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"Hindsight" the ability or opportunity to understand and judge an event or experience after it has occurred.

# HindSight

## Production Pressure



EUROCONTROL
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## Coding of Subject Matter

To help identification of subject matter, each article is coded and marked by a coloured icon which appears at its head


**Loss of Separation**


**Level Bust**


**Runway Incursion**


**Controlled Flight into Terrain**


**Airspace Infringement**


**Wake Vortex Turbulence**


**Human Factors**


**Air ground Communication**


**General**

# Food for thought

## while waiting in the queue

Do you like standing in a queue, waiting for your turn? Sure some people do, but not the majority of us.

Queues are everywhere - roads, supermarkets, career development tracks...You'd better know the dynamics of the queues and always have some nice back-up thoughts to fill in the waiting time, otherwise you'll be totally lost.

Here, I am going to propose to you some thoughts you can keep in mind for the next time you are waiting in a queue, when time seems like it's totally stopped.

Air Traffic Controllers use various resources like brainpower (they really do!), attention, articulation, equipment and procedures to "work-out" the traffic passing through the airspace they control. The resources are limited and not surprisingly, when the number of aircraft to be served exceeds the capacity, the waiting time grows very rapidly.

What often surprises people, however, is that the waiting time in many real-world queues increases substantially even when total capacity is not being used. In fact the relationship between waiting time and utilisation is not linear: Queuing theory (this theory really exists and a lot of people make money out of it) has shown that the waiting time gradually increases until a resource is utilised around 70%. In this case the resources are critically strained; the length of the delays surge; the chance of errors increases, and safety can be compromised.

It seems like a no-win situation for managers - either they use the resources up to 70% and explain to the "stakeholders" why they are not that "cost-efficient", or they take the risk and press the system to migrate into more efficient but very unstable business models. Unstable, in the sense that the inadvertent combination of some other "small" variations in human performance, traffic or the weather situation, can have a disproportionately "big" snow-ball effect, dangerously overloading the ATC "production".

This edition of HindSight will not pretend to come up with magic solutions to solve the production pressure dilemma. We will rather try to point out the problem and with the help of our very qualified authors explore different facets of it.

One can either have (1) traffic arranged ready for "production" by the Air Traffic Controller and achieve the maximum efficient use of ATC resources or (2) more freedom when and how to fly in real time, paying for some reserve resources to manage the side effects of this freedom. The third option, not mentioned above, is to be avoided!

Does anyone know a win-win solution for this managers' dilemma?

Share it with us!

Tzvetomir Blajev

Eurocontrol Coordinator,
Safety Improvement Initiatives &
Editor in Chief of HindSight

# Safety
## as we see it

### a picture is worth a thousand words.

They say that “a picture is worth a thousand words”, meaning that complex stories can often be described with just a single image, and that that image may have more impact than a written story. A glance at Page15 makes this point clear: the all too familiar picture of the aircraft queuing for take-off underlines the potential conflict between the need to optimise runway usage and the danger of reducing aircraft separation.

Anthony Seychell’s article Wake Turbulence is the first of what we plan will become a regular feature of HindSight: authors will write articles illustrated by one or more pictures which portray graphically important aspects of Safety – as we see it.

We hope you get the picture!

# Safety
## Alerts 121.5

The HindSight Editorial Team was impressed by the large number and high quality of contributions to this edition. However, this caused a problem because the physical size of the magazine was too big! We considered removing one or two articles but could not decide between them and eventually agreed that the correct choice was to make space in another way.

Accordingly, the Safety Alert section has been left out of this edition of HindSight; though we do intend to include it in future editions.

**All current safety alerts may be viewed on the EUROCONTROL Safety Alert web-site, or in Skybrary at:**

http://www.skybrary.aero/index.php/Category:EUROCONTROL_Safety_Alerts




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# Are we too good?

## By Bert Ruitenberg

**Bert Ruitenberg** is a TWR/APP controller, supervisor and ATC safety officer at Schiphol Airport, Amsterdam, The Netherlands. He is the Human Factors Specialist for IFATCA and also a consultant to the ICAO Flight Safety and Human Factors Programme.

