlighted is that, although there is immense value in the capture and analysis of causal factors, it can be difficult to provide an in-depth of understanding of these factors without providing greater context. To demonstrate how, in the future, a deeper level of understanding of incident causation can be achieved, a runway safety incident has been analysed using the JEDI methodology. This incident is based upon an actual event, but some of the details have been altered in order to protect the identity of the airport and personnel involved.



The incident is first described and then analysed by a flow chart which shows the time-line of the event, from initial decision to final outcome. It shows how the incident progressed and, from this, it is possible to see where safety was first breached, where opportunities to prevent or resolve the incident may have been missed and the associated severity of the final outcome. On the right hand side of the flow chart, the final safety severity score has been entered [Safety Significant Event – SSE – 1 very significant to 4 – of least significance]. Additionally, the likely severity scores have been added to show the pivotal moments at which severity could have been reduced. Using this method it is possible to provide greater context to each causal factor and provide an enhanced level of understanding of how these events could be prevented in the future.

Event Example : An aircraft started to cross the main runway, without clearance, whilst another aircraft was cleared to land.

Severity Level - 1



This incident occurred at a medium complexity airport, during daylight hours, in good visibility conditions. A basic representation of the layout is shown above.

Runway 27 was the main runway in use for the majority of traffic. The crossing runway, Runway 36 was available for use for light, non-jet aircraft.

A locally based light, twin-engine, propeller aircraft had landed on Runway 36. The aircraft had crossed the runway intersection during the landing run and, after slowing to taxiing speed, had been instructed by the aerodrome controller [ADC] to perform a 180 degree turn and hold at holding point C2. This clearance was read back correctly and completely. A further aircraft was then cleared for take-off from Runway 27. After this aircraft had departed, an Airbus A320 on final approach to Runway 27 was cleared to land.

ADC then issued a series of conditional clearances involving permission to enter the runway, all subject to the same landing aircraft. These clearances were all fully compliant with the rules as described in the Manual of

Air Traffic Services. They were all delivered clearly and correctly and all read-backs were complete and correct. However, the aircraft holding at C2 started to cross Runway 27 before the A320 had actually landed. Upon entering runway 27, the pilot of the light aircraft realised that the A320 had not yet landed, and was at that moment crossing the Runway 36 threshold. Fortunately, the pilot managed to 'power back' and reverse the aircraft away from runway 27, shortly before the landing A320 crossed the runway intersection.

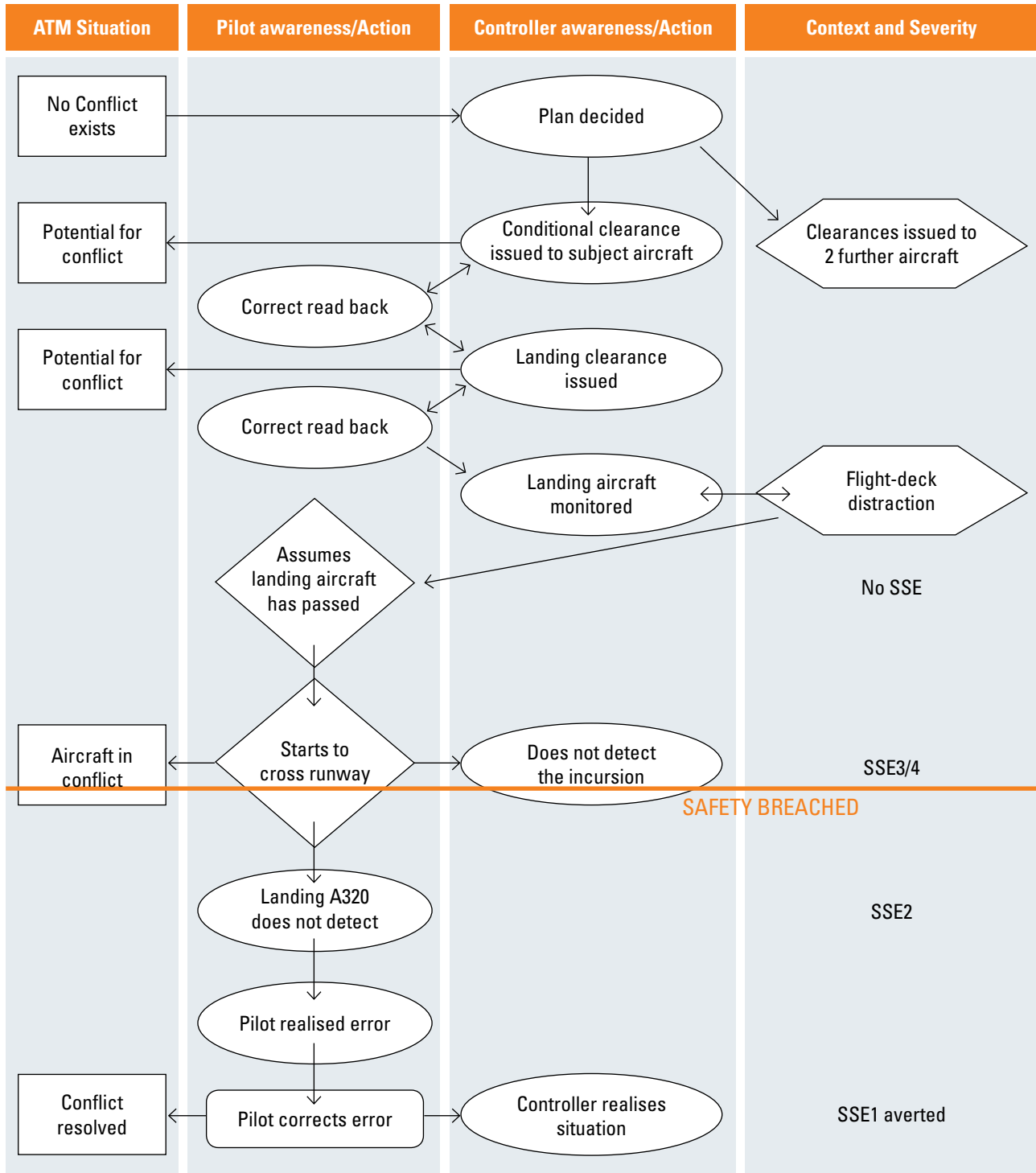
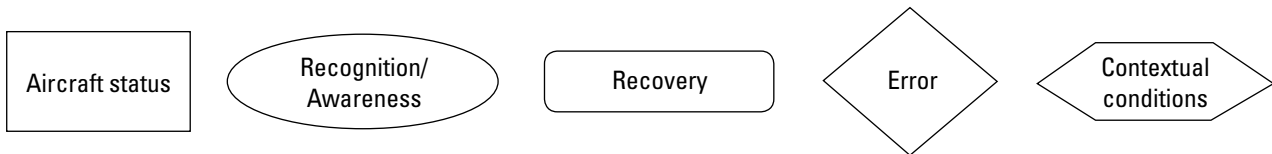
The course of events was as follows:

1. Light, propeller aircraft lands on Runway 36, crosses intersection with Runway 27 and is instructed to hold position at C2.
2. Aircraft departs runway 27.
3. A320 cleared to land on Runway 27
4. ADC issues the following instructions:
 - a. Light aircraft holding at C2 instructed "after the landing A320, to cross Runway 27 at the intersection".
 - b. Saab aircraft holding at B1 instructed "after the landing A320, to line-up on Runway 27" and warned that there will be traffic crossing ahead.
 - c. A further A320 holding at A1 is instructed "after the landing A320, to line-up on Runway 27" and warned that there will be an aircraft departing ahead from B1.
5. The attention of the pilot is distracted by a conversation in the cockpit. The pilot then assumes that the aircraft has already landed and commences crossing 27. Upon realising that the A320 is actually still in the process of landing, they power back and reverse back towards C2.
6. The controller had been monitoring the landing aircraft and did not see the light aircraft cross holding point at C2.

A number of causal factors were assigned to this incident, the primary causal factor being 'Pilot failed to follow ATC instruction'. The use of conditional clearances is also assigned as 'contributory'; as, although there was no fault on the part of the ADC controller, it is clear that had the clearance not been issued then the incident would have been less likely to happen.

However, using the JEDI methodology gives a much more structured framework to this process. It also enables the investigator to clearly identify those 'pivotal' moments during the incident where the event outcome increased in severity. This process begins to add context to the causal factors, rather than simply provide a two-dimensional list. The following diagram is a simplified version, intended to show how the process works.

The meaning of the symbols represented on the flowcharts are as follows:



The JEDI approach has now been used to analyse many aerodrome and airborne events and it has proven to assist, not only in the understanding of the causal factors present, but also the contextual complexities and individual contribution of the teams and crews involved.

Let's hope we don't have to wait for more classical Yoda predictions before we start to learn the lessons from this JEDI.

WHAT GOES UP MUST COME DOWN

by **Maciej Szczukowski**

Aviation is organised around cycles. Shift cycles, engine cycles, flight cycles. Every departure, sooner or later, closes the cycle with a landing. In the centuries-old phrase used in the 1969 Blood, Sweat & Tears hit single 'Spinning Wheel' we know that 'what goes up must come down'.

In general, the quality of each part of the cycle is important for each flight crew and each involved controller. However, some parts are a bit more crucial for the controllers only. Preventing runway incursions, let alone collisions, has been for many years a hot topic in discussions about runway safety. The importance of correct runway vacating is usually left behind.

My experience in discussing the consequences of unpredictable runway vacating can be now counted in years. E-mail, texts, telephone calls and extended conversations with pilots who have alternative views to established and/or published procedures has improved my

understanding of the complexity of this issue. Here I would like to share with you what I think are some of the risks and my thoughts about the lack of standardisation of one of the last flight cycle's phases.

Air traffic rises every year. Expectations are higher and higher whereas the airports are not balloons, which can be quickly inflated to a larger size. On the other hand, we have Rapid Exit Taxiways (RETs) to get the aircraft off the runway as quickly as possible and there is no other obvious way to minimise runway occupancy time. Some airports provide the exact distances from runway thresholds to their available RETs. Some go further and suggest the best option for each category of aircraft. And some even give the turn off angles at each runway exit, including RETs. Ideally, exits are available where they are expected to be useful in minimising both runway occupancy time and taxi-to-gate time. But on any particular day, pilots can be expected to prioritise a safe runway exit over the shortest taxi in distance once clear.



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has been an Air Traffic Controller for almost 15 years at Warsaw Okecie Airport, Warsaw, Poland. He has also been an aviation consultant and ground school instructor, working with pilots and cabin crew. He has experience as a private pilot.



Designated exits are established on the basis of 'standard' aircraft performance which will not always be a valid assumption. Although it all seems so straightforward, let's go through a few thoughts, which are not always mentioned and remembered:

1. The Operations Manual used by a pilot may contain a statement along the following lines: "When approaching a turn, speed should be reduced to that appropriate speed for the extent of the turn and the prevailing surface conditions. On a dry surface, use approximately 10 knots for turns greater than those typically required for high speed runway turnoffs". Occasionally, such good advice is ignored, often because the pilot has heard – or been directly advised by a controller – that the next landing aircraft should expect a late landing clearance and, not knowing how close the one behind actually is, tries to help. In this case, the first question is whether the distance between the aircraft during approach was sufficient.

But there is usually another side to such a story¹. Maybe the approach of the first aircraft was stabilised, the taxiway to vacate was nominated and briefed, touch down occurred in the touchdown zone but on a wet runway the aircraft did not decelerate as expected and the usually convenient RET was missed. Then, although the pilot was able to reduce speed, the end of the runway was the only remaining exit and involved a 90° turn. The process of exiting the runway began normally, but directional control was lost as the aircraft began to skid sideways. According to ICAO Annex 14 "the intersection angle of a rapid exit taxiway with the runway shall not be greater than 45°, not less than 25° and preferably shall be 30°". As stated above airports can rarely expand the way they, or pilots, would prefer. Towards the end of a runway, 90° turns may sometimes be the only option available and the exit may be at or near the touchdown zone for

the opposite runway direction. Thus where there will often be significant rubber deposits which will reduce the effectiveness of braking action especially in wet conditions.

2. Aerodrome controllers are expected to monitor the manoeuvring area to the extent possible but there are times when their focus must be on one area or movement at the expense of others. Having seen a particular type of an aircraft vacating the runway at a similar groundspeed a thousand times before may easily lead to an assumption that another thousand times will be the same. Looking back at the runway, after a brief moment of 'distraction' elsewhere, and not having seen that the aircraft did 'as expected' by exiting at the anticipated point may lead to wrong conclusions and even inappropriate decisions. The chances of this increase at night and/or in low visibility conditions.

3. Pilots are not aware of the equipment available to air traffic controllers. However, they probably recognise that it differs between countries or depends on the size of an airport. ICAO PANS-ATM, in chapter 7, protects a controller by allowing him to request pilot's report of leaving the runway.



1- like the one at http://www.skybrary.aero/index.php/B733,_Birmingham_UK,_2012



It adds that "the report shall be made when the entire aircraft is beyond the relevant runway-holding position" when in reality, a pilot may not necessarily know when the 'end' of his aircraft crosses the line, let alone when it is clear of the ILS sensitive area.

4. Asking pilots about their runway exit choices, I got many different answers – place of touchdown, runway state and braking action, distance to designated stand, etc. I learned how certain aircraft type reacts to various types of pavement or how, for individual aircraft, engine cooling requires extended taxi time. There is, however, one common element. As pilots are sometimes recommended to nominate a preferred runway exit when briefing I, as an air traffic controller, am always encouraged to support this by adding a reasonable preferred exit with or prior to the landing clearance. But always remembering that it may happen otherwise due to the reasons presented above.

5. It is well known that no matter what quality of systems and equipment are available in an aircraft or a control tower, there may always be an extra factor which changes everything. Acting under the pressure of time and limited space, we tend to assume that certain things are clear and understandable. But it is not always so. Therefore a pilot, taking the next exit (due unexpected braking coefficient or even a decision to shorten the taxi route) may be completely justified. But for the controller it may be otherwise, due traffic, closures or other movements. Most probably taking an unexpected exit will not lead to an incident, let alone a collision. But a closer look at this problem reveals that there may be more at stake than a little extra work or a reduced runway capacity.

We already know how important communication is. Not only our everyday task on our headphones every day, but also the one which

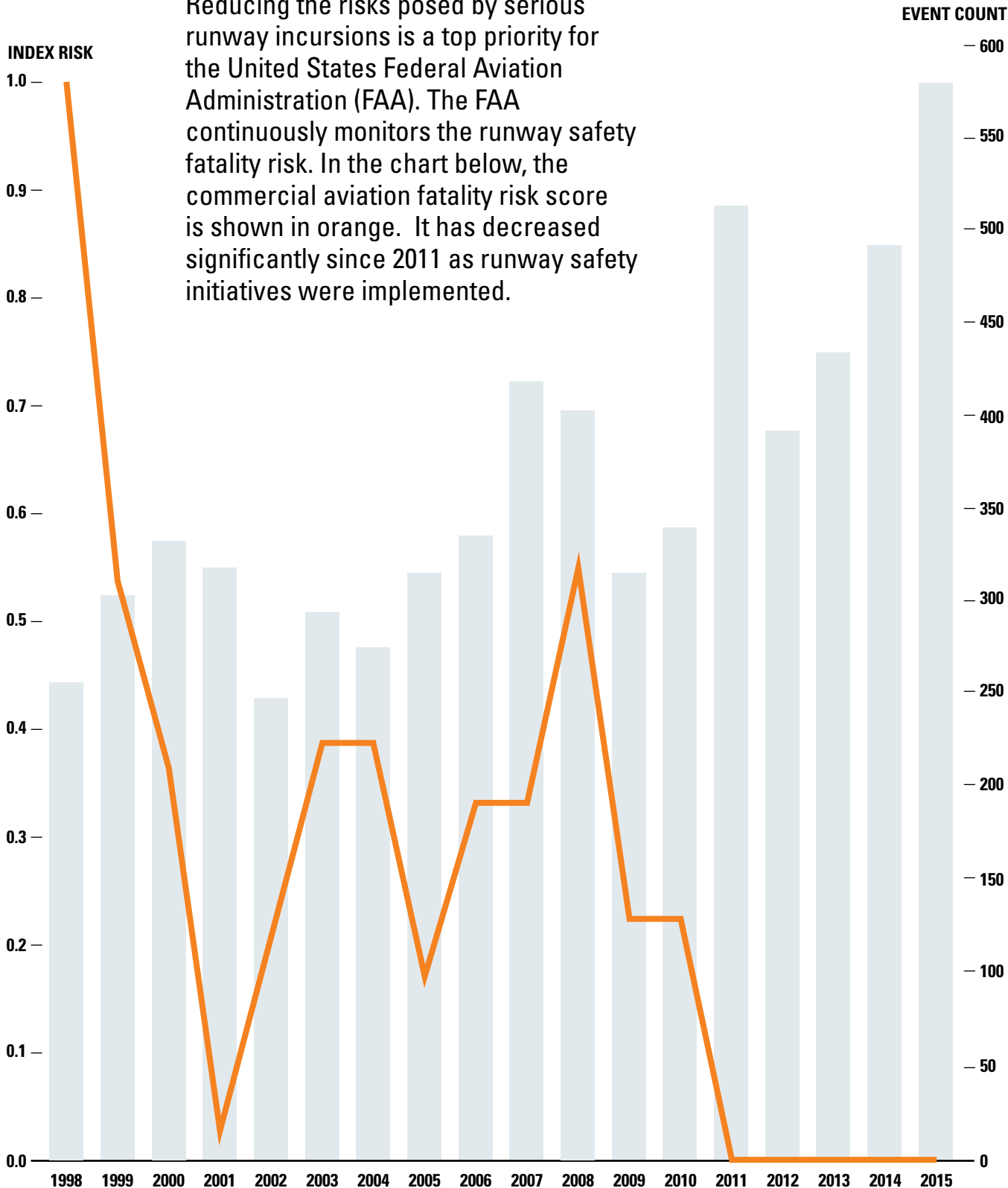
happens in between the cycles. My idea is to give pilots as much useful information as possible, not just what is strictly required by the regulations. We all function more efficiently when we have a reason for a specific choice. Therefore, I suggest that you check with your Local Runway Safety Team, whether they think it would be helpful to provide standard exits in the AIP entry – distances, angles and possible limiting factors such as wingspan, hotspots nearby and reduced braking. Also consider introducing signs of ILS sensitive area limits for vacating traffic. Try to check, with operators based at your airport, whether their proprietary sources match information given in AIP and whether they are always current. If there is an opportunity to do so, discuss particular pilot choices and behaviours when exiting the runway. Don't be reluctant to state your preferences and perspectives. Critical analysis does not have to be unpleasant. After all 'talking' 'bout your troubles', as Blood, Sweat and Tears sang, is not 'a cryin' sin'. **5**



FAA UPDATE

by James Fee

Reducing the risks posed by serious runway incursions is a top priority for the United States Federal Aviation Administration (FAA). The FAA continuously monitors the runway safety fatality risk. In the chart below, the commercial aviation fatality risk score is shown in orange. It has decreased significantly since 2011 as runway safety initiatives were implemented.