As air traffic controllers we provide a service. Some of us may feel we provide that service to airlines, others may think we provide it to pilots. There may even be a group of us who think that airline passengers are the true beneficiaries of the service we provide. Yet no matter to which of the mentioned categories air traffic controllers provide their services, we all take great pride in our job and we all try to provide the best possible service at all times.

Examples of how this personal pride translates to what our clients can notice include the offering of shortcuts (direct routings) in the air or (during taxiing) on the ground, the offering of alternative runways for departure or landing, and even offering the use of a single runway in the opposite direction to the one active at that time.

Our reasons for offering those "goodies" to pilots are usually not selfish: we genuinely think we're doing the pilots a favour by giving them the option we offer. It could reduce the distance between their parking place and the runway, so it might save them a couple of minutes of taxi time. It might get them airborne a minute or so earlier, or save them a minute or two of flying time. Wasn't it IATA (the International Air Transport Association) who sent out an appeal a few years ago to air traffic controllers to try and shave off 1 minute of flight time for every flight they handled, in order to achieve a significant cost reduction for their member airlines? Therefore the kind of "micro improvement" we're sometimes able to offer to individual flights must be important to our customers!

But are we really doing pilots a favour when we offer them such micro-improvement alternatives, especially when this is done at short notice?
And that the notice time is (really) short almost goes without saying: we see an opportunity for a micro-improvement develop, we immediately put it to a pilot as an option.

This "real time" modification of existing (and understood) plans[1] of pilots used to be fine in the days when aircraft were analogue machines that were operated by manual control inputs of the pilots. But those days are gone: aircraft nowadays are complex digital machines, operated by computer systems that are managed by the pilots.

To put it simply, in the old days a "real time" change-of-plan usually didn't require many changes to the aircraft configuration – it just was necessary for the pilots to understand the change and carry it out. Today however almost any "real time" change requires an update of the FMS – in addition to having to understand the change the pilots must also re-program the aircraft in order to be able to accommodate it. This potentially adds to the workload of the pilots at a time when they least need it, i.e. just before takeoff or landing.

[1] *"mental model"*

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In order to illustrate the scope of this issue I'd like to introduce Archie. Archie is the nickname given to the LOSA Archive by its creators, Dr. James Klinect and his team at the LOSA Collaborative (from the University of Texas, Austin, Texas). And LOSA is the acronym for Line Operations Safety Audit, an airline safety programme to monitor safety in normal operations that is endorsed by ICAO.

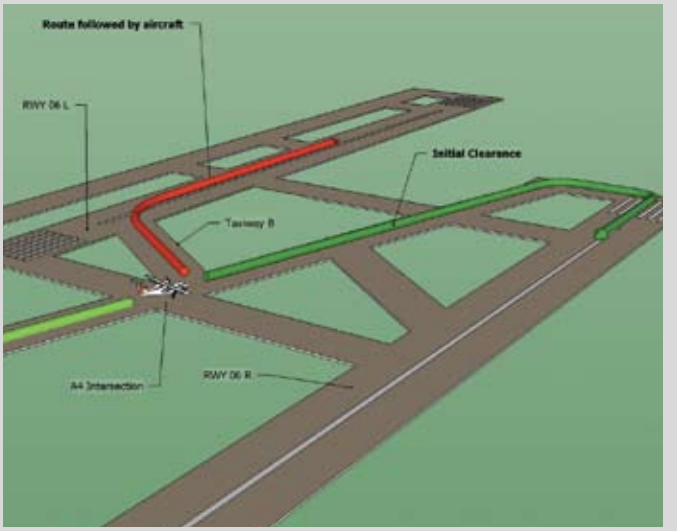
At the time of writing Archie comprises records of 6439 observations during commercial flight operations of more than 25 participating airlines (large and small, from all regions of the world). It is important to realise that by definition these records represent 6439 "normal" flights, i.e. flights during which no reportable safety incident occurred – successful operations from point A to point B, if you like.

In Archie's data a late runway change is identified as an "ATC threat to the flight crew[2]" in 843 of the 6439 observations. That is in 13% of the flights - which means that on average one in every eight flights faces a late runway change.

One in every eight! And Archie has more to tell us: of the late runway changes, 39% occur after pushback and 61% occur late in the descent or approach (i.e. below FL200, including multiple runway changes after Top of Descent).