The FAA has made significant progress in improving runway safety at U.S. airports over the past 15 years by working with other members of the aviation community on education, training, marking and lighting, standard runway safety areas, new technology, and airfield improvements. But we know there is still risk in the system.

To monitor the risk FAA uses precursor events called runway incursions. These occurrences involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and take-off of aircraft. In the United States, there is an average of three runway incursions daily. Each of these incidents has the potential to cause significant damage to both persons and property. Over the past few years, the precursor events have been rising in severity and frequency.



Data Review

The runway incursion data was reviewed to identify any changes or trends that account for the rise in serious events. While the large initiatives such as expanding the

Runway Safety Areas including EMAS and Runway Status Lights have been effective, the procedural compliance from pilots, ATC, and vehicle driver needs to be enhanced. The root cause is lack of communication. Simply stated, it is when the mental pictures don't match and the most critical portion of the communication is misunderstood, confused, or missed.

A good example is featured in the following event narrative and picture. In this event, the critical information of which runway the vehicle driver intended to access has not effectively communicated to the air traffic controller and the flight crew did not mention the illuminated Runway Status Lights when they received their takeoff clearance.

At the time of the event Runway 28R was in use and 28L was closed due to construction. A vehicle (Truck 54 in picture below) contacted the air traffic tower controller requesting access onto Runway 10L. The tower controller cleared the vehicle onto Runway 28L where 3 other vehicles were operating as part of the construction. The vehicle driver responded "proceeding on Runway 10L." The tower controller

failed to catch the read back error. Five minutes later an A321 (NKS 371 in picture below) was cleared for takeoff on Runway 28R. As the A321 entered the runway the Runway Status Lights illuminated. As the aircraft began its takeoff roll, an ASDE-X alert was generated advising the runway was occupied. The ASDE-X alert allowed the tower controller to cancel the A321's takeoff clearance with enough time for the aircraft to come to a stop. The closest proximity between the vehicle and the A321 was estimated to be 400 feet. A radar replay indicated the A321 was approximately 2,900 feet down the runway at a ground speed of 120 knots before aborting takeoff.

There are multiple factors in this event; but, it shares a common theme of lack of effective communication with other high severity events.

The FAA is currently promoting a Back to Basics campaign to emphasize basic ATC, pilot, and vehicle driver roles and requirements that form the safety barriers that ensure runways are clear for arriving and departing traffic and provide backup in the event of miscommunication or pilot, vehicle, or pedestrian deviations. **5**



To learn more about on runway safety, please visit: http://www.faa.gov/airports/runway_safety/

RUNWAY SAFETY-II

Jim Krieger

Much has changed since 1977 when two jumbo jets collided on a foggy runway in Tenerife.

Globally, we have implemented many strategies to eliminate runway collisions but runway safety (RS) continues to be a concern. The nagging question remains: Are we doing everything we can to prevent runway collisions? No doubt our mitigations have positively affected runway safety but if you believe that there is any correlation between the number of runway incursions (RIs) and the likelihood of future runway collisions, you will be concerned about RI statistics.

JIM KRIEGER

is an experienced Air Traffic professional who recently served as the FAA's Group Manager for Runway Safety in the United



States. He has held numerous air traffic control and leadership positions at Chicago-O'Hare International Airport and he currently works as the Air Traffic Manager at O'Hare Tower.

Across the European region for example, there are two runway incursions every day, while United States towered airports average more than three. Those are only the runway incursions that we know about by the way. What exactly do these numbers tell us though? Do they really tell us anything about the likelihood of upcoming runway collisions?

While we should care about the number of RIs we are having, I think that a preoccupation with those numbers will actually do very little to prevent runway collisions. Instead, I think we would be better served by learning more about runway safety from the experts – pilots, air traffic controllers, and vehicle operators – who deal in runway safety all of the time. Two ways we can learn more from them are clearly within our grasp:

1. We can conduct better investigations that include as many of the people who were present at the time of any runway safety event. They can help us put ourselves into the situation they were in provided that they feel safe to do so. "Safe" means that the investigation cannot resemble a witch hunt in any way and that it strives to advance our runway safety learning.

2. Instead of limiting our investigations only to events in which something went wrong, let's start investigating routine operations in which everything goes right too. That means opening up our runway safety knowledge-base to probing not only the relatively minute number of runway safety incidents (bad things) that we look at today, but also exploring what goes right millions of times (good things).

First let's take a look at what we can learn from better investigations. On September 27, 2010, there was a runway incursion at O'Hare International Airport (ORD), involving AWE983 (US Airways 983), a B734 that began takeoff roll on runway 9R without a takeoff clearance. This put them in conflict with UAL942, a heavy jet rolling simultaneously on intersecting runway 32R (see figure 1).

On-the-job training (OJT) was in progress in the tower and the Local Control (LC) trainee and instructor immediately detected the conflict and instructed AWE983 to cancel takeoff. AWE983 had just started its departure roll and never got close to UAL942.

I was the Quality Assurance Manager at O'Hare Tower at the time and a

cursory investigation revealed that AWE983 had apparently taken the departure clearance given to UAL942 heavy. Oddly though, AWE983 had never responded to any instruction given by LC on the tower frequency, 126.9. Listening to the recordings, no AWE983 takeoff acknowledgement was heard and the telltale "squeal" of two aircraft answering at once was also absent. However, when the LC trainee listened to the event on LiveATC.net later that night at home, she reported that AWE983 could be heard responding to every tower instruction! We were mystified as to how that could happen.

Had we chosen to end the investigation here, we would have concluded that we had some sort of communications equipment problem in the tower and that AWE983 was wrong nevertheless. We would have then written a pilot deviation, checked out the tower equipment and would have officially closed the door on an opportunity to learn more about runway safety. We instead conducted a comprehensive event review that included the AWE983 crew members, the controllers involved, and the O'Hare Tower Plans and Procedures, Quality Assurance, and Training managers.

From this we learned:

- That AWE983 was actually transmitting and receiving on 128.15, the ORD north tower frequency and not on the appropriate frequency, 126.9.
- That LC was transmitting on frequencies 126.9 and 128.15 (because the north tower was closed) but unknowingly was receiving only on frequency 126.9. They therefore could not possibly receive transmissions from AWE983 on 128.15.
- That the crew of AWE983 was unsure about the correct tower frequency and to avoid bothering a busy ground controller, instead looked up the frequency on the airport diagram. They mistakenly concluded that since they were taxiing to the north part of the airport, that the “north tower” frequency, 128.15, had to be the correct one. (Because of this RI, the charts have since been changed to include the associated runways for the O’Hare north and south tower frequencies.)
- That both the tower trainee and the instructor on LC both diligently scanned all intersecting runways after takeoff clearances and were especially wary of AWE983 because they were not completely communicating.

Knowing this, let’s put ourselves on the flight deck and in the tower that night:

1. LC transmits “AWE983 position and hold runway 9R and be ready.”
2. AWE983 hears this and acknowledges on frequency 128.15.
3. LC cannot hear this response but observes AWE983 taking position as instructed and does not demand a read back from the crew. That may not be a great technique but is frankly something that frequently happens when pilots try to break in to busy frequencies.
4. LC clears UAL942 heavy for takeoff on runway 32R on frequency 126.9. UAL942 heavy acknowledges this also on frequency 126.9. AWE983 cannot hear UAL942 acknowledge the takeoff clearance.
5. Hearing no other aircraft respond on 128.15 the crew of AWE983 thinks the takeoff clearance is for them. After twenty seconds, they respond “runway heading, cleared to go, AWE983”, all on frequency 128.15. This transmission cannot be heard by LC or UAL942.
6. LC immediately spots AWE983 rolling, cancels their takeoff and gets no response but observes AWE983 slowing and exiting the runway.

What first seemed to be a straightforward pilot deviation turned into much more than that but only after closer inspection.

Had we ended our investigation sooner, we would not have learned that something as simple as the frequency verbiage used on an airport diagram could be misinterpreted and contributory towards a RI. We may not have considered that flight crews are really busy “multitasking” while taxiing and that both pilots and controllers sometimes feel the need to take shortcuts during busier traffic periods. We may have also ignored the fact that pilots often do not want to “bother” controllers even though doing so would be safer for everyone. Finally, we probably would not have learned that people, the controllers in this case, sometimes do (or don’t do) certain things in response to the behaviors of other people in our system. They have a lot of good operating practices that should be passed on to others.

If all of this can be gleaned from one very complicated, isolated runway safety event where things went wrong, can you imagine what we could possibly learn from the millions of operations in which everything

goes right? To advance runway safety further then, we also need to learn about why and how things go right almost all of the time. In other words, it’s time to think about runway safety differently as suggested by the Safety-II perspective spearheaded by Professor Erik Hollnagel.

While Safety-I, our traditional approach to safety, concentrates almost solely on looking at what went wrong (like the RI at ORD for example), Safety-II looks at all possible outcomes related to the daily routine of getting the job done. A key aspect of Safety-II is that it therefore includes looking at how people get things right so often, virgin territory for most safety professionals and particularly with respect to runway safety.

And people get things right almost always; millions of air traffic operations occur safely every day and that is because of the unseen things that pilots, controllers, and airport vehicle operators do to keep people safe. The trouble is that except for those very deep in the trenches, most people do not know exactly what is being done to keep the flying public safe. I guarantee that you will rarely find their actions

documented anywhere, especially in the standard operating procedures (SOP). While this information may not reduce RI numbers, it will probably teach us a lot about preventing runway collisions.

Just what are people doing? Simple things like a controller choosing not to clear a departure for takeoff after hearing a dubious hold-short read back from a pilot on an intersecting runway or taxiway. No one usually knows what they did or didn’t do but things are certainly a lot safer because of it.

To enhance runway safety we can either continue what we have always done or change our tactics. Considering what they say about those who do the same things repeatedly while expecting different results, I think we should do something different. First, let’s commit to investigating all events much more robustly, including the people involved whenever possible. Second, let’s add Safety-II concepts to runway safety by closely examining the routine performances of our pilots, controllers, and vehicle operators. After all, they are the real runway safety experts out there and I think we can learn a lot from them. **S**



FROM THE BRIEFING ROOM

RWY AHEAD

by Libor Kurzweil



6:30

Little Julia is usually the first one up. She is followed by her younger brother Lucas and together they attack their sleeping parents for the first time today. Their screaming would even wake up the dead. We continue pretending that we are still asleep, not willing to admit that it is already morning. The desire to wake up in the morning cannot possibly differ more between generations.

A few moments later, we are feeling better. This morning "ritual" works perfectly and leads to good mood for all, not just our family. Mum's cheeks warm up with an aromatic coffee and Dad is exploring the contents of the fridge, bringing food to the table. Little Julia has dropped a piece of bread to the carpet and, in a moment, a second one. Both times butter-side

down. The statistical probability doesn't work in such cases. Lucas is mischievously giggling. "You know, Julia, there is nothing wrong with making a mistake. But only the less smart ones repeat their mistakes. Make sure you don't drop it again..."; I am trying to come up with a pearl of wisdom first thing in the morning and give her some advice she can use throughout her life. It was just a matter of several seconds and a piece of peeled orange is flung to the ground. Lucas is giggling.

7:00

Martin is enjoying another moment of delight. He will always love moments like this. To drive his Škoda along the new rebuilt TWY, with the brand new painted marking and centreline lights shining in the grand finale of a ten-hour working test. Everything is the way it should be, the construction fence is gone and only the sweeper remains to clean the new surface. "Great job, it deserves some pictures in the corporate album", says a grinning Martin. He has worked as a site construction manager for many years. He likes doing work that produces tangible results and this definitely applies to the construction industry. He would not want to do anything else.

LIBOR KURZWEIL

has a Ph.D. in Airport Operations from the Czech Technical University in Prague. He has worked for Prague Airport for 13 years, the first 9 years in the Airport Strategy, Capacity Planning and Development Department and then as Director of Quality, Safety and Process Management.



7:10

"Vacate via Delta, continue Fox-trot and Hold short of RWY 12/30", instructs the TWR frequency not long after both reversers of a Boeing 737 could be heard rumbling in the morning silence. Just another in a long line of instructions with which the control tower unconsciously brings an end to the best week of the year for 160 holidaymakers...

LEAD

The crew thanks the passengers and comments on the smooth landing and beautiful morning weather. "Now we just have to cross RWY 12/30 via the taxiway as straight as Champs-Élysée towards Terminal 2", the First Officer said.

7:11

Dad, with considerable help from Mum, had cleared away the breakfast mess from the carpet a long time ago, kissed everybody good-bye and is making his way towards the city through a typical traffic jam from the north. "Hold short of Prague" applies to everybody no matter what day of the week it is. And you will not get priority even if you are running low on fuel.

7:12

The morning shift in the control tower has an extra reason to be happy. The construction work on Foxtrot ends today after two months and the runway system and all procedures will return to standard operations. It had created an enormous amount of stress and now only the last few hours and minutes are left. In the middle of this positive moment, a red alert from the A-SMGCS goes off. The charter flight from the Mediterranean, which had been instructed to "Hold short of 12/30" a while ago, first confirmed the instruction and then crossed. The crew of the flight that just departed from RWY 30 learns about what happened down below them from the radio. They were not alone on the runway this time...

7:45

Dad is just approaching the airport in his car. As the airport Safety Manager, he is going through the assessment of the first six months of 2016 in his head, thinking about how to best turn the collected findings into safety recommendations. The bird strike rate was down as was the number of laser incidents. The A380 also made him happy. The big bird had begun using the airport regularly a few weeks ago and everything has been working the way it is supposed to. A sore point for Safety was the Apron, where they could never manage to make it through the year without

scratching a plane again. And always at least one or two RWY incursions. "Is it ever going to be possible to complete a year with zero incidents for these two?", he asks himself as he is passing crowds of passengers looking forward to their flights in the departure hall. "Their good mood is always contagious," he thinks.

8:30

The Safety departments of airport operator and ATC are five kilometres apart as the crow flies. The morning coffee aroma was still in the air in both workplaces while another incident happened in front of their windows. It was just like during breakfast at home with pieces of food falling to the floor one after another, the second Safety event at the airport was very similar to the first one. Precisely 81 minutes after the charter flight incident, the story of RWY being crossed following the instruction "Hold short of" happened again.

8:35

An incident like this has never happened before and so it was no wonder that an emergency call rang on the hot line between the two Safety departments. The second incident speeded everything up and both places were loudly calling for a quick response. What is going on outside? This question is hanging in the air and the first speculations are starting to emerge. Did anything happen to the holding point? Is it related to the construction ending on Foxtrot? Did the cargo Jumbo blow away the mandatory instruction signs like it used to in the past? And even if it did, there are still painted markings on the taxiways saying 'RWY AHEAD'. "In short, we have to look at the place immediately, take some photos and, if necessary, take the area concerned out of operation" is the first fast decision made at the airport.