Yet these figures don't say much by themselves, other than maybe underscoring the statement about air traffic controllers trying to provide the best possible service at all times, earlier in this article. But Archie goes on: of the 843 late runway changes 17% were mismanaged by the flight crews, which means the flight crew committed one or more errors that are linked to the ATC threat of a late runway change. This makes "late runway change" the most often mismanaged threat in the LOSA Archive - other mismanaged threats average around 10-12%. Here's an example of an observation narrative from Archie:

## **Helping too much** an example




The aircraft was late off blocks and was close to slot time

The aircraft was instructed to taxi via taxiway A for departure from Rnwy 24L

Surface wind was 150/04 Kts

As the aircraft passed point A4 (where the red line begins) the controller offered taxiway B for departure on Rnwy 06L

The aircraft entered taxiway B and took off on Rnwy 06L without clearance

*After takeoff briefing had finished, rwy changed to 16R from 34L. So Pilot 2 changed FMS setting and Pilot 1 checked the reverse side SID chart (16R) and set proper course and altitude on Mode Control Panel, but didn't change the HDG selector from 336 to 156.*

Remember that the percentages mentioned above relate to "normal flight operations" without reportable safety incidents. The flight crews that had the 17% mismanaged late runway changes must therefore have been able to successfully manage their errors, otherwise their flights wouldn't be included in Archie. But that implies that they must have experienced a higher than usual workload between the moment the late runway change was given to them, and the moment at which the operation was returned to normal again. A higher than usual workload in what is universally regarded a critical phase of flight. Is that what we want to achieve when we try to provide the best possible service to pilots?

Of course there are late runway changes that are unavoidable. If there is a constant stream of traffic and the weather is changing (or whatever other reason prompts the runway change) there will be some flights that need to be re-cleared after they've commenced pushback or after theirTop of Descent. This is all part of the game, and pilots as well as controllers have to manage those situations to the best of their abilities. But for the other type of late runway changes, the "unforced" ones that we offer to pilots because we think we're doing them a favour, Archie's statistics tell us that we may need to reconsider our way of thinking: we may actually do pilots a bigger favour by NOT offering them an alternative runway for departure or landing than by offering it at the stage where we tend to do so.

So, next time you are in a position to offer a micro improvement to a flight, ask yourself if the perceived gain will outweigh the imposed increase in workload for the pilots (with the associated chance of flight crew errors) and make a judgment call. Sometimes in service provision "less is more", especially when viewed from a safety perspective.

[2] *A "threat" in this respect is something that originates from outside the flight deck and that has to be managed by the flight crew in order to maintain the margins of safety for the flight.*



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# As usual

## By Hindsight Editorial Staff

TEAM HindSight

As usual, Bert's article was the first we received for publication and as usual, it raised one or two eyebrows. I had not even printed it off when a colleague came into my office and started reading it over my shoulder from the computer screen. "That's all very well," he snorted, "but all we do is make opportunities available to pilots; we don't force them to do things – the decision is theirs, and if they choose to try to do something that is beyond them or the plane's capabilities, that is not our fault. We're not mind-readers, you know."

"And what about the 83% who get it right?" he continued, referring to Bert's statistic that 17% of late runway changes were mismanaged by the pilots, "maybe the 17% would have fouled up anyway! Should we stop trying to help the majority of good, well-trained pilots just because a minority are inexperienced, or badly trained, or lacking in judgement or ability?"

Of course my friend had missed the point. We have all, whether controllers or pilots, seen some pretty good (or bad) examples of how a below-standard pilot has turned an invitation to cut a corner and save some time into a potentially dangerous situation, but that was not what Bert was talking about. Most of the 17% must have been good, well-trained and experienced pilots; otherwise they would not have been able to "successfully manage their errors".

And Bert was not saying, "Never offer pilots short cuts." He was simply drawing our attention to the fact that doing so without any forethought could lead to unexpected and undesired consequences. There are many variables involved in any situation and the correct decision – whether or not to offer a short cut – will depend on local conditions as well as the ATCO's experience and his perception of the situation. Here is an amplification of some of these factors:

- At major European international airports, the majority of aircraft are "modern", with a considerable degree of automation, but this is not always so. The controller must understand the characteristics of both "modern" and "classic" aircraft, and be able to manage the mix of different types which come under his control.