8:45

"Ruzyně Tower, both holding points on the Foxtrot TWY are in working order and without any defects", reports the airport operations officer from his yellow Toyota to the tower and later the Safety Department. The infrastructure passed the test

without any reservations, it can stay in operation and the incidents will be the subject of standard incident investigations, conducted by the airport Safety Department with cooperation from ATC.

12:10

"This is really good today," comments the sweeper driver on his lunch "beef Stroganoff" with satisfaction and returns to complete his afternoon work. "The construction site is done and there is only a little section of the Echo taxiway left." He did his job really thoroughly and extended one drive along the TWY all the way across the holding point up to the unservisability markers. His sweeping was interrupted by the assistant to the TWR Ground controller, responsible for controlling the vehicle movements on the manoeuvring area, who had heard the third red A-SMGCS alert of the day. The machine quickly turns 180 degrees on the red and white markers 60 meters from the RWY centreline. The driver can hear the departing Boeing 737 almost over his head.

19:00

The SMS database stubbornly resists and for some reason, does not want to accept new entries on that day. As if a machine operating with zeros and ones could not believe that there were three incidents of the same kind on the same day.

20:30

"They had a long day and are already asleep", whispers Mum as Dad comes home after the busiest day in 14 years. It is impossible to cope without a glass of wine and, while drinking it, we are thinking what our little daughter would say if she knew that mistakes not only happen at a large airport, but can happen again even before you know it. "Each of them happened to somebody else", might be the excuse. "And why, and why and why?" the inquisitive child's voice would continue asking.

We have to find some answers to every "why" – this is the reason a SMS exists.

What happened to the crews?



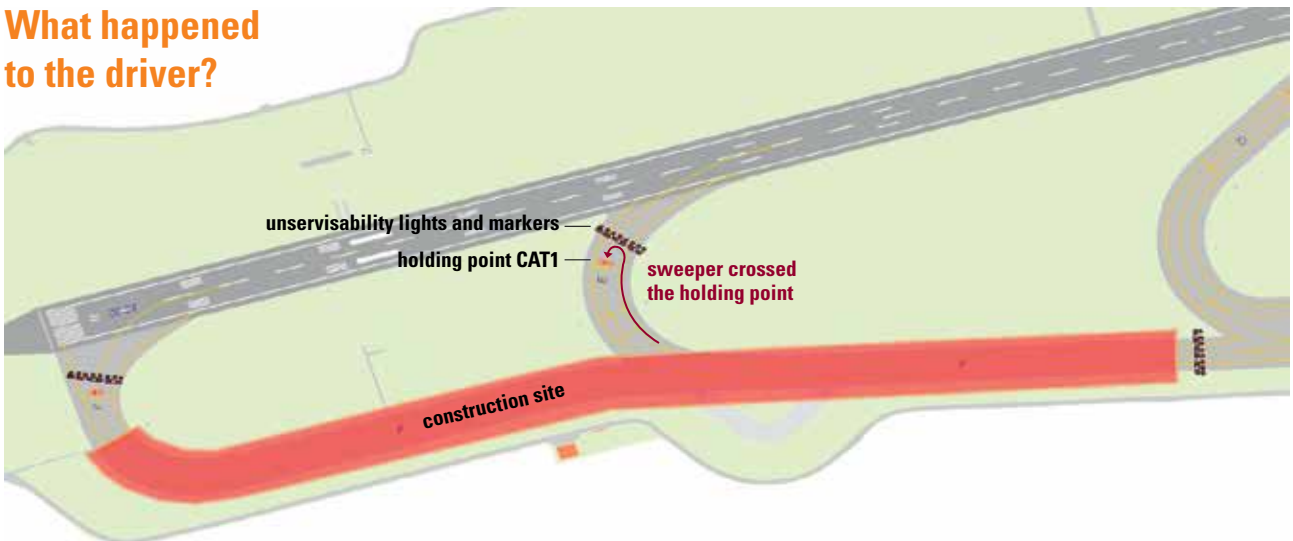
When vacating RWY 24, they were instructed to taxi via TWY D and F and “Hold short of RWY 12/30”. The restriction is not very common, crews are more used to receiving permission to continue all the way. The instruction was given when the crews were busy with their routine tasks after landing. When they reached the holding point, the first crew crossed in good faith that it had received a “green light as usual”. The second crew was not so sure but the last-minute transmission

to the TWR “we are crossing...” was blocked by another transmission.

Since that strange day there hasn’t been any other Safety incident. The place is already equipped more than ICAO/EASA standards. RWY AHEAD Marking and extended centreline marking are implemented.

RECOMMENDATION:
awareness campaign for pilots:
read-back procedures, holding
points, “hold short of”.

What happened to the driver?



The sweeper worked independently on TWY E. This TWY was closed until the holding point and the sweeper did not need permission from TWR to be on it. It occurred at time when the large construction project was ending on TWY F and the surface was being prepared to be opened. The fence had been removed. A closure was marked with unservisability lights

and markers for aircraft coming from the RWY. To make the signs more visible for the crew and make sure an aircraft did not enter a “dead end”, they were installed 60 meters from the centreline. The sweeper driver, operating in the closed section, interpreted them as closure limits. He crossed the holding point even though there was visible traffic

on the RWY. This shows that the commencement and completion stages of construction are the most critical ones.

RECOMMENDATION:
install unservisability lights
and markers at the holding
point level. 5

A SIMPLE IDEA: NO WIND, NO CLEARANCE, NO RUNWAY COLLISION!

by Patrick Legrand

Who has never forgotten something?

Many years ago, when I was training as an ATCO in a control tower, I forgot a vehicle on a runway and cleared a military aircraft to take off. The workers ran from the runway and the aircraft took off avoiding their van by flying over it. I had some difficulties sleeping in the following nights and this memory is still carved in my mind. What went wrong? What was the situation?

There were two intersecting runways. The main one was long enough for any traffic using this airfield. The other runway was shorter but long enough to be used by the light aircraft on training flights that particular day. The main runway was occupied by workers undertaking maintenance on the runway lighting. For the young ATCO I was, the workload was heavy.

The military aircraft couldn't take off from the shorter runway and I thought it would want to depart from the main one as soon as possible – meaning when the steady succession of light aircraft flying across the main runway axis would allow sufficient spacing between two aircraft. I knew this could mean a long wait.

My strategy was to let the people work on the main runway for as long as I couldn't use it. When the opportunity presented itself, I would ask them to vacate the main runway and then clear the military aircraft to take off. Under such pressure because of the close timing, I accidentally skipped the "vacate the runway" step along with the usual runway clear visual check and the event occurred.

My strategy was wrong, but this is not the purpose of the article.

At least, two prevention barriers have failed. ATCO are human beings, and human beings make mistakes and can sometimes forget about something. It is part of Man's very efficient mind. We (really) can't do much about it. How could we design a prevention barrier to prevent this omission? What could we deploy to reinforce the existing prevention barriers? One possibility would be to introduce a system that would check the efficacy of ATCO-given clearances. If deployed at an Integrated Tower Working Position (ITWP) it would trigger an alarm each time a clearance was not consistent with the disposition of airfield activity. In this particular case, that would have been me clearing the military aircraft to take off on an occupied runway. But such a system would be complex to build, to deploy and probably too expensive anyway.

Analysing this locally, we decided to set up a new, very simple, prevention barrier – the inhibition of the wind velocity display when the runway was occupied for a long time. If I hadn't sight of the wind velocity, which was required for issue a take-

off (or landing) clearance, I wouldn't have been able to issue a take-off clearance.

Since then, when a vehicle is cleared to enter a runway, the controller (among other actions) pushes a button that triggers a flashing light at his position and removes the display on the wind velocity screen. We also use this 'reminder' when aircraft are backtracking a runway. This simple procedure prevented many potential mishaps in the years following my own event.



The Wind Velocity Display 'On' – when switched off, the light at the lower right with the runway in use card next to it flashes



PATRICK LEGRAND

started his career as first controller for 15 years and worked as tower manager in Lille airport over 10 years. Keen on improving the quality of service he took on a job as safety investigator for three years before recently joining the French NSA DSAC.



Of course, it cannot be used where there is a continuous flow of aircraft departing and landing. Inhibiting and de-inhibiting the display very frequently would not only be time consuming but probably also unnecessary if not useless. In such situations, a controller is permanently aware of the availability of a runway because his attention is continuously focused on its occupancy. The case of a vehicle and workers is different – there is no dynamic exchange with the controller so that he may simply forget about them.

Temporarily disabling the wind display screen need not be difficult. At first, we had just interrupted the power supply. At another airport, they just hid the wind display screen with a piece of cardboard.

I can see someone raising an eyebrow. In this situation, how could a controller clear an aircraft taking off from the second runway?

Good question.

In fact, the wind velocity readouts are also available elsewhere at the ATCO working position. But when an ATCO needs the wind, he automatically looks towards the same screen. It's an automatism – in the same way that you would continue to look at your wrist all day long to check the time even when you've left your watch on the bedside table. Every single glance at your wrist reminds you that you have forgotten your watch today. It may seem totally useless to most people but it reminds the controller there is a vehicle on the runway.

Using this type of reminder the controller has a better situational awareness and may still use the wind indication for its intended purpose. I think this idea may be useful at some airports – those with variable and often low movements – where when it's quiet, ATCOs may fail to remember the traffic already on the runway. **S**

RUNWAY CLEAR

by Captain David Charles & Captain Andrew Elbert

"Runway Clear" is a routine call made on the flight deck prior to entering the runway. That sounds simple & effective. Visually clear to see if there are any aircraft, vehicles, persons, wildlife, etc., on the runway and then line up. But is it always that simple & effective? While obvious visual impediments exist during inclement weather & LVPs, there are other less obvious visual impairments that may prevent the crosscheck and reassurance that the runway is truly clear of any hazards.

Two of the main contributing factors to runway incursion incidents are lack of situational awareness and complacency.

One of the best practices, contained in one of the Airbus series of Flight Operations Briefing Notes – *Preventing Runway Incursions*¹, is "visually scan to the left and the right and check that approach path is clear of traffic". But is that visual scan always giving you all the information you think it is. It's easy to become complacent and assume simply carrying out all the good practices will keep you safe every time. Complacency can be hiding even in the best SOPs.

The renowned "Bristol Hump," whilst a hindrance to landing perfectionists on Runway 09 at western England's busiest airport, hides a much greater threat – one that exists to various

degrees at many other airports and which is not always obvious to visiting, or even based aircrew – Runway Incursion (RI).

When pilots line up on Bristol's Runway 27, they are faced with a picture not unlike an old Royal Navy Harrier ski jump. The problem is that the end of the runway is not at the top of the hump.

The topography of the runway means that when lined up for departure on Runway 27, pilots cannot see the threshold and runway exit at the 09 end of the runway. Although they can see commercial airliners vacating, the sight line is enough to hide a vehicle or a light aircraft.

Even in daylight at relatively simple airports, 'Murphy's Law' prevails – no matter how carefully you have

taxied, no matter how carefully you have briefed and executed your route to the runway, no matter how carefully you have identified the correct runway and carried out the line-up procedure, you still can't see through a hill! In such circumstances, part of an operator's CRM and, where used, Threat and Error Management (TEM) should ensure that when one cannot truly survey the entire runway, pilots and ATC must mitigate complacency and perform SOPs with discipline and precision.

Ground movements at any airport can be a surprisingly complex business. Controllers have a strategic overview and tactical game plans to orchestrate

1- see <http://www.skybrary.aero/bookshelf/books/185.pdf>



and synchronise movements of aircraft, ground vehicles and airport personnel. As pilots, our main lines of defence against runway incursion and ground collision (GCOL) events are SOP, sterile flight decks, and CRM. Within this toolbox, situational awareness (SA) is the key. SA is not only about knowing where you came from, where you are presently and where you are going, it also requires one to develop a mental model of where everyone else is and where they are going. Essentially, pilots need to comprehend and appreciate the controller's plans and instructions, especially when time does not permit broadcast of the "big picture" over the frequency.

To make sure one keeps the "big picture," it is vital for all persons, aircraft, and vehicles manoeuvring

around the airport to listen out on frequency and use it to manage their mental model and maintain SA regarding airside movements. This is especially important when you are unable to physically see what lies behind another terminal, hangar, airport structure, or even over the next hill or behind the tree line.

Pilots are made aware of areas that controllers are not visual with as these are depicted on airport charts. This allows a threat to be identified, briefed and planned for when expected taxi routes and stands exist within one of these areas. Pilots can utilise TEM to anticipate and recognise threats associated with areas where aircraft or ground vehicle movements cannot be visually monitored by the ground controllers. Whilst areas of restricted visibility are usually noted on aeronautical charts,

rarely do these charts advise when airfield topography may pose a threat to being able to visually confirm the route or runway is clear.

Visual illusions work so well because our cognitive processes make convenient assumptions about objective reality based on the 3D visual stimulus received. The core of Situational Awareness is the effective extraction of information from the environment. Especially in areas with line-of-sight restrictions, these human factor realities and GCOL & RI imperatives dictate that pilots and controllers alike should incorporate these risks into their CRM and TEM. Whether anchored in the old adage that "forewarned is forearmed" or in TEM's "anticipate, recognise, recover," SA is fundamental for the maintenance and synchronisation of the mental models involved during airport ground operations.

For both pilots and controllers, remembering that up to half of our mental model comes through aural cues and that receiving,



comprehending, and utilising that information is essential to SA and GCOL/RI mitigation. Every pilot knows how important it is to monitor the active frequency on the ground. It not only contains the instructions needed to manoeuvre as your own aircraft, but also as an aircraft safely and securely synchronised within an airport's entire system. A call to another aircraft or ground vehicle could be the information that alerts you to a potential threat or conflict lurking just around the next corner or beyond the runway hold line. Hence, the necessity for SA and a shared mental model.

We are certain we can agree that SA and a shared mental model can be best built and synchronised by following established procedures, utilising CRM and incorporating the real-time visual and aural inputs received during ground operations. Back at the beginning, I mentioned the often overlooked visual threat associated with obstruction in the normal line-of-sight and one must also not forget the main threats to communication – interruption and distraction.

Taxiing is a critical phase of flight and is rightly seen as such by Safety Regulators. Although normally the shortest segment of a flight duty, there are plenty of regulated activities that pilots are required to do whilst manoeuvring the aircraft on the ground that can take a proportion of their attention away from monitoring the radio communication frequency and keeping a good visual lookout such as briefings, checklists and performance crosschecks. Some airlines even require crews to confirm final load sheet figures with the handling company after pushback and of course there are always vehicles, personnel, ground equipment, wildlife hazards, and aircraft to scan for – especially distracting when there is a new, distinctive livery on the apron which can tempt a sterile flight deck environment!

It should be recognised that any distraction is an interruption of one or both pilots' capacity to monitor



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the surrounding environment and maintain SA. It is also natural human behaviour to chat. If the airport is busy or there is a significant delay at the holding point before departure, pilots must overcome a natural tendency to break the silence with 'idle' conversation. The threat to safe operations is that general conversation is distracting. Thus, regulators and operators alike promote "sterile flight deck" concepts during critical phases of flight so that pilots' mental models, which are supporting safe operations, are protected.

Sterile flight decks restrict communication to standard operating procedures, checklists, and discussions necessary for the safe conduct of the flight. Discussions of the ground situation and the on-going airport environment and movements are, however, encouraged. To discuss the "Bristol Hump" and its potential impact on RI during taxi-out does not violate a sterile flight deck environment as it aligns with safety, TEM and sterile flight deck concepts. If the potential threat is one of runway topography, then discussing what may lie over the horizon is essential to maintain the mental picture since the visual picture which will be encountered will be restricted. Which aircraft have been cleared to line up? Where was the landing light aircraft supposed

to vacate? Did the landing aircraft vacate the runway? TEM combined with proactively monitoring the ATC frequency can provide an aural alert and anticipation of potential conflicts.

Human factors add another challenge, as even when being presented with the same information whilst within the same environment, not everyone will construct the same mental picture. It is therefore vital for pilots and controllers to communicate and synchronise their mental model so that any differences can be identified and resolved prior to an incident or accident. Numerous flight safety studies have highlighted the negative consequences associated with assumptions. In aviation, one should never, ever, assume and CRM best practices demonstrate the effectiveness of advocacy. So, if you are unsure or the clearance or SA, ask the question!

During a sterile flight deck period, both pilots should remain on the operational frequency unless there is an overriding safety related or operationally imperative situation. If away from it, once back on frequency, pilots should check with their colleague what they've missed – maybe new instructions and traffic movement updates. Sharing the latest "big-picture" once both pilots are on frequency again is essential to re-establish and re-synchronise SA.

Has the runway inspection vehicle vacated the runway? Can I see the full length of the runway from my position? Did ATC say line up or cleared for takeoff? Wasn't there a runway inspection in progress while I was off the frequency? A simple operational discussion can be a most effective RI safety net.