- Almost all aircraft today, whether "classic" or "modern", operate with a crew of two pilots only. They share their workload according to a routine laid down in their company SOPs, which aims to ensure that they operate at all times as a safe and efficient team. But safe and efficient team-work depends on each member of the team having the same mental model of the situation. This requires a series of briefings and re-briefings throughout the flight, in which the pilot flying explains his intentions and the pilot not flying has a chance to understand and if necessary to question the plan. Re-briefings may consist of a few words covering differences from the original plan, or may be lengthy processes where important changes are required. Many accidents and serious incidents have resulted because re-briefing following a change of plan was omitted.

- Following a re-briefing, changes to equipment settings are almost always necessary. The complexity of these changes varies from, for example, changing the heading set on the flight director, to a lengthy re-programming and checking process. The complexity of the changes necessary usually increases with the degree of automation.

- It follows from the above remarks that the ease with which a flight crew can respond to a change depends on the time available – to re-brief and re-set equipment – before the next event in the flight occurs. The ATCO will not know exactly the situation on board the aircraft, and therefore the production pressure put on the crew by a change of plan; but he will often have a fairly good idea, and this should influence his decision whether or not to offer a short cut.

As my colleague remarked, the ATCO should be able to expect that the flight crew will know whether they can cope safely with a pro-posed change, and so make a good decision to refuse a change if they consider it places too much pressure on them. Sadly, as Bert has remarked, this is not always the case.

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# Clashing moral values

## By Professor Sidney Dekker

**Sidney Dekker** is Professor of Human Factors & Aviation Safety at Lund University in Sweden. He gained his Ph.D in Cognitive Systems Engineering at the Ohio State University in the US. His books include "The Field Guide to Human Error Investigations" and "Ten Questions about Human Error". His latest book, "Just Culture: Balancing Safety and Accountability" has just appeared. He flies as a first officer on B737NG.

"Who wants to be part of a trial to see if we can go up to fifty-five aircraft in this sector?"

It was a question put to a group of controllers by a supervisor a few years ago. The approach facility was under severe pressure to accept a greater traffic load during certain times, and did not have the staff to handle the demand. But more traffic meant more cash. A little study was launched, a nominal risk analysis performed, and now the question was out there. As always, no plausible, fixed ceiling on possible controller taskload was found. We believe we can go up to fifty-five aircraft here. We're already at forty-seven now, so what's the big deal? Who wants to give it a try?

Some controllers volunteered. Others balked. Most were repulsed.

How is it that to managers, such decisions to increase throughput can seem entirely rational, legitimate, worth pursuing? And how is it that to operational people, these same decisions can be seen as threatening the very foundation of their ability to do their job well?

Of course, dividing things into two categories, into managerial versus operational, runs roughshod over the real complexity of organizational life. I know, the border isn't that clean, that neat, and the world is not that dichotomous. But laying out two extremes may offer a different way to think about this fundamentally irreconcilable problem. Here's why. To managers, a basic goal is to help their organisation generate the greatest return from an investment. To do the most with the least. To run an efficient business. This is what ethical theory would call utilitarianism (which comes from utility, out of the Latin utilis, meaning "useful").

What is most ethical, says utilitarianism, is to do the greatest good for the greatest number of people (or clients), or, for that matter, to do the greatest good for the amount of resources that you have at your disposal. Actions are ethical, in other words, if they benefit some majority. More aircraft benefit, more clients benefit, more money gets made without an increase in resources.

To a controller, however, who is working operationally at the scope or in the tower, rates of return on investment or organisational efficiency aresecondary concerns, if that.
To some controllers they are mere distant rumblings, rumours, whispers, with no relevance to the sharp end work. Because at the sharp end, nothing is as important as the few (or more) aircraft under her or his control right then and there.

This is an approach to ethics that we call deontology, or duty ethics (from the Greek deont- or being necessary). Also known as obligation ethics, it says that an action is morally right when it lives up to the duty that was entrusted to the person and her or his profession. There is, between the controller and the aircraft (or the people in them), something that we could call a fiduciary relationship (from the Latin fiducia, meaning trust). People put their trust in other people to keep them out of trouble, which pretty much sums up what controllers do.

And indeed, if it really comes down to it, then whatever it takes to keep those at the other end of a fiduciary relationship out of trouble, you want to invest. You want to give. More time? Sure. Separate frequency? No worries. Call over more warm bodies to help controlling this situation? Absolutely, you got it. That is your duty, that is what is ethical.

That managers pull their hair out when you do all that; that they see some of these actions as waste, as inefficiency, is incomprehensible to you, the operational controller. Because you speak a different ethical language. I have yet to see a meaningful discussion or recommendation about dealing with production pressures that actually manages to reconcile these two completely different ethical starting points.

So what about the trial to go up to fifty-five aircraft?

It was a success. These things always are a success. Until they no longer are.

Actually, as for that facility, it may still be a success. In fact, it may have been such a success that they are now running trials to go up to, well, let's say sixty aircraft per hour. After all, fellows, we're only five aircraft away from that, with us being at fifty-five already and all, so what's the big deal? This is how acute production concerns trump chronic safety concerns. Each little step is only a small increment away from the previous norm. What's the big deal? Things have gone right so far. It's easy to measure the success. It's hard to know how much you borrowed from safety to achieve it.

And then, slowly, we might just drift in to failure.



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# **Friday the 13th** Is on a Thursday

## By Bengt Collin

**Bengt Collin** works at EUROCONTROL as an expert on the Advanced Surface Movement Guidance and Control System (A-SMGCS) Project (part of the Airport Operations Programme (APR)), and also for the Directorate of ATM Programmes.

### The Controller

It was Thursday lunch-time and he felt terrible. It felt like a cold, misty Monday morning in the winter; the first day after the vacation, back from two wonderful weeks in southern France; ten months to his next leave. He was on his way to work at the control centre, it started raining.

He began thinking about unimportant details, sometimes it irritated him but not now, he thought about the weekly information meetings at the centre called Monday meetings; not that they were arranged on Mondays, in fact they were never arranged on Mondays nowadays; someone had explained to him that in the beginning they were and the name stayed. Then he thought about Friday the 13th; why is Friday the 13th on a Friday and not on a Thursday?

Why am I focusing on these details; I should start focussing on more important things, a healthier life for example; I will definitely start jogging tomorrow.

### The Private Pilot

The woman sitting next to him in his car was beautiful. Slim, dark hair to her shoulders, she was wearing an elegant, smart dress - Kenzo?

He had been dating her for just over two months now; at their very first date he told her about him being a private pilot; it was true, but trying desperately to impress her he overlooked the fact that he actually only had very limited experience in flying. He had got his licence a year ago and being extremely busy at his job he was at the minimum hours to keep the licence valid.

Today they were going to fly for an hour or so, the weather being nice, and at least he had the basic knowledge in handling a PA28.

### The Captain B-Jet 3158

She had always loved flying. Now with six months experience as a captain it was even better; she worked with her favourite hobby, fantastic. The passengers often mistook her for a cabin attendant, she was a smart, tall, professional woman in her best years (some women always are); she thought about the airline she worked for in the same way, she was very loyal. The work was hard, really hard, but she never complained, why should she? This was what she had always wanted, she was young and healthy like the rest of her colleagues; they were like a big family.

The only blot on the landscape was from the competitor airline her company had bought recently; the merger between the two airlines' pilots had not been without problems to say the least. They could not in the short term survive without the other pilots, but they were used to a slower pace in doing things, very irritating; probably that's why they almost went bankrupt, she thought as she prepared the fourth leg of the day.

Her first officer, a man with some fifteen more years flying experience than her, was a nightmare; he kept talking about either:

A. When he was a fighter pilot (World War II she thought), or

B. The good old days in his previous job.

Either way it made her feel annoyed; 25 minutes turn-around was the maximum allowed; now they were late because the first officer just did not do things fast enough.

### The Controller

Normally the traffic in the afternoon slowed down only marginally before increasing again in the evening, this afternoon being no exception. The supervisor closed down two of the terminal sectors; he was now in charge of a larger area than usual but this was the normal practice at this time of the day; he did not think about it – and others needed to eat, did they not? Besides, he thought, he was one of the best approach controllers in the centre and definitely did not need to ask anyone for help; no way, he never did.