One of the key recommendations from the EAPRR² document is that all runway operations should be conducted in aviation English where possible. While various reasons are given for not doing this everywhere, such as when English language proficiency is not required to obtain airport driving permits, the use of multiple languages on an ATC frequency certainly hinders the ability to develop the required SA and the effectiveness of using TEM to mitigate RI. Take for example, Airport Z, a busy national general aviation (GA) airfield with frequent international commercial traffic movements which all occur on a sloping runway.

There are three major threats which increase the probability of Murphy's Law resulting in RI:

- The GA traffic and ground ops all communicate in the national language.
- From the threshold of Runway XX one cannot see the Runway YY threshold, nor the adjacent GA grass runway.
- Airline traffic can only enter the runway at the mid point and must back track down the hill to the XX threshold.

As most aeroplanes are not equipped with rear view mirrors or cameras, it is hard to keep a mental picture of what is happening behind your aircraft, especially if one cannot use ATC communications and their aural inputs to model it. Developing technologies, however, offer to mitigate many of the obstacles to safe operations which often lead to RI when SA and CRM fail to mitigate or trap the causal factor(s).

Aircraft based RI mitigation systems and runway incursion monitoring systems at airports give a further layer of protection against runway incursion, however, SA and CRM will continue to be the most effective safety nets. Whereas technological safety nets by design normally increase SA because of their functional reliability, this very reliability can foster complacency-creep which can easily neutralise any benefits gained by their introduction.

In summary, every day pilots and controllers perform with extraordinary discipline and precision to mitigate and prevent RI events which can easily occur when people lose their SA or become complacent because of the well-trained, finely-tuned, highly reliable systems and individuals which operate in the aviation industry. Despite the arrival of many high-tech safety nets which have been shown to mitigate RI, pilots and controllers alike still need to make use of basic sensory cues (visual, aural), standard procedures (sterile flight deck concepts), CRM (SA, communication, advocacy), TEM (anticipate, recognise, recover), or – in two words – basic airmanship, to prevent RI events – especially when confronted with the “Bristol Hump” or similar constraints to the “Mark-One” eyeball. 

2- see: [http://www.skybrary.aero/index.php/European_Action_Plan_for_the_Prevention_of_Runway_Incursions_\(EAPRR\)](http://www.skybrary.aero/index.php/European_Action_Plan_for_the_Prevention_of_Runway_Incursions_(EAPRR))



RUNWAY INCURSION PREVENTION

A SAFETY II APPROACH

by **Maria Lundahl**

In 2014 the Swedish ANS provider LFV initiated a project with the aim to reduce the risks involved in Runway operations – the Runway Incursion Prevention Programme. As the Safety coordinator for LFV operations, I got the task of chairing the project and below I will share some of our experiences and results.

INVOLVED PARTIES

To facilitate the spreading of potential learning effects, LFV decided to invite a number of strategically important stakeholders to be part of the project. All of them accepted and were happy to be part of this project. The work began in November 2014 with participation from:

- LFV – ANS provider
- ACR, Aviation Capacity Resources – ANS Provider
- The Swedish Armed Forces – airport and aircraft operator, training organisation
- Swedavia – Airport operator, owned by the Swedish State
- SRF, Swedish Regional Airports – a network of airport operators with different ownership¹.

Our first task was to decide on how to attack the problem. We had read numerous reports of actions already taken and knew that Runway Incursion is a subject which has already been thoroughly analysed. We also understood that most (if not all) previous reports and action plans are based on learning derived from incident and occurrence reports. So, how could we make our project contribute with new learning?

SAFETY II

The project group was introduced to the theory of Safety II, Professor Erik Hollnagel's theory of how both safety and risk emerge from the same source of performance variability and adaptive strategies, often called "work as done". We agreed to let Safety II form our project philosophy, based on a belief that operators' adaptive strategies more often ensure safety than give rise to risk and agreed that we should look for examples of normal work by asking questions like "when, where and why does a Runway Incursion NOT occur?"

All through the project our objective was to try to understand how normal work is done. Meanwhile we made an effort to make Safety II a well-known concept all through the participating organisations; we developed a leaflet with an "Introduction to Safety II" (to be used in one of our activities) and published articles in an LFV magazine.

ACTIVITIES

Now that we had agreed to focus on studying "normal work" we realised that we would have to search for data in other sources than the traditional source for lessons learned – occurrence and incident reports². We decided to perform a number of different activities in order to find examples of normal work:

- Observations
- Interviews
- Workshops

All the project participants were asked to perform observations and/or interviews in their own organisations. We agreed that focus should be on normal work and on trying to find out when, where and why a Runway Incursion does not happen.

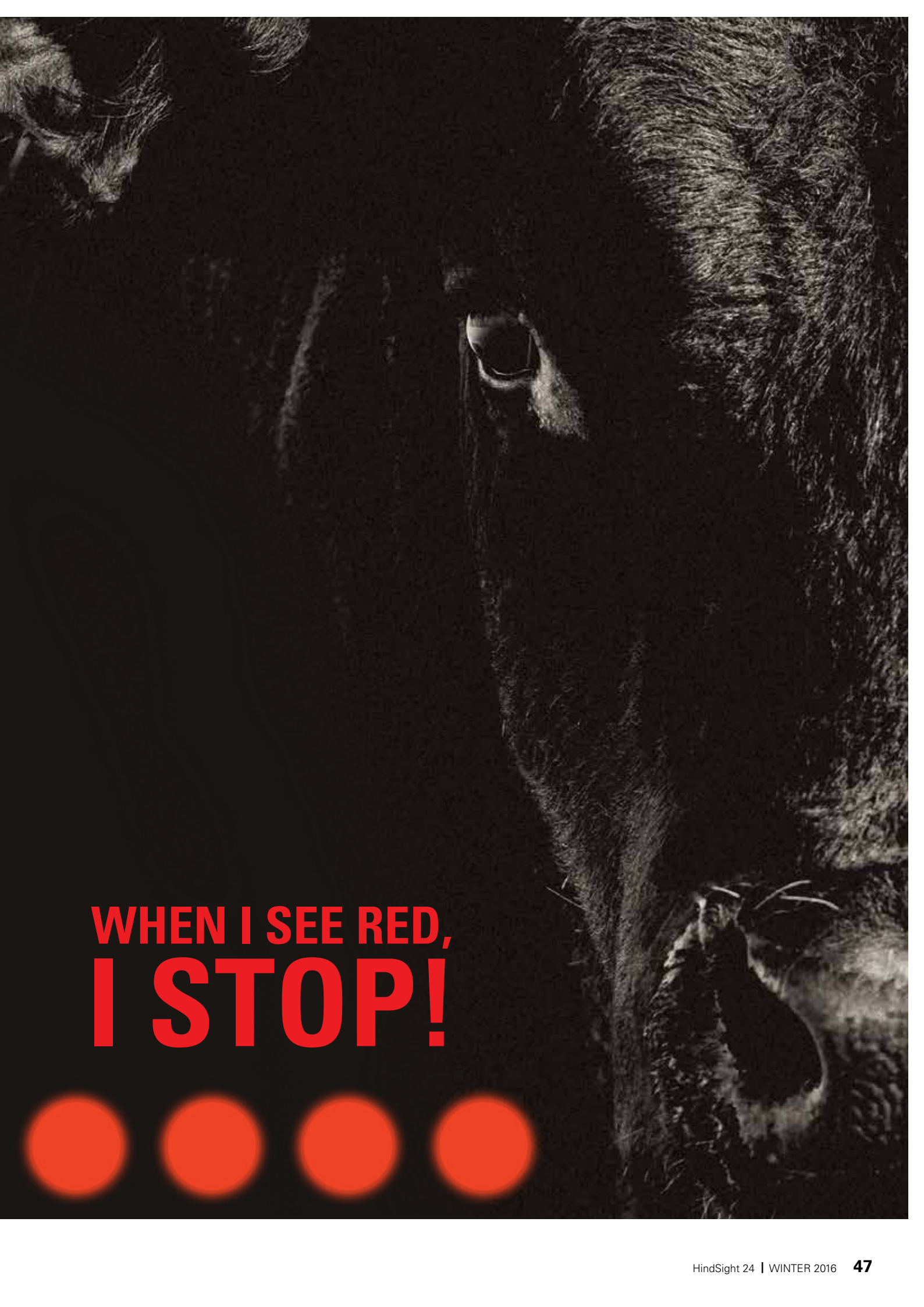
1- SRF was not part of the project initially but was invited to join later on.

2- In fact, even the occurrence reports provided us with many good examples on situations that could have led to a Runway Incursion, but did not ...



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is an Air Traffic Controller who has worked for LFV, Swedish ANS provider, for more than 25 years. She has worked in ATC training for many years, mainly within the Human Factors domain, has experience from Occurrence and Incident Investigation and currently holds the position as Safety Coordinator. Outside of work Maria has studied System Safety at Lund University, combined with courses in Psychology and Education.



**WHEN I SEE RED,
I STOP!**



In addition we arranged a number of workshops for different professional categories. The workshops were mainly aimed at controllers and pilots, but we were also given the opportunity to run a workshop for a mixed group, with participants from all parts of the aviation industry, at a Runway Safety Team meeting at Stockholm Arlanda Airport.

In these workshops we gave the participants a number of tasks all aimed at discovering examples of normal work and good practices:

1. First the participants were asked to think of a situation they had been involved in that could have led to some kind of incident but did not. They were then asked to try to think of what it was that stopped the situation from turning into an incident or accident.
2. In the second group discussion, the participants were presented with cases from real life. All these cases did, in reality, end in Runway Incursions, but in this exercise we "paused" the course of events just before it developed into an incident. The idea was to let the participants use their experience and come up with strategies to prevent the situation from developing into a Runway incursion.
3. In the third exercise, we asked the participants to picture themselves in a different job to their normal one. They were then asked to come up with good ideas that they would have liked to share with the other party had they been given the chance.
4. In the last exercise we presented a number of strategies on the walls of the workshop room. These strategies were products of discussions in the aftermath of incidents or had been offered to us as suggestions on good practices. The idea was to ask our workshop participants if they should be added to our list of recommendations.

RESULTS

With all the data collected, we went into the second phase of the project, analysis of the material. For this phase we formed an analysis group consisting of myself and my operational LFV colleague, supported by another operational TWR-controller who helped us by using a thematic analysis approach. A large number of possible actions or recommendations were identified and further investigated in several steps. All-in-all, the analysis resulted in 53 recommendations that were presented to the rest of the project participants. The project group unanimously decided to deliver these 53 recommendations to the following six groups of aviation stakeholders:

- The Swedish Transport Agency, Transportstyrelsen (13)³
- ANS Provider organisations (7)
- Local ATS organisations (11)
- Airports (15)
- Airlines (6)
- Training organisations (1)

The recommendations spanned a large variety of areas for example:

- technical solutions for ATCOs, pilots and airport drivers,
- training – with special focus on Human Factors,
- phraseology and clearances – with special focus on airport staff, Example:
 - Introducing a tool for marking and monitoring clearances to enter the Runway in airport vehicles. The project found that vehicle drivers at airports often lack this kind of tool and the participants agreed that introducing such a tool would enhance runway safety.
- airport infrastructure – with special focus on signs and signals, Example:
 - Painting a red box with the runway number as a warning on taxiways that connect directly to a runway. After a number of runway incursions at a Swedish airport during the summer, the airport took the decision to paint such a box on the taxiway. Since then no runway incursions have occurred at this very position. The airport has now decided to mark all taxiways that connect directly to the runway the same way.



- increased sharing of experience between pilots & ATCOs and ATCOs & drivers,
- joint analysis of incidents – TWR & Airport Operator,
- implementation of a Safety II and learning-from-normal-work approach as a basis for investigation & analysis of incidents as well as for dissemination of lessons learned,
- operational methods and clearances for ATCOs, Airport staff and pilots,
- seasonal meetings – airport & TWR,
- TWR environment and FPB⁴, Example:
 - Introducing a flow-model for TWR FPB. The flow model for FPB was developed many years ago, by an LFV-project group⁵, with the aim to enhance focus on the runway as well as TWR controllers' ability to monitor and detect conflicts on ground. For some reason only a few TWRs had up until then introduced the concept, but now the ideas behind the flow model have spread and several TWRs have introduced the model into their FPBs.

The project group agreed on pitching the recommendations at as high a level as possible, which meant that if we wanted a certain recommendation to spread to different aviation categories we aimed this recommendation at the safety regulator. It is our belief that this will contribute to harmonisation across organisations.

The recommendations have been presented organisations other than just those who participated – another couple of ANS Providers, to an ATS Training Academy and to the Swedish Transport Agency.

3- The Swedish Aviation Authority

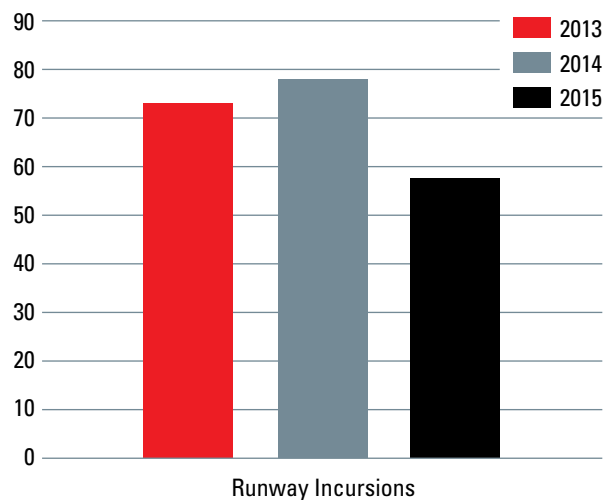
4- Flight Progress Board

5- Change Management and Harmonization in ATC Ground Operations – Non-technical safety and efficiency improvements (LFV 2009)

LESSONS LEARNED

Our first, and very positive lesson learned was that it is extremely beneficial to do this kind of work across organisational and professional borders. The wide range of expertise and competencies provided by the participants in the project gave us an amazing opportunity to look into this area from many different perspectives; the roles of tower controller, military pilot, airport safety coordinator, incident investigator, safety manager, civilian pilot, operational manager and more.

Another positive outcome is that both the ANS Providers involved experienced a significant decrease in the number of Runway Incursions during the course of the project. This graph shows the decrease in Runway Incursions at airports where LFV provides ATS:



We hope that this is a first and positive signal that raised awareness and focus on the risks involved in Runway operations has contributed in a positive way. We will continue to monitor these figures in order to prevent a drift into failure scenario.

It is our belief that additional observations, workshops and interviews would have got us even further and it would have been interesting to see if the same results would show up again. Throughout the data collection phase, we kept learning new things and saw additional strategies up to the point where we had to stop conducting data collection and initiate the analysis. Even though no formal decision has been taken on when to perform a follow-up, the project plan includes an ambition of some kind of follow-up one year after the implementation of the recommendations.

INTEREST IN THE PROJECT

There has been a lot of interest in the project, partly because Runway Incursions continue to be one of the main safety concerns in the aviation business so that attempts to address this risk are of course of great interest to all those involved. But a lot of the interest has come because of our focus on the Safety II concept in the project and learn from normal work. **S**

TO KNOW WHAT TO INSTRUCT WHEN!

by **Captain Wolfgang Starke**

ICAO document 4444 (PANS-ATM) clearly states the phraseology for rejecting a take-off or a landing. But as a controller, do you know when it is a good idea to use it? There is no way a controller can assess the risks of a rejected take-off or a go around from low altitude from outside the aircraft. What is missing in this ICAO document is some clear and unambiguous phraseology for passing essential information to aircraft which are at high speed on an active runway or on short final. Of course some appropriate training would be an essential prerequisite for the use of such new phraseology.



**Intruder in sight...
And don't worry...
we have a better solution
than rejecting take off:
JATO!***

***JATO - Jet Assisted Take-Off**

When ICAO developed a manual on Ground Based Safety Nets, both IFALPA (International Federation of Airline Pilots' Associations) and IFATCA (International Federation of Air Traffic Controllers' Associations) asked how an Air Traffic Controller (ATCO) is expected to react upon receiving a warning of from such systems. How can an ATCO safely, unambiguously and quickly pass essential information to pilots in a situation that is developing extremely quickly?

In ICAO's Document 4444, the PANS-ATM, there is phraseology on how to instruct an aircraft to reject take-off or landing. This phraseology is either "callsign, STOP IMMEDIATELY" or "callsign, GO AROUND". Of course, the final decision on whether to reject a take-off or to initiate a go around lies with the pilot in command of that aircraft. He is expected to evaluate the situation and determine the safest course of action.

But how can a pilot in command evaluate a situation when he cannot necessarily know the reason for such an instruction or know whether a safety net alert is the reason behind the ATC instruction?

Imagine a wide body aircraft accelerating for take-off to begin a long-haul flight. Aircraft weight is high, kinetic energy as result of speed and mass is tremendous. Now the pilots are instructed to reject take-off a couple of knots below take-off decision speed (V1). A rejected take-off in that situation is a high-risk manoeuvre! As long as the aircraft is flyable, in most situations it is safer to continue the take-off.

Shifting into the head of that particular pilot in command, he will need to make a quick decision. He may use a very abbreviated version of the FORDEC-technique. This is an acronym which leads him through the decision-making process. The acronym is decoded as Facts, Options, Risks / Benefits, Decision, Execution and Check.