He had five aircraft on the frequency but few conflicts; four were inbound, number one and two from one airline (A-Jet), the two last from another airline (B-Jet), one aircraft just departed (C-Jet), with a second departure soon to be airborne. From experience he knew that the first departure probably had to level out at around FL 100; he thought it was better to wait and see how things developed rather than re-clearing the pilots to a lower flight level; this was the way he had been trained, well almost anyhow; having developed his working methods further he now worked in a less strict way, allowing him to handle more traffic.

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**The Private Pilot**
They departed from the small grass field and turned west. The flight was smooth and he explained what was happening during the flight for his girlfriend. He never used a map; instead he brought his new GPS, it was still in the box but no problem; it was only a short local trip in an area he knew well.

He did not file a flight plan; he did not like to talk to ATC anyway. They always spoke very fast and sometimes got irritated if he did not understand the instructions immediately. Once he had overheard a Tower Controller who in a very unfriendly way had "taught" a pilot who had obviously made a mistake; he would never call the Tower for sure, he did not like controllers.

**The Captain B-Jet 3158**
It was as soon as they got airborne, she asked for a direct route. They were twenty minutes late and she felt it was her personal responsibility to be on time. The relationship with the first officer was a bit "chilly", he obviously felt her getting irritated even if she did not say anything directly to him, she was far too professional to do that. They started descent a bit late, no problem; she instructed the first officer to keep a higher speed than normal during the descent, that would save a minute or two.

**The Controller**
"I knew this would happen," he thought as the first departure climbed towards the south west. The first two inbound aircraft would pass well ahead of the outbound aircraft, but he needed to re clear inbound number three, B-Jet 3158 and the first outbound aircraft, C-Jet 1582. The tower controller contacted him on the intercom:

**TWR:**
Do you know what is in the southern part of my control zone? It is moving west and blocking my departures. He saw the symbol on the screen moving west, it did not have a transponder on, it was definitely an aircraft; what was it doing there?

**APP:**
Haven't seen it before, can you see it from the tower?

**TWR:**
It's a PA28. I guess it is turning south now

**APP:**
Wait, just a second. C-Jet 1582 stop climb flight level 100

**C-Jet:**
Stopping climb at flight level 100 C-Jet 1582

**APP:**
B-Jet 3158 stop descent flight level 110, traffic below

**B-Jet:**
Stopping descent level110 B-Jet3518

**APP:**
TWR, I will follow it on radar and see where it lands

**TWR:**
OK, thanks, are you joining us tonight for…

**APP:**
Sorry mate, I am on my own, need to work...

**TWR:**
See you.

**The Private Pilot**
Everything went very well, they talked, he told her his great joke about having some pork, she laughed, he was happy, the sun was shining; "Wow a jet aircraft that close," she said; the departure was passing well above them; instinctively he knew he was too far north, he discretely turned left, south away from the big airport.

**The Captain B-Jet 3158**
They were doing 270 knots indicated during the descent, 240 was the published speed but what the heck, ATC won't care, they never did.

**APP:**
B-Jet 3158 stop descent flight level 110, traffic below

**B-Jet 3518:**
Stopping descent level110 B-Jet3518.
"Was that for us?" the first officer asked. The captain did not answer, he asked again, they were level 120 descending with high speed; we won't be too late after all she thought, great I hate being late, "Was what for us?" she asked; if everything worked out they could even be at the gate on time.

**The Controller**
The third inbound aircraft, B-Jet 3158 (the first B-Jet) was fast, the distance to number two, the second A-Jet decreased rapidly. Strange, I will wait and see; this was a working method he practiced frequently, wait and see and do not overdo things, he thought controllers using belt and braces were chickens; he followed the VFR that now left the control zone and headed for the nearby grass field; he would tell the supervisor to phone the flying club.

**The Captain B-Jet 3158**
"TRAFFIC, TRAFFIC." The TCAS system brutally made them alert as a rabbit caught in the head lights. She checked the display, something was climbing towards them from the left, "ADJUST VERTICAL SPEED; ADJUST." "Increase the descent," she told the first officer. "CLIMB, CLIMB". Both instinctively almost at the same time initiated a climb; two seconds as long as years passed, they were in clouds…



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# By Bert Ruitenberg

**Bert Ruitenberg** is a TWR/APP controller, supervisor and ATC safety officer at Schiphol Airport, Amsterdam, The Netherlands. He is the Human Factors Specialist for IFATCA and also a consultant to the ICAO Flight Safety and Human Factors Programme.