Now let us follow this sequence:

FACTS:

Speed and Energy are high, ATC-instruction to reject the take-off is received when slightly below V1.

OPTIONS:

Follow the instruction or continue take-off.

RISKS:

The risks involved in a high speed rejected take-off are well known, but risk of a continued take-off is completely unknown (as we do not know why that instruction has been given).

How do we make the right decision now?

A situation exactly like this happened to a crew of a Boeing 767 performing their take-off for a transatlantic flight in May 2015. They got their take off clearance, set the thrust and began to accelerate. During the take off roll, a heavy jet approaching on the parallel runway pulled up for a go around. As the departure track and the missed approach track did not diverge, the ATCO almost immediately instructed the 767 to reject the take-off. The crew followed the instruction four seconds later. Highest speed recorded from the flight data recorder was however 165 knots, which was 14 knots above take-off decision speed.

The incident did not result in a runway excursion or any injuries, luckily the runway was long enough to allow a safe stop even from above V1. However, the aircraft brakes and tyres needed some attention and the flight got cancelled that day. Still, it was a safe outcome for that situation – but a shorter runway could have been more dramatic.

As the weather was pretty good with excellent visibility and no cloud below 5000 feet, continuing the take-off and then doing one's own visual separation between the two aircraft would still have been likely the safer option.

The purpose of the story is not to be critical of the ATCO or the pilot but rather to illustrate how a situation can develop even though everyone is following procedures and no one is making a mistake. The problem just lies in the fact that the ATCO cannot judge the safest course of action from outside the aircraft and the pilot does not know what has happened to cause the controller to issue such an instruction. Both sides are missing essential information for appropriate decision making. In this particular case the design of approach and departure procedures has obviously been inappropriate but that is not a matter for this article.

While a high speed rejected take-off is accepted as a relatively high risk manoeuvre, a go around is usually seen as the safer option compared to a risky landing.

Still, we see numerous accidents resulting from 'simple' go-arounds like the recent crash of Flydubai 981 or the crash of Afriqiyah Flight 771. Both of these crashes had a number of contributing factors leading to the disastrous end. However, as an ATCO, can you check the contributing factors prior instructing the crew to go around? How can you know or judge the risk of a go around when instructing a crew to make one?

Let's now imagine an aircraft attempting to land on a long runway. With the aircraft on short final, the ATCO sees a runway incursion by a car about 2500 metres down the runway. If you instruct the crew to go around, the risk of an inappropriate and possibly fatal go around is present. Or the crew is sent on a go around with possibly very little fuel remaining putting the pilots into a stressful situation and increasing the chance of follow-up mistakes or a rushed approach.

An alternative could be to pass information to the crew about the incursion, such as the relative runway position and let the pilot in command decide whether it is safer

to go around or land based on the time available for decision making and operational aspects such as aircraft type, mass, fuel remaining etc. However, this may be too much information to give in way too little time and also the time available for pilots to assess options might be too short. However, the option of going around would still exist but the possibility to continuing to landing would be added.

There are discussions about exactly this question when thinking about details of introduction of various ground based safety nets. However, these discussions are neither mature nor have they found good answers yet.


For the runway incursion case described, in a heavy Boeing 747 I would expect the crew to judge the go around safer but thinking about a light commuter aircraft like the Bombardier DHC8-Q400 it could be safer to land on the first 2000 metres as the landing distance required is typically less than 1500 metres.

Still there are two problems. On the one hand there are simply no procedures allowing a pilot to land on a runway while a runway incursion is taking place. Even if this might be the safer course of action in some rare situations, it is simply not allowed for in existing procedures.

On the other hand we do not have phraseology to communicate all the information. To develop that kind of phraseology would be a large piece of work. For a situation where seconds really do count, phraseology needs to be extremely concise and strictly unambiguous. Passing a lot of information quickly and still being precise is not easy. Another possibility would be for a controller to offer alternatives. When British Airways Flight 38 approaching a landing at Heathrow suffered a dual engine failure and crashed short of the runway the tower controller instructed the following aircraft to either swing to the parallel runway or to go around. He just stated "if you can, swing runway 27R". This instruction enabled the crew to quickly assess their options and decide the best course of action for them.

There is no quick fix to this problem. Of course the best way is to have safe procedures in place which do not bring pilots or controllers into a situation where such hard decisions have to be made. But aviation is very dynamic and no one can always foresee every single situation that might happen.

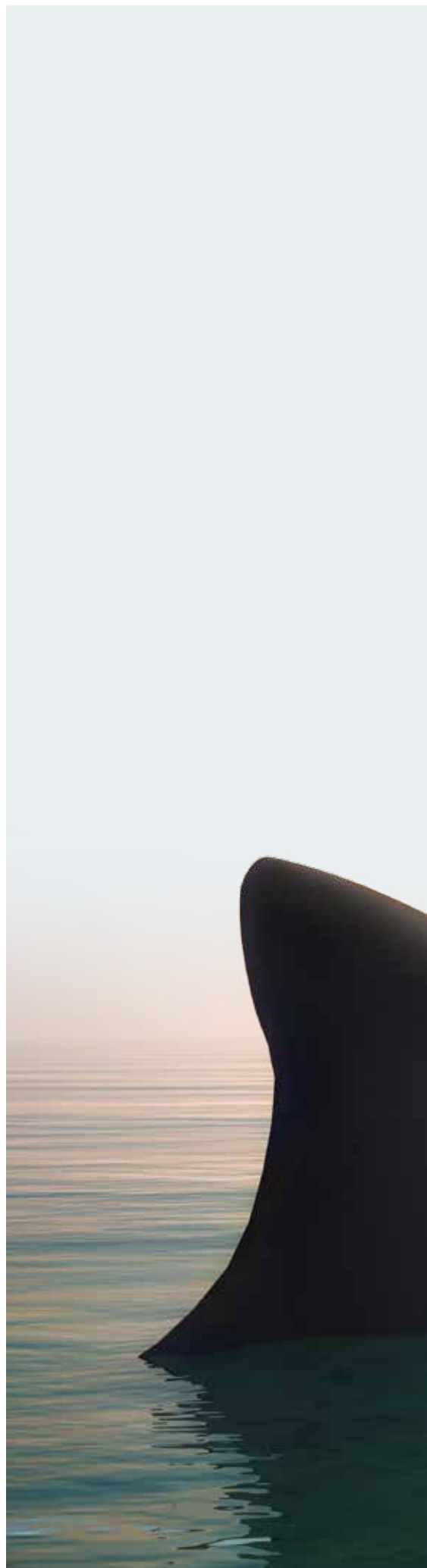
What is important is that controllers are aware of the risks and implications of manoeuvres like a rejected take-off or a go around and give instructions on these manoeuvres very carefully. And pilots sometimes need to be reminded that it is their primary responsibility to not just follow every instruction but to always evaluate the situation, decide the safest course of action and then apply the techniques they have learned.

Aviation is not and will never be a black and white thing! 



WOLFGANG STARKE

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THAT WAS CLOSE, HOW DID THAT HAPPEN?

by Mike Edwards

It was early evening as the passengers boarded for the one hour flight. As usual at this time of day, the flight was running about 30 minutes late "due to late arrival of the inbound aircraft". The passengers looked tired and grumpy, as were the two pilots – Ben, the Captain and Jerry, the First Officer. They generally got on well, but tiredness had made them tetchy and irritable. They got start up clearance from the Tower and briefed for the standard "EMMA Two Charlie" departure off runway 29.

In the Tower, Lisa was the Aerodrome Controller in charge of the runway, and Bill was plugged in on the Ground position. They worked well together and had a conspiratorial smile at every grunt, which passed for co-ordination from Alistair, downstairs on radar, for whom the word "dour" would be optimistic.

It was Ben's turn to fly the aeroplane (call sign Homebird 69 Bravo Charlie) for the last sector back to base in the South. Jerry got taxi clearance "via Mike, Bravo Three hold for runway Two-Nine". Bill knew that these crews were happy with a departure from Bravo, which was about 600m down the runway from the threshold.

Just then, Alistair piped up from downstairs "Check southbound, I've got another infringer, probably looking for Kingley". Kingley was a small grass airfield just outside the Control Zone.

Bill transferred Homebird 69BC to Lisa as it taxied along "Mike", the plan being to depart two from the full length, the second of which was the same vortex category as the Homebird.

The infringer was circling randomly to the south so Alistair and Lisa agreed a plan to take the Homebird 69BC north and east after take-off instead of the normal south bound SID. Lisa had just cleared SkyTrans 491 to depart from the full length when Homebird 69BC came on to her frequency. Lisa responded with "Homebird 69 Bravo Charlie good evening, short delay to your departure, I have a revised clearance for you while we wait". Jerry told her to go ahead and then wrote down the new heading and level on his pad. Ben tutted and said "great, all around the houses, wonderful" and then "get it loaded". This was directed at Jerry to update the FMS.

Jerry spent the next 30 seconds or so with his head "in the office" and looked up to see them crossing the stop bar towards the runway. "Stop bar" said Jerry in a questioning way. "We've got line up clearance" said Ben. Jerry couldn't remember a line up clearance, but didn't say anything as Ben was clearly not a happy bunny. He tried to look right towards the runway threshold but the angle of the taxiway and the high wing of the aeroplane made it difficult.

Meanwhile, back in the Tower, Bill was standing up and laughing. So Lisa stood up too to see what was so funny. They chuckled as they watched the antics of a marshaller trying to manoeuvre a light aircraft on the GA Apron which was next to the Tower. He clearly wasn't getting through to the pilot and his signals were getting more extreme as he shook with frustration.

Ben was turning the aircraft on to the runway, looking left at the remaining runway length as he did a full and free movement check, when they heard someone say "Stop Stop" in an agitated voice on the R/T. Just then an aircraft came passed their nose on the far side of the runway under heavy braking.

"Er Tower, SkyTrans 491 that was close, how did that happen?" Lisa turned around and went as white as a sheet. "Oh my.....standby SkyTrans"" Homebird 69....."was all she could manage. She looked at her strips, which all looked correct. What had she done? Bill had been quickly on the phone to the Supervisor and a relief controller ran up the stairs, took over and unplugged Lisa. SkyTrans 491 vacated the runway and held on the taxiway; and Homebird 69BC requested a minute and then reported ready for take-off.

So, what did happen?

- The RTF recordings showed that the controller, Lisa, had used non-standard phraseology in telling Homebird 69BC that she had a revised clearance "while we wait". The pilot report from Homebird Airways stated he had been cleared to "line up and wait".
- Homebird 69BC was using a holding point on a taxiway that was angled primarily to speed the exit from the runway 11. This made it more difficult for pilots to turn enough to see the final approach and threshold.
- Captain Ben crossed an illuminated red stop bar onto the runway. He did this because he believed that he had a clearance to line up, which must therefore also be a clearance to cross over the stop bar.

It is best practice that pilots should never cross a lit stop bar even if they have a runway entry clearance from ATC. This is supported by all signatories to the European Action Plan for the Prevention of Runway Incursions (EAPRI), which include EASA, IATA, IFALPA, IFATCA, ECA, and EUROCONTROL.

- First Officer Jerry was concerned about Captain Ben crossing the stop bar and did query it. But when the Captain asserted that he had a line up clearance, the FO did not push the issue because he knew that the Captain was tired and irritable, thus allowing human performance and the flight deck relationship to override the safety of the aircraft.
- In the Tower, the Aerodrome Controller, Lisa allowed herself to become distracted from her primary role of monitoring movement on the runway. An aircraft had been cleared for take-off and her primary task was to observe that departure. She could not have prevented the runway incursion but there is a chance that by remaining vigilant the risk of collision could have been reduced.

This story is illustrative of the most severe and challenging type of Runway Incursion. This is **Sudden High-Energy Runway Conflict (SHERC)**. These events typically involve a situation where, once it has been initiated, the time available for ATC to prevent a collision is likely to be less than the time so needed.

SHERC events are intrinsically last minute occurrences where an aircraft or vehicle enters the runway ahead of an aircraft that is in the act of landing or taking off. This can happen for a variety of reasons, but can be grouped into four areas:

1. Incorrect ATC clearance
2. Aircraft or vehicle becoming confused as to its physical position on the airport
3. Aircraft or vehicle mishearing or misinterpreting its ATC clearance
4. Aircraft or vehicle not complying with its clearance due to the mind-set and focus of attention of the pilot or driver.

EUROCONTROL through its Safety Improvement Sub-Group is carrying out an Operational Safety Study on Sudden High-Energy Runway Conflicts. The general methodology is to examine what assistance is available to controllers, pilots and drivers to prevent the runway incursion from happening in the first place; and secondly if that fails, what assistance is available to prevent it turning into a runway collision.

The Study suggests that there is currently no silver bullet, no one procedure or tool that can prevent all SHERC events. It has found that a combination of procedures and hardware have the highest potential to prevent most events. Whilst everything helps, the study suggests that the following could have the largest positive impact in the prevention of SHERC events:

- Functionality to give ATC alerts of aircraft/vehicles not conforming to clearances or ATC clearances that are conflicting
- The correct use of ATC memory aids, such as a common method of indicating that a runway is actively occupied, plus competency checks that monitor compliance.
- The use of stop bars together with procedures never to cross an illuminated bar.
- The installation of Autonomous Runway Incursion Warning Systems (such as Runway Status Lights)
- Flight deck equipage showing Airport Moving Maps.

The EUROCONTROL study includes the analysis of real SHERC events around the globe and found that once a SHERC event had been initiated, almost all of them relied upon belated visual detection from pilots or drivers for collision avoidance.


Visual detection by ATC of SHERC events is limited by meteorological conditions and is unlikely to be effective once the event has been initiated. This would suggest that ATC training should emphasise the importance of Preventing SHERC events by focussing on the correct use of memory aids, visual vigilance and precise ATC clearances.

Finally, the study found that the use of stop bars together with procedures for all pilots and drivers to never cross a lit stop bar or for ATC to never give a clearance across a lit stop bar could have prevented half of the actual serious runway incursions studied.

EUROCONTROL, in a joint initiative with the Flight Safety Foundation European Advisory Committee are producing a series of very short videos, called SKYclips, to highlight particular risks to operational safety. The crossing of lit stop bars or the clearing aircraft to cross them is the subject of one and can be accessed on SKYbrary¹.

After the event, Lisa had to listen to the RTF recordings three times before it dawned on her what her contribution to the event had been. She won't be saying THAT ever again!

Ben was called into the Chief Pilot's office to be told that the company SOP was indeed to never cross a red stop bar without checking with ATC, and why didn't he know that. Trouble was that Ben did know actually.

Jerry was glad of a day off. He had promised his kids that he would take them to the new Ice Cream store. 

1- [http://www.skybrary.aero/index.php/Stopbars_\(SKYclip\)](http://www.skybrary.aero/index.php/Stopbars_(SKYclip))

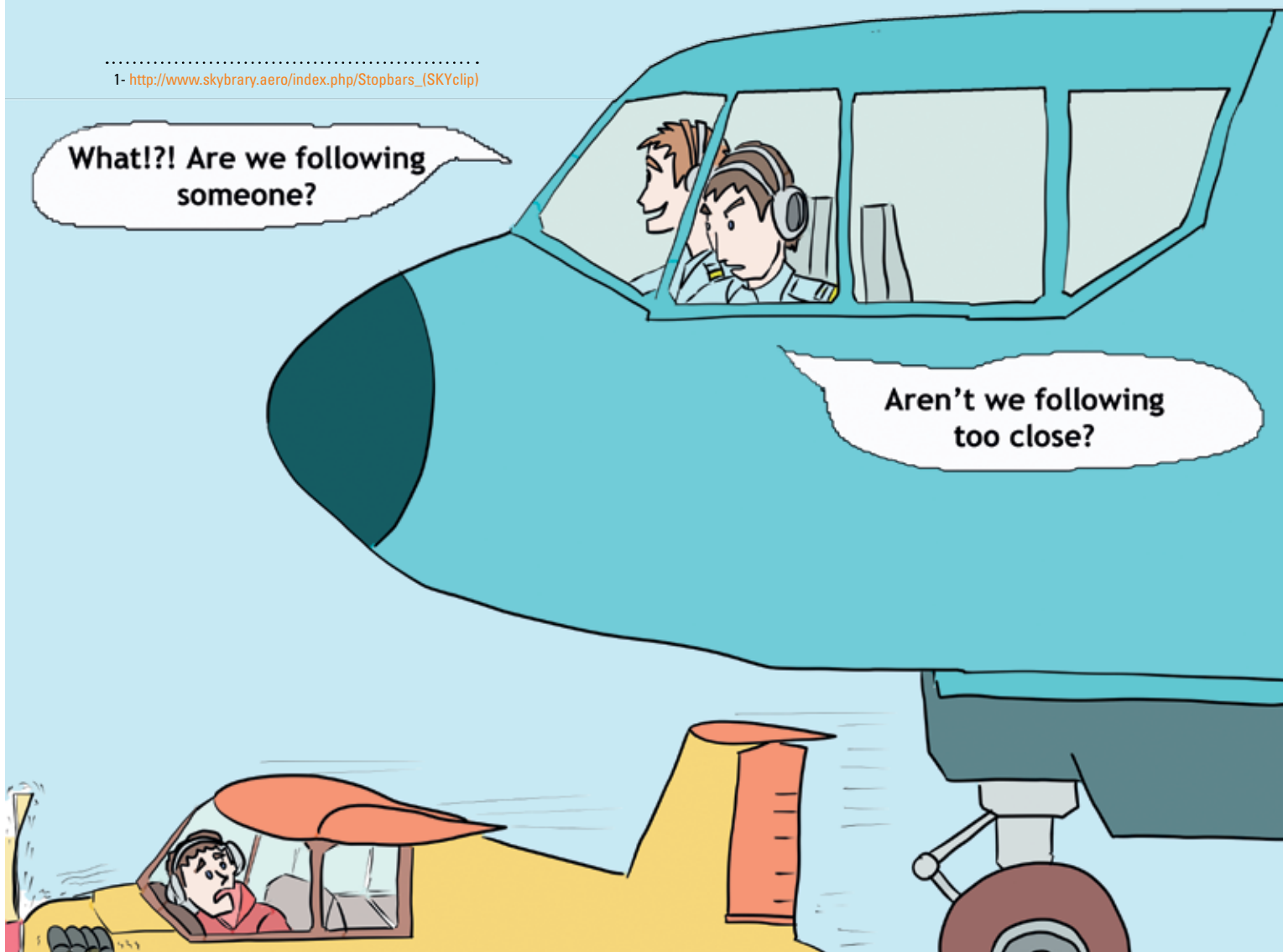
MIKE EDWARDS



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What!?! Are we following someone?