In the narrative there are at least two items that correspond with the theme of this HindSight issue, i.e. "Production Pressure": the feeling of the airline captain that it was her personal responsibility to be on time, and the air traffic controller's conviction that he didn't need to ask anyone for help (ever!).

But in addition to this there are many other items that can be identified as "holes in the Swiss cheese" (cf. Reason's[3] model of accident causation). The controller was working on the first day after a vacation; the private pilot had very limited flying experience and flew only the minimum required hours to keep the licence valid. There had been an airline merger that went not without problems between the groups of pilots. The controller was working an area larger than usual, because he wanted to let his colleagues have a meal break. He had developed personal working methods that were less strict and allowed him to handle more traffic. The private pilot didn't use a map and his new GPS was still in the box; furthermore he didn't file a flight plan and didn't like to talk to ATC. The relationship between the crew on the flight deck of the airliner was "a bit chilly"; the descent was started late, and they kept a higher speed than normal during the descent. The private pilot didn't operate a transponder. The intruding VFR flight caused a distraction for the controller. There were similar callsigns of successive inbound flights. The captain in the airliner didn't notice the R/T call from the controller, and was slow to respond to the query from her first officer. The airliner crew initially chose a response that was contrary to the TCAS advisory. And this list is probably not even exhaustive…

According to the theory, the event could have been prevented by plugging any of the holes in the layers of the Reason trajectory. Bear in mind though that some of the holes identified above may actually belong in the same layer of the Reason model, so it doesn't necessarily mean that each of the items mentioned carries the same weight.

My challenge is to come up with one single safety recommendation for this case, and I'll restrict myself to the ATC environment for it. Although it would be tempting to say that the presence of a second controller (to assist the first one) would solve everything, this is probably not the best solution for there is no guarantee that this second person would catch the wrong read-back. Neither can it be assumed that such a second person would be handling the coordination with the Tower – it all depends on the task distribution in a 2-person set-up. My recommendation therefore is to integrate multi-antenna Direction Finding equipment on the radar screens that would present the controller with a graphical indication of which station is transmitting at a given time (e.g. with crossing lines over the target). This would increase the chance of a controller detecting a read-back by an incorrect station, regardless of the presence of another alert controller at his side.

[3] *A brief explanation of the Swiss cheese model may be found at http://www.skybrary.aero/index.php/James_Reason_HF_Model*

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# By Alexander Krastev

**Alexander Krastev** works at EUROCONTROL as an operational safety expert. He has more than 15 years' experience as a licensed TWR/ACC controller and ATM expert. Alexander is the content manager of SKYbrary.

The incident described in "Friday the 13th is on a Thursday" is a typical example of an incident caused by failed air-ground communication.

The direct cause for the loss of separation between B-Jet 3158 (descending to land) and C-Jet 1582 (climbing out) was the failure of B-Jet 3158 to follow the ATC clearance to stop its descent at FL 110. There are numerous causal and contributory factors which lead to this outcome. In my view the most important are:

- **The call-sign confusion**

B-Jet 3518 took incorrectly the clearance issued to B-Jet 3158. This is a classical example of call-sign similarity, which should have been acted upon in advance. [Since both aircraft were operated by B-jet, it should have been possible to detect and eliminate this obvious source of confusion. Studies have shown that the majority of call sign confusions are between flights operated by the same company. Ed.]

- **The hear-back error**

The APP controller did not pick up the different call-sign in the pilot's reply. Several factors lead to this error: the distraction caused by the airspace infringement (the APP controller did not monitor the developing unsafe situation); the overconfidence of the APP controller in his ability to manage traffic in a larger volume of airspace "than normal" and the reactive mode of air traffic control practiced by him ("wait and see how things develop"). Instead of acting on the threats, the APP controller is waiting for undesired states to develop.

- **The Captain of B-Jet 3158**, being responsible for the communication with the ground as PNF did not hear the ATC clearance. She was distracted from her pilot and pilot-in-command duties by the fixation on the on-time arrival, for which she felt personally responsible. Apparently production pressure is an important factor in the cockpit too. This and her negative attitude to the first officer prevented her from paying attention to the first officer's warning ("Was that for us?") and from taking timely action to clarify the issue with the APP controller.