Aren't we following too close?



RUNWAY COLLISION RISK: WHAT DOES SAFETY SCIENCE TELL US?

by Dr Sybert Stroeve

The risk of a collision due to a runway incursion depends on many aspects, such as the situation awareness and performance of involved pilots, vehicle drivers and air traffic controllers, the size, weight and performance of involved aircraft, the layout and hold-short positions of intersecting taxiways, the availability and use of advanced surface movement guidance and control systems (A-SMGCS), and the prevailing weather conditions. This issue of HindSight focuses on the ways that these kinds of aspects can contribute to the collision risk, and what kinds of measures can most effectively reduce this risk.



When evaluating the collision risk in a particular context, it is a key insight from safety science that the risk contributions of these aspects are highly interdependent and non-linear. This implies that collision risk cannot be calculated simply using some constant probability factors for barriers against a collision, but that the risk calculation needs to account for the context-dependent interaction between the various aspects. This is of course no surprise for operational experts, who are well aware of the complexity and variability of day-to-day operations and who are the first to say "well, it depends...". The key question, however, is how the collision risk of such complex operations can be calculated in a valid way. This article provides some recent insights which safety science has contributed towards this end and it discusses how they can be effectively used to improve safety management of aerodrome operations.

Rather than trying to assess probability factors of safety barriers, agent-based Dynamic Risk Modelling (DRM) explicitly represents the processes, variability, dynamics and interactions of human operators and technical systems in runway incursion scenarios¹. Next it uses dedicated computer simulation techniques (the rare event Monte Carlo simulation) to evaluate each particular scenario millions of times, accounting for the variations that exist in the interactions and dynamics of the involved humans and systems. Basically, in these Monte Carlo simulations the frequency of collisions between the aircraft (or vehicle) in each runway incursion scenario is used to estimate the probability of a collision occurring. For instance, the agent-based DRM of a runway incursion scenario between an aircraft taking off and an aircraft taxiing describes the aircraft dynamics during takeoff and taxiing, the situation awareness updating and aircraft manoeuvring actions of the pilots of both aircraft, the situation awareness updating and control actions by the runway controller, the functioning of surveillance and communication systems, the functioning of runway incursion alert systems, the aerodrome infrastructure and the visibility and wind conditions. These models represent the dynamics of these processes, such as the durations of task performance by the human operators, the acceleration of an aircraft during takeoff or the braking action during taxiing or rejected takeoff. The key point is that they also represent variations in these processes, such as the timing of a runway incursion with respect to a conflicting take off, variations in task duration, errors in task performance and system failure modes.

Typical probabilities of a collision in such runway incursion scenarios are in the range of 1 collision per 100 to



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1,000,000 take offs, dependent on the particular context. If we view these collision risk rates from a Safety-II perspective, they show that all but 1 event in up to 1,000,000 runway incursions, a collision is avoided due to the overall performance of the interacting human operators and technical systems in the runway incursion scenario. In agent-based DRM, such reasoning is not just playing with probabilities of events (collision) and opposite events (no collision), but ensuring that the performance variations leading to successful avoidance of a collision are truly reflected in simulation of the socio-technical system. So agent-based DRM is fully compatible with a Safety-II perspective.

Agent-based DRM has provided interesting results on the effectiveness of runway incursion alerting systems as part of A-SMGCS². These results show that in a runway incursion scenario with good visibility and A-SMGCS level 1 (without runway incursion alerts), where pilots are lost and start crossing an active runway without appreciating it, the probability of collision with an aircraft taking-off is about 1 per 5,000 take offs. In the same scenario with A-SMGCS level 2, meaning that

1- Stroeve S H, Blom H A P, Bakker G J. Systemic accident risk assessment in air traffic by Monte Carlo simulation. *Safety Science*. 2009;47:238-49.

2- Stroeve S H, Bakker G J, Blom H A P. Safety risk analysis of runway incursion alert systems in the tower and cockpit by multi-agent systemic accident modelling. 7th USA/Europe Air Traffic Management R&D Seminar, Barcelona, Spain, 2007.

the runway controller is supported by a runway incursion alert system, the collision risk is almost the same as in the A-SMGCS level 1 case. We can deduce that runway incursion alerting systems are not effective in good visibility because the pilots can very often recognise and resolve the conflict before they receive a warning from ATC. In the same scenario with A-SMGCS level 4, where the pilots in both aircraft as well as the controller are supported by their own runway incursion alerting systems, the collision risk is reduced significantly by a factor 2.8. This risk reduction is facilitated by the communication of a direct warning to pilots which is independent of both communication from the controller and any errors in controller clearances. In reduced visibility (with a runway visual range between 400 and 1500 m), very different collision risk results are achieved for this runway incursion scenario at the various A-SMGCS levels. With level 1, the probability of a collision is about 1 per 200 takeoffs, which is 25 times more than in good visibility. A huge increase, since the pilots are far less capable of timely visual recognition of the conflict. In A-SMGCS level 2, the risk is reduced significantly by a factor 3.8 and the ATC alerting is more effective because the visual recognition of the conflict by the pilots is less effective.

In A-SMGCS level 4, the risk is reduced by a factor 31, since the direct warning of the pilots is most effective and to a large extent compensates the lack of timely visual recognition by the pilots.

Apart from the key implications for the value of runway incursion alerting systems, the above results clearly show the non-linear and hard to predict interdependencies between the contributions of the different human operators and technical systems for reduction of the collision risk. Yet, many risk assessment studies use event sequence diagrams (ESDs) or barrier models, which look at the success or failure of the available barriers. My detailed comparison of two risk assessment studies for a same runway incursion scenario, where one study used ESDs and the other study used agent-based DRM, concluded that the collision risk was assessed to be considerably lower in the ESD-based study³. This was attributed to the absence in the ESD-based risk assessment of sufficient consideration of the interdependencies between the risk reduction contributions of the pilots, controller and runway incursion alerting system.

Another of my studies⁴ has concluded that the results of agent-based DRM can be effectively used to strengthen safety management in aerodrome operations. This study noted that current severity categories (A,B,C,D,E)

for runway incursions are based upon the outcomes of these events, in particular on the closest distance attained. This closest distance attained depends to a considerable extent on uncontrolled random circumstances, such as another aircraft being nearby at the time of the initiation of the runway incursion. In incursions that are judged as being less severe (C, D) typically the same types of errors or misunderstandings by pilots or controllers lead to initiation of runway incursions and the distinction with more severe (A, B) cases is primarily due to some uncontrolled circumstances. Lessons from incursions with less severe (C, D) outcomes may be undervalued and there may be an overreaction to severe (A, B) outcomes. It is proposed that the analysis of runway incursion events should not use an outcome-based severity category, but one which is strictly based on the collision risk of scenarios associated with runway incursions. It is shown that these collision risks for large sets of runway incursion scenarios can be effectively attained by agent-based DRM. **S**

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- 3- Stroeve S H, Blom H A P, Bakker G J. Contrasting safety assessments of a runway incursion scenario: Event sequence analysis versus multi-agent dynamic risk modelling. *Reliability Engineering & System Safety*. 2013;109:133-49
- 4- Stroeve S H, Som P, van Doorn B A, Bakker G J. Strengthening air traffic safety management by moving from outcome-based towards risk-based evaluation of runway incursions. *Reliability Engineering & System Safety*. 2016;147:93-108.





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A COLLABORATIVE APPROACH TO IMPROVING AIRSIDE CLEARANCE COMPLIANCE

by Davy van Hyfte

Problem Definition

During 2015, Brussels Airport recorded cases of aircraft:

- lining up on the wrong runway from taxiways W41 and W42 (25R instead 19 or vice versa)
- mistaking taxiway C6 for taxiways INN or Z

Safety Reports were also filed by pilots about misleading or absent taxiway signage which they felt had – or could have – contributed to failure to taxi as cleared:

- at the junction of taxiways R4, S, M and INN
- as a result of mistaking taxiway C6 for taxiways INN or Z

The absence of specific ICAO-compliant signage to indicate the TORA for intersection take offs from 07R at taxiway C6, from 25L at taxiway C1, from 07L at taxiway B9 and from 25R at taxiway B5 was also noted.

Starting with this knowledge on the risk of aircraft not following the taxi clearances given to them, the Brussels Airport operator organised a formal consultation through members of the Local Runway Safety Team (LRST). To complete the picture, a LRST 'walk round' was held with the aim of identifying any other potentially hazardous or confusing elements of the exiting taxiway network that could also lead to misrouting or even runway incursions. An additional perspective was added through the holding of a brainstorming session involving the workers responsible for maintaining the taxiway infrastructure – people who operate on the manoeuvring area on a daily basis. The question for the session was "predict your next involvement in a hazardous situation or incursion". This collaborative effort led to proposals for modest changes to the design of taxiway infrastructure, signs or markings, which were implemented..

Action Taken

- Modification of Mandatory Instruction signs on W41 and W42 by phasing out the runway 19 sign at height of the runway holding position CAT I/II/III (Platform 3)



- Addition of an Information Sign to Taxiway Z to the existing signs at the southern end of taxiways INNER and OUTER 10

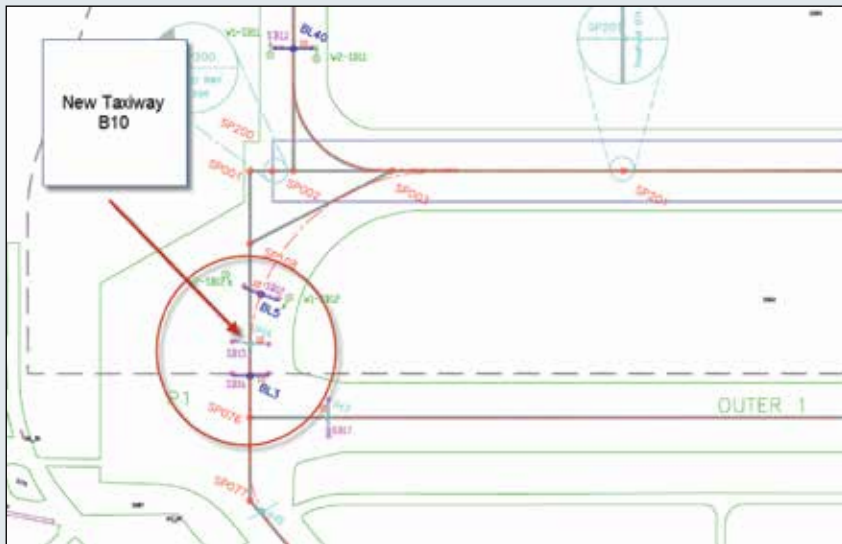




DAVY VAN HYFTE

started his aviation career as a military air traffic controller. He gained experience as a Tower, Approach and Area controller and participated in overseas missions too. For the past six years, he has been Safety Development Manager at the Brussels Airport Safety Management Unit and is involved in auditing, incident investigation and human factors.

- Creating a new TWY named B10 together with corresponding signage, markings and lighting



- Changing the Information signage from taxiway INNER 8 to taxiways S, R4 & M




- Adding TORA indicator signs at taxiways B5, B9, C1 and C6

All of these changes were subject to a full 'Change Case' and Belgian CAA approval under the provisions of aerodrome certification. This included reference to the effect on the following stakeholders:

- The Airport Operating Company
- Aircraft operators
- Ground handling Service Providers performing aircraft towing
- The ANSP

Working groups were used to deal with specific topics – Aeronautical Information Publication, Airside Works and Airside Operations – through the LRST.

Both the financial and human resources required for the successful implementation of these changes required a full report to the Airport Safety Board which in turn reports performance and actions to the Airport's Accountable Manager and Board of Shareholders.

It is considered that the implementation of proposals derived from the comprehensive collaborative process described will lead to a higher level of taxiway and runway safety at Brussels. 

PREVENTING RUNWAY INCURSIONS WITH ENHANCED AIRFIELD GEOMETRY

by Gaël Le Bris

As advanced systems for preventing runway incursions and collisions have been introduced in the past few years such as the Runway Status Lights (RWSL)¹, we should not forget the fundamentals. A proper configuration of the taxiways in the vicinity of the runway, a simple and clear taxiway naming system and effective aerodrome signage are all key elements in reducing the likelihood of one aircraft entering a runway which could already be occupied by another². As stated in Recommendation 1.2.12 in the European Action Plan for the Prevention of Runway Incursions (EAPPRI)³, "new aerodrome infrastructure and changes to existing infrastructure should be designed to prevent runway incursions".

A fatal accident at Paris-CDG in May 2000 led to major infrastructure improvements. A MD83 on its takeoff roll on runway 27 at night collided with a Shorts 330 that had entered the same runway from a 09 Rapid Exit Taxiway (RET)⁴,⁵.

The MD83 was cleared to taxi along taxiway 19 (current taxiway Q4) to make a full length takeoff on runway 27 (since re-designated as runway 27L) while at the same time, a Shorts 330 was cleared to taxi to taxiway 16 (since re-designated as Y5). At this time, Rapid Exit Taxiways (RETs) were also used as intermediate access taxiways - 90° access taxiways were only introduced a few months after

this accident, when the outer runways 09L/27R and then 08R/26L were opened.

The MD83 was cleared to line up and takeoff and the Shorts 330 to line up and wait "number two". The investigation found that the controller thought both aircraft were taking off from the full length when clearing them to line up in turn. As the MD83 began to accelerate, the Shorts 330 entered the runway further along having assumed that the aircraft which had just passed them was the "No 1" taking off when in fact it was a landing aircraft. As the MD83 approached the taxiway 16 intersection and its crew saw the other aircraft, it was already beyond V1

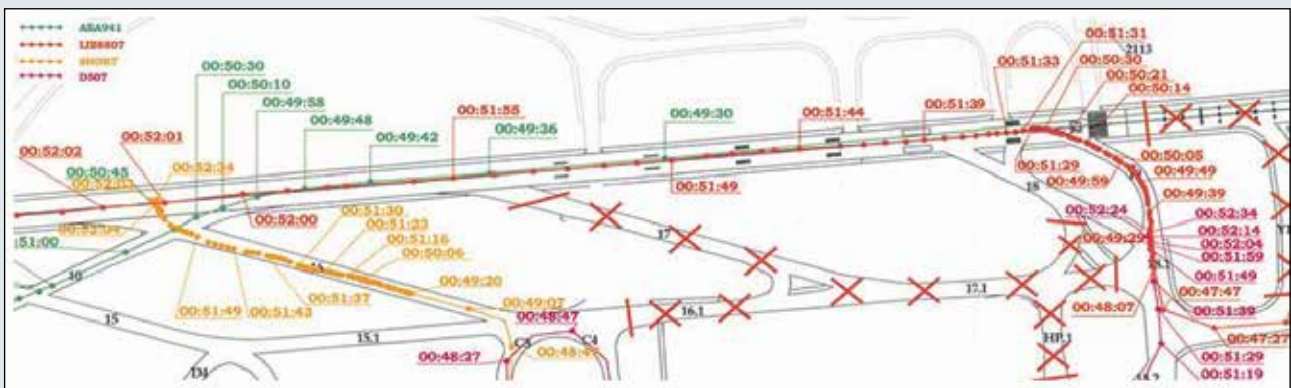


Figure 1 – Tracks of the two aircraft which collided on 25 May 2000

- 1- [http://www.skybrary.aero/index.php/Runway_Status_Lights_\(RWSL\)](http://www.skybrary.aero/index.php/Runway_Status_Lights_(RWSL))
- 2- http://www.skybrary.aero/index.php/Runway_Incursion_and_Airport_Design
- 3- <http://www.skybrary.aero/bookshelf/books/151.pdf>
- 4- http://www.skybrary.aero/index.php/SH33/_MD83,_Paris,_CDG,_France,_2000
- 5- Runway Incursion, HindSight Magazine No 1, January 2005, EUROCONTROL pp. 7-9, <http://www.skybrary.aero/bookshelf/books/23.pdf>

and impossible to stop their aircraft before reaching the Shorts 330. The MD83 left wingtip went through the flight deck of the Shorts 330, killing the Co-pilot and seriously injuring the Pilot.