Aggravating factors for the severity of the outcome were the higher descent speed and the incorrect interpretation of the RA by the captain of B-Jet 3158.

Actually, the loss of separation discussed above might have been the second in a row involving the climbing out aircraft - C-Jet 1582 as it passed very close to the infringing aircraft – PA 28. This (potential) loss of separation was not detected by the commercial flight, nor by the ATC as the PA28 did not have a transponder on. Such occurrences caused by airspace infringement are of highest severity because the aircraft pass each other in an uncontrolled way. TCAS is useless (needs altitude reporting transponder) and visual avoidance is ineffective in IFR/VFR flight encounter. Again, numerous factors "helped" the private plot enter the CTR without clearance:limited experience and pilot skills; lack of pre-flight preparation, no map on board; GPS not switched on (but overreliance on GPS is often misleading); overconfidence; distraction; negative attitude towards ATC (often mutual). These and many more factors have been identified and analysed in the course of the Airspace Infringement Initiative. It delivered a comprehensive set of risk reduction recommendations consolidated in an action plan(http://www.eurocontrol.int/safety/public/standard_page/Airspace_Infringement_Initiative_Actionplan.html).

A dozen recommendations to both controllers and flight crews can be derived from the analysis of this incident, but one of the most important for this particular case appears to be the prevention of call-sign confusion through correct application of read-back and hear-back procedures.

# By Captain Ed Pooley

**Captain Pooley** is an experienced airline Captain who for many years also held the post of Head of Safety for a large short haul airline operation. He now works as an independent air safety consultant and is currently acting as Validation Manager for the safety web-site - SKYbrary.

What a plausible – and typical – scenario! At the outset, every player carries their unknown-to-others personal 'baggage' with them as they go about their often demanding jobs or, in the case of our typically under-cautious private pilot, a leisure activity which can directly impact the safety of the others!

The scenario provided has all three players exhibiting 'individualism' in their performance. All of them also exhibit a certain deficiency in either self-awareness or the potential for other peoples' perspectives to be different. A series of actions and decisions involving all three of our players begins to build towards a potentially dangerous situation in which 'production pressure' is gratuitously increased by the sum of their actions. Fortunately, when 'it' happens, a more serious outcome is averted by the correct use of the available safety net - TCAS - by the flight crew who, at last, work as an integrated team for some critical moments.

It's worth taking a look at the constituent behaviours which we can see have a bearing on this build-up.

**First the Private Pilot**: Given his relative lack of experience and flying recency, he figured that it was good to be flying an aircraft he was familiar with in an environment he was also familiar with in ideal VFR weather. But he was also displaying the beginnings of complacency. He did not think a map - or map-reading ability - were relevant and he seems to have acquired the view that a GPS, in or out of a box, could be considered relevant to his intended VFR navigation. He also appears to have allowed past experience of 'unfriendly' ATC to affect his judgement on the value of keeping at least a listening watch so that what, in this case, was effectively a basic safety net against airspace infringement was lost. Of course, the presence of his passenger removed any possibility, probably remote in the first place, that he would admit his navigation error to ATC.Self-awareness of the implications of his decision-making is lacking

**Next the Controller**: A can-do man as many controllers are, he had allowed his task familiarity to breed a little bit of over-confidence or complacency which in turn had fuelled an 'independent approach' to maximising the capacity and efficiency of his sector. He was in no doubt that his liaison with TWR about the infringement was not going to interfere with his assigned sector control task. After all he knew not to spend any more time on this 'diversion' than was strictly necessary. But being firmly in his relaxed comfort zone, he failed to pick up the incorrect read-back from a very similar call sign and then failed to spot the conflict developing so that TCAS was all that was left. Again, there is a lack of self-awareness of the implications of his style. Had he been more attentive, the read-back error would have been neutralised quickly and normal standards would have been maintained.

**Finally the Captain**: Unfortunately, her obvious enthusiasm for her job is accompanied by evidence of an underlying and fundamental lack of ability to carry out flight management and to exercise leadership in an appropriately balanced