The Final Investigation Report of the BEA (the French Accident and Incident Investigation Board), gave the 'Probable Causes' of the accident as the TWR controller's erroneous perception of the position of the aircraft (reinforced by the prevailing context and working methods) which led him to clear the Shorts 330 to line up, the inadequacy of systematic verification procedures which made impossible for the error to be corrected and the crew of the Shorts not dispelling any doubts they had as to the position of the "number one" aircraft before entering the runway. One of six 'Contributory Factors' also identified was "the angle between access taxiway 16 and the runway which made it impossible for the Shorts 330 crew to perform a visual check before entering the runway".

After the accident, the Air Traffic Control Tower (ATCT) decided to ban line ups from any RET⁶.

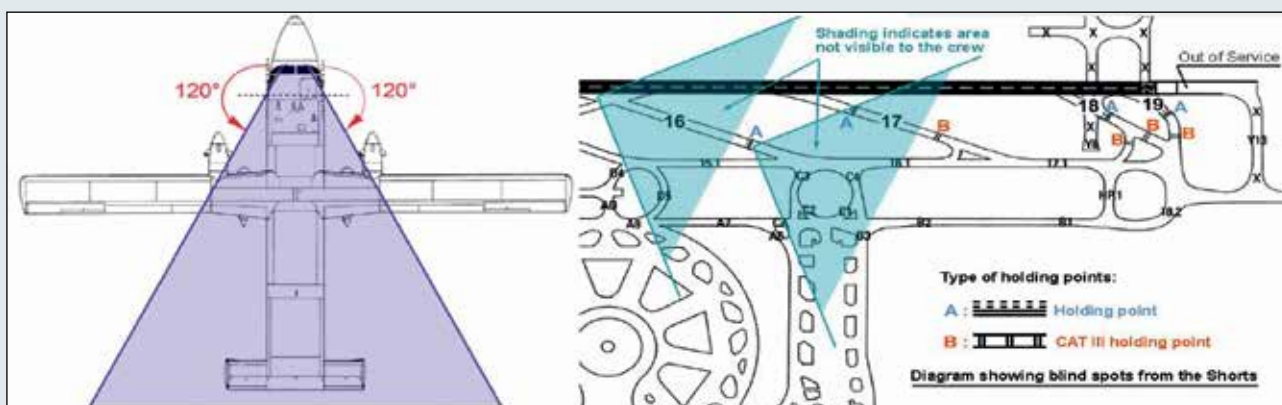


Figure 2 – The sector invisible from a Shorts 330 flight deck when entering from a RET

This rule is since then strictly applied by both the airport operator (Groupe ADP) and the ATCT, even during construction projects where an alleviation could help maintain runway capacity.

This accident was also one of the influences on a large scale taxiway reconfiguration project around Threshold 08L. Between 2011 and 2014, more than 3 hectares of taxiways were reconfigured. While this work was not wholly motivated by runway safety concerns, one of its objectives was to help prevent an accident similar to the collision of May 2000. The threshold area of southern runway 08L was the only one not reconfigured with 90° access taxiways at that time. Taxiways W1 (now T1), WB (now T2), W1 (no longer exists) and the original W2 (now W1) all retained an acute angle recognised as conducive to hazardous runway entry.

Improving an existing airfield infrastructure

These four access taxiways were historically used to queue aircraft near to runway access points to maximise outbound traffic during peak times because of uncertainty about the time it would take aircraft to get from pushback clearance to 'ready-to-line-up'. This uncertainty has now been mostly resolved by the Collaborative Pre-Departure Sequencer (CPDS), component of the local A-CDM (Airport Collaborative Decision Making) in place "CDM@CDG"⁷,⁸. This system reliably estimates taxi times so that departing aircraft can hold on their stand instead of consuming fuel waiting in a queue near the runway threshold.



Figure 3 – Taxiway configuration around the runway 08L threshold circa 2005

6- With the exceptions of the Spiral Rapid Exit Taxiways (S-RET) V2, V7, Z2 and Z7 on the outer runways 09L/27R and 08R/26L. These taxiways are the second from the threshold, their layout is a non-standard spiral and it is still possible to see the first taxiway entrance until arriving on the runway itself.

7- [http://www.skybrary.aero/index.php/Airport_Collaborative_Decision_Making_\(A-CDM\)](http://www.skybrary.aero/index.php/Airport_Collaborative_Decision_Making_(A-CDM))

8- <https://www.cdmparis.net/Pages/CONCEPT.aspx>

It was therefore decided to redesign this area. The changes took place over a 4 year period and introduced a new 90° access (T3) and made the other main access taxiways (current T2 to T6) straight or straighter. They also improved the intersections around the former "KILO loop", preventing confusions between taxiways W1 (ex-W2) and TANGO when turning counter clockwise on the loop.

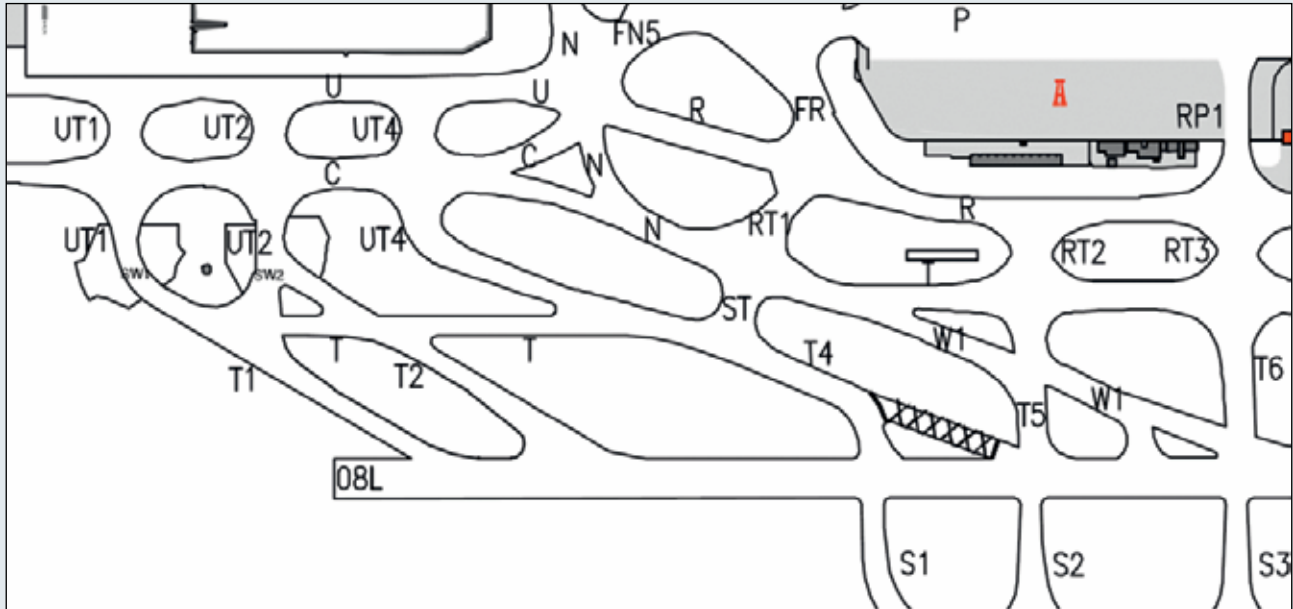


Figure 4 – Configuration of Threshold 08L in 2011 before the construction works
Note the closure of the angled access between T4 and T5 (ex-W1)

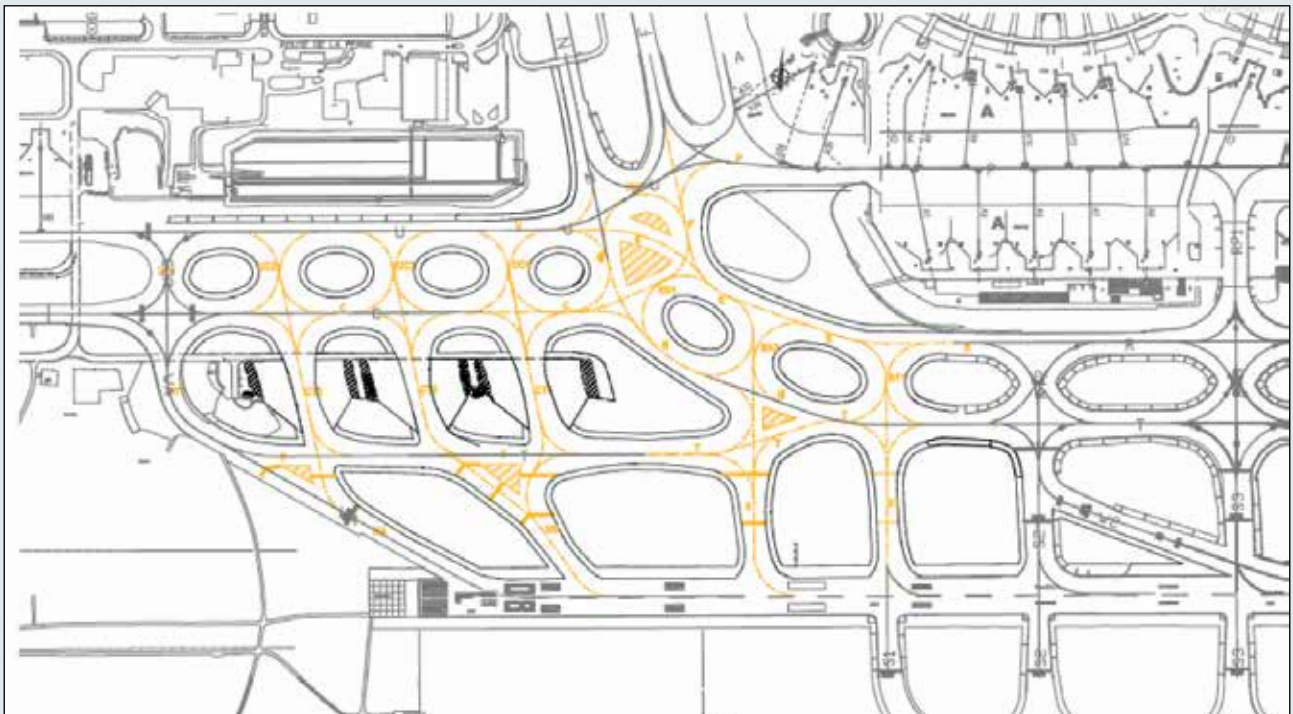


Figure 5 – Configuration of Threshold 08L in 2014 after the construction works

Due to the topography, it was decided that it was not practical to make taxiway T2 a 90° access without compromising the longitudinal slope and the connections from de-icing pads SW1 and SW2. But it was realigned to increase its angle to the runway from 30° to approximately 55° to make a pre-entry visual check of the 08L approach by pilots practicable.

The final configuration of these access taxiways left 'islands' between taxiway TANGO and taxiways T1 and T2. The main concern was reduce the risk of an aircraft taxiing in the middle not seeing the CAT III stop bar or misunderstanding of the switching off of the entire bar if two aircraft were holding the CAT III holding position at the same time. After considering and consulting on different options with the airside community (e.g. LRST), it was decided to remove the marking and lighting of the holding position between the two entries to T1 and T2 and in both cases to extend the unavailable area markings (yellow hatching) as far as practicable (option N°2). The paths were delineated with blue taxiway edge lights. This final configuration is similar to FAA practices for islands between multiple runway entrances⁹.

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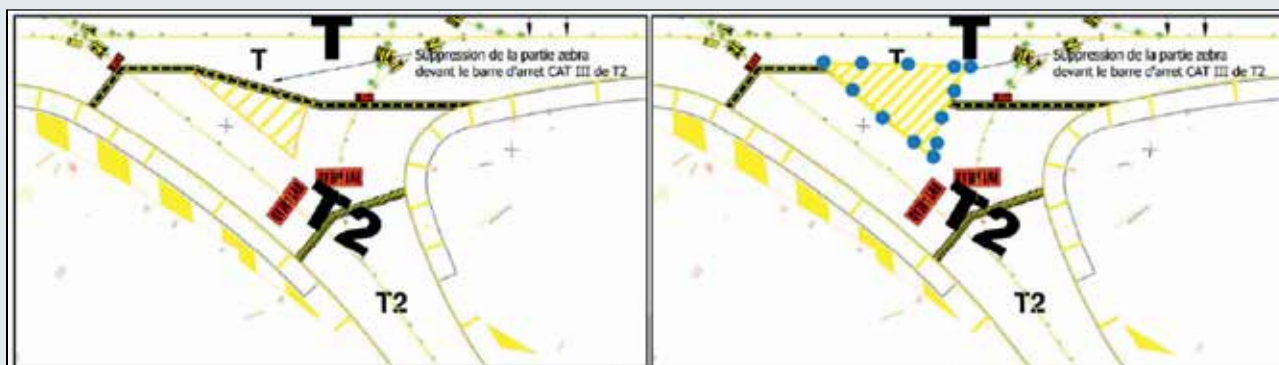


Figure 6 – Project for taxiway T2 (option n°1 on the left / option n°2 on the right)

Simple is beautiful...

Taxiway designations can either reduce runway incursion risks in an existing infrastructure, or they can contribute to the efficiency of a brand new runway. Simple aerodrome layout must be supported by a simple taxiway naming system which is effective in terms of both safety and operational efficiency. The ICAO, FAA and IFALPA have produced guidance and recommendations on this matter and a case study on their application at Paris-CDG was published in HindSight N°21¹⁰.

The most important rules for taxiway naming relevant to the prevention of runway incursions are to:

- use a different set of letters for 90° runway access taxiways and RETs,
- avoid including the number of the closest runway threshold in the designation of access taxiways,
- use different letters for the taxiways on each side of a runway,
- use different numbers (and letters) when a taxiway crosses a runway.

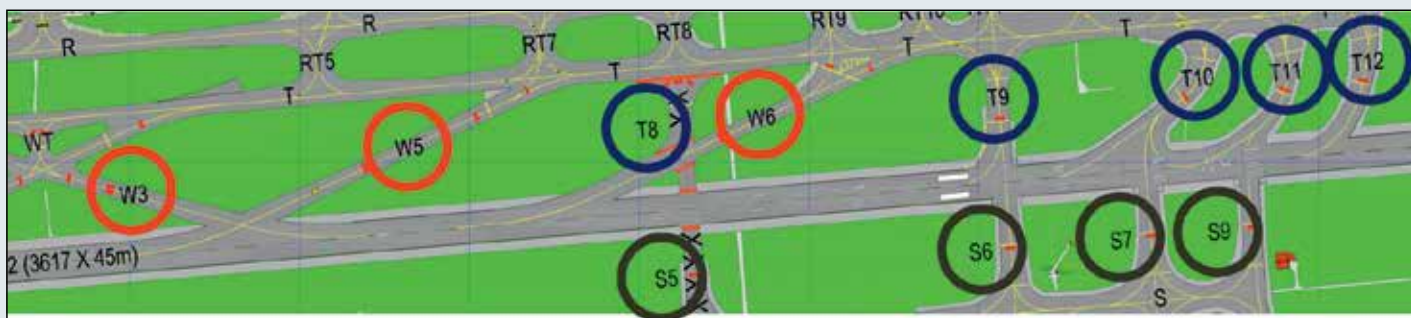


Figure 7 – Taxiway naming system around runway 08L/26R

9- Airport Design, Advisory Circular 150/5300-13A, Section 410, FAA, September 2012, p. 148

10- Le Bris G. and Kintzler M., How to design a simple, safe and efficient taxiway designation system, HindSight Magazine N°21, EUROCONTROL, Summer 2015, pps. 84-88
<http://www.skybrary.aero/bookshelf/books/3088.pdf>



Figure 8 – Temporary information signage at Paris-CDG and Paris-Orly

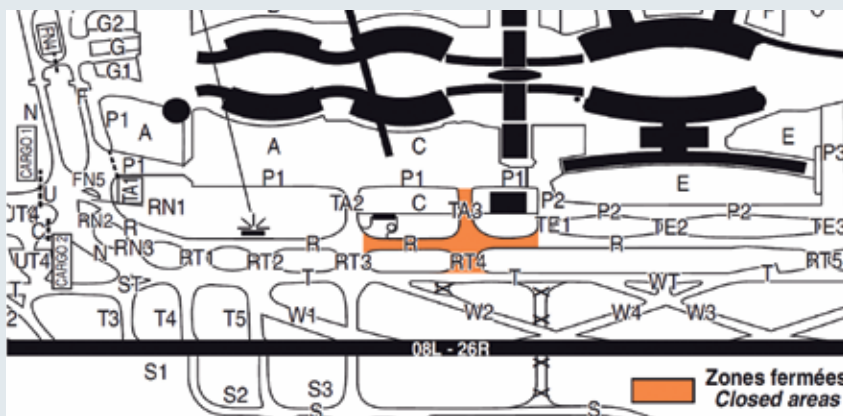


Figure 9 – Rehabilitation of taxiway ROMEO in 2015

Mind the gap... Construction Ahead!

From a pilot and air traffic controller perspective, aerodrome layout should be carefully considered when preparing for a construction project which will modify taxi routings and may increase existing runway incursion and collision risks or create new ones. At Paris-CDG, the rehabilitation of taxiway ROMEO south of apron CHARLIE during the autumn of 2015 raised concerns about the potential for runway incursion via RET W2 by aircraft taxiing east around the closed section of the taxiway on taxiway TANGO (see the illustrations above). Controllers were informed about this risk and the Orange Construction Signage (OCS) jointly developed by the FAA and Paris-CDG for this purpose¹¹ was used to increase pilots' situational awareness. Since 2014, this signage has been deployed at various airports in both the United States and Europe.

The concern about this risk had been founded on a previous incident in October 2007 when a Boeing 747 which had just landed on runway 09L and crossed runway 09R then turned onto RET Y6 from taxiway Q2 instead of continuing as cleared on taxiway QUEBEC.

Usual routing
Modified routing
Risk of mirouting

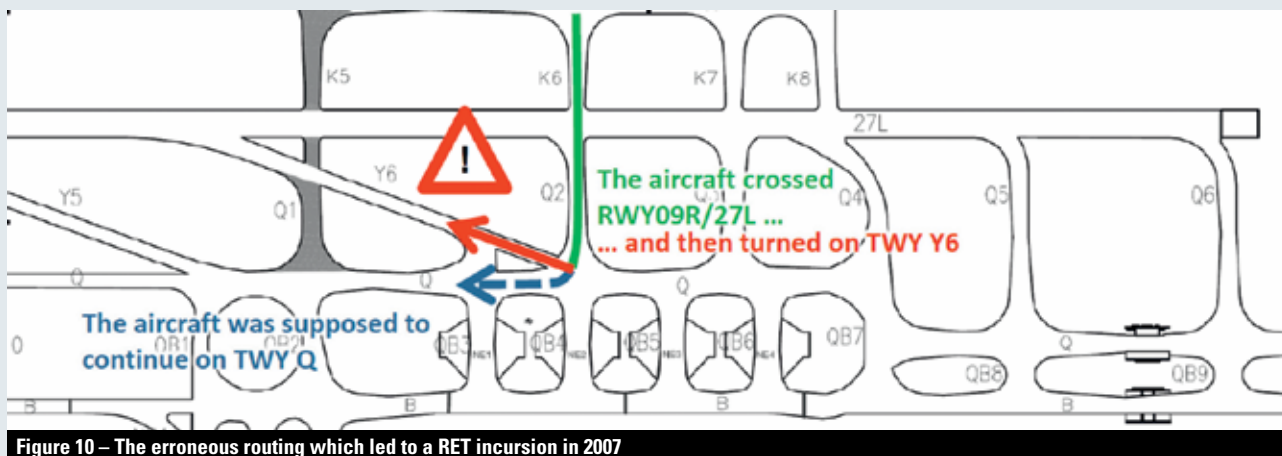


Figure 10 – The erroneous routing which led to a RET incursion in 2007

11- Le Bris G., Siewert D. and Berlucchi R., Enhanced airfield signage to improve situational awareness in the vicinity of aerodrome construction works, HindSight Magazine N°23, EUROCONTROL, Summer 2016, <http://www.skybrary.aero/bookshelf/books/3470.pdf>

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RUNWAY INCURSION AND AIRPORT DESIGN

Introduction

Recommendation 1.2.12 from the European Action Plan for the Prevention of Runway Incursions states:

"new aerodrome infrastructure and changes to existing infrastructure should be designed to prevent runway incursions"

Poor infrastructure design has contributed to the quantity and severity of previous runway incursions. Good aerodrome design can directly reduce the potential for runway incursions whilst maintaining operating efficiency and aerodrome capacity.

The design principles suggested in this guidance material can be applied to new aerodrome infrastructure and changes to existing infrastructure. Enhancement to existing infrastructure may be especially effective at hot spots i.e. areas vulnerable to ground navigation errors which may lead to runway incursions, wrong runway selection, taxiways mistakenly used as runways.

Whatever the infrastructure, it should be easy to understand and so minimize the potential for pilot and manoeuvring area vehicle driver distraction or confusion.

Aerodrome Design Principles – Taxiways

Entry

Flight crews need an unobstructed view of the runway, in both directions, to confirm that the runway and approach is clear of conflicting traffic before proceeding to enter or line up. To achieve this clear view, runway entrances should be at right angles to a runway.

Where the aerodrome has more than one runway, ensure that runway ends are clearly identified as separated. This may be achieved through visual aids or taxiway design.

Use standard taxiway widths, suitable for a wide range of aircraft, including the largest type expected to use the aerodrome. Wide (non standard) taxiway entrances reduce the effectiveness of signs and markings as aids to prevent ground navigation error and wrong runway selection. Use islands or barriers to avoid disorientation at large expanses of pavement. In order to visually round or limit the runway surface, another solution is to apply green artificial turf to the surface pavement, which will blend in with surrounding grass areas.

Locating an elevated lighted X at the prethreshold area of the taxiway is a simple way to provide a clear signal to pilots on approach that the area is closed and is not safe for landing. In a situation where there is no room for an elevated lighted X, a lighted X can be imbedded in the pavement.

Crossing

Avoid designs that include crossing a runway to access a taxiway or another part of the aerodrome. Limiting the number of aircraft crossing an active runway can be achieved through the use of perimeter taxiways. Perimeter taxiways (that run around the runway ends) avoid aircraft having to cross a runway. perimeter taxiways can reduce runway occupancy times, taxi times and congestion on the manoeuvring area, as the time taken to cross a busy runway can be considerable.

Sufficient space is required between the landing threshold and the taxiway centreline where it crosses under the approach path, to enable the largest aircraft to pass under the approach without violating the approach surface. The requirement for Runway End Safety Areas, and possible interference with the ILS should also be taken into account. The perimeter taxiway should route traffic behind the localiser antenna, not between the localiser antenna and the runway, due to the potential for severe ILS disturbance, noting that this is harder to achieve as the distance between the localiser and the runway increases. Perimeter roads should also be provided for vehicles wherever possible.

Where perimeter taxiways and roadways are not possible, intersections used for crossing a runway, should be perpendicular to the runway. This will allow flight crew an unobstructed view of the runway, in both directions, to confirm that the runway and approach is clear of conflicting traffic before proceeding to cross that runway. Avoid using mid-runway (high energy) crossing points, because the departing aircraft has too much energy to stop, but not enough speed to take-off. Taxiway fillets should be used to allow the aircraft to be perpendicular to the runway, thereby assuring clear line of sight to the runway ends.

If runway crossing cannot be avoided then minimise the potential for runway entry at an unintended location by providing only essential entrances. It is important to have a consistent design of runway entrances and exits with the same ICAO compliant format for visual aids at each taxiway to ease navigation on the ground. Multiple taxiway entrances at one location, e.g. y-shaped connectors present opportunities for ground navigation errors such as runway incursions and for aircraft vacating one runway to enter a wrong taxiway or a different runway. Limiting the options available to pilots on each entrance or exit helps to avoid runway confusion.

Exit

Rapid exit taxiways (RET) are designed to be runway exits only. The geometry of the taxiway/runway intersection of a rapid exit taxiway does not allow the crew to see the runway is clear of conflicting or other traffic in both directions. No Entry signs should be used to avoid aircraft entering the runway via a rapid exit taxiway.

Where possible, do not mix high speed (RET) and taxi speed runway exits. if RETs are provided, have a series of RETs without interruption by other taxiway, entrances or exits. Avoid a crossing runway in between exit taxiways. RETs should be of sufficient length to be effective in allowing the aircraft to slow to an appropriate taxi speed and should terminate onto a parallel taxiway. RETs should not terminate directly on to a parallel runway. Runway/taxiway separations must be sufficient to permit space for effective RETs.

Exit taxiways should be long enough to assure an aircraft has adequately vacated the runway according to the category of operations and is clear of the ILS.

Other

The use of runways as taxiways should be avoided. if necessary, design out runway incursion hot spots.

When practicable, permanently disused taxiways and roadways should be removed to prevent ground navigation error. If left in place, the taxiway must be closed with ICAO compliant markings, signs and lighting and correctly shown and identified for navigation purposes on the aerodrome map/chart.

The air traffic Control tower should be located such that it has good visibility of surface movements of aircraft and vehicles, without any visual restrictions.

Avoid designs that lead to backtrack operations for aircraft prior to take-off or after landing. Taxiways that are parallel to the runway minimize the time aircraft (and also vehicles) stay on the runway, so are a key element for safety and efficiency.

Aerodrome Infrastructure Naming Convention

Where possible, taxiways should be designated in a logical manner that is instinctive to pilots and manoeuvring area vehicle drivers. Different taxiways on the same aerodrome should not have the same or similar designations.

Connecting taxiways (links between major traffic routes) should be designated in such a way that they cannot be mistaken as taxiways that connect to a runway. Those

taxiways that connect to the runway should be clearly designated. The naming of taxiways should follow ICAO recommendations.

Aerodrome Signs, Marking And Lighting

Ensure signs, marking and lighting, conform to ICAO Annex 14. The visual aids must be clear, in good condition and correctly located. All visual aids must be visible to the pilot and driver from their respective aircraft type and vehicle type, from the angle of their approach to the visual aid in question e.g. stop bars that protect the runway.

Consider the benefits of using technology as a safety net to provide immediate and simultaneous runway and traffic proximity alerts for pilots, air traffic controllers and manoeuvring area vehicles to help to protect the runway.

Stop bars and runway guard lights that protect the runway should be ICAO compliant. Consider using stop bars and runway guard lights at all runway/taxiway intersections under all weather conditions (24 hours a day) to help prevent runway incursions. Manage the length of time the stop bar is extinguished to ensure that aircraft and vehicles have crossed them prior to their re-illumination.

Manage the length of time stop bars are extinguished when conditional clearances are in use to avoid the incorrect presence of a second aircraft or other traffic on the runway.

Consider the use of LED lighting as they give superior luminance.

Lighting systems that provide taxiway routing guidance are considered beneficial to navigating on the ground by pilots.

The installation of omnidirectional runway end identifier lights (REILs) and replacement of unidirectional REILs would be an additional enhancement for the runway environment.

Aerodrome Operations

Flight crews and manoeuvring area vehicle drivers should not be instructed to cross illuminated red stop bars. In the event of stop bars failing in the illuminated state, appropriate contingency procedures are required, such as the use of alternative runway entry or crossing points, etc.

Stop bars that protect the runway should be individually selectable by the runway controller and co-located with the working position.

All access to a runway requires a specific ATC clearance to enter or cross the runway, regardless of whether the runway is active or not. An extinguished stop bar, or any other red light, is not a clearance to enter or cross a runway.

When warning systems can be installed, such as within a surface movement guidance control system (A-SMGCS),

they should provide aural (word) warnings, not just sounds, when practicable. All staff working on the manoeuvring area should carry an up-to-date airport map/chart, including hot spots, to ensure awareness of areas that may be difficult to navigate correctly.

Work in Progress

When planning and carrying out work in progress on the manoeuvring area the aerodrome operator should:

Ensure in the design stage that the changed layout does not increase the likelihood of runway incursions;

Ensure that the layout changes are published in the AIP, NOTAMs or ATIS and local airfield notices in a timely fashion as appropriate;

Ensure that the airfield signs, lights and markings are altered to reflect the changed layout;

Ensure that air traffic control are aware of the changes;

Ensure that the ground lighting and any associated control software are altered to reflect the new layout e.g. availability of green taxiway centre line lights linked to an unserviceable stop bar should not occur.

Related Articles

- Parallel Runway Operation
- Surface Movement Radar
- Taxi-in Runway Incursions
- Runway Status Lights (RWSL)

Further Reading

- European Action Plan for the Prevention of Runway Incursions (Edition 2.0). Appendix K: "Aerodrome Design Guidance for the Prevention of Runway Incursions"
- An example of a clearly written and unambiguous Aerodrome Manual: Manchester UK – 2013 Aerodrome Manual, version 3
- FAA Engineering Brief No. 89 Taxiway Nomenclature Convention, 2012
- UK CAA CAP 1069 'Preventing runway incursions at small aerodromes'
- Identification Techniques to Reduce Confusion Between Taxiways and Adjacent Runways, J. W. Patterson, Jr., R. N. Frierson, September 2007.
- Engineering Brief No. 72A – Positive Identification Of Runways For Landing, FAA, November 2007.

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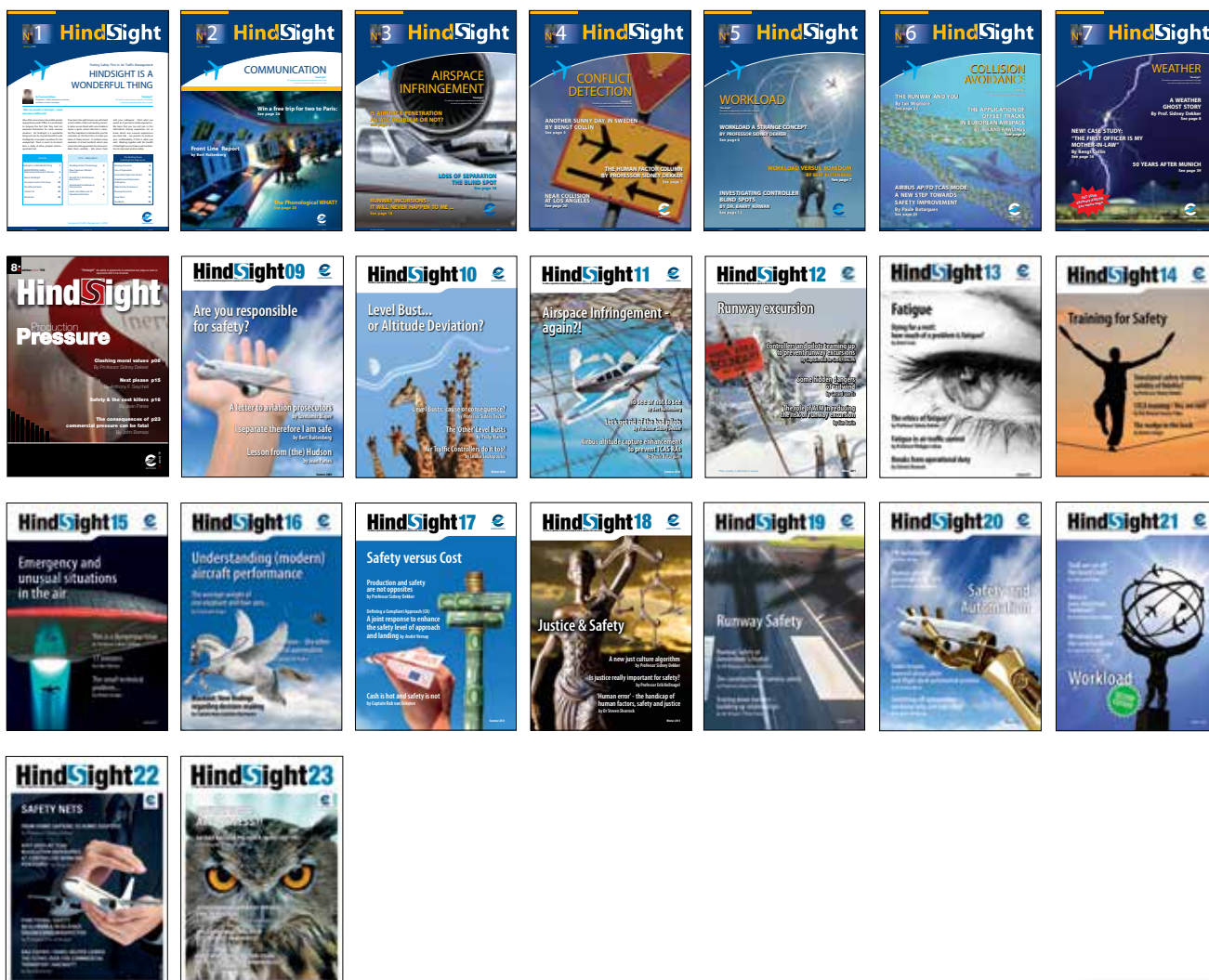


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In the next issue of HindSight: **"Work as imagined versus Work as done"**



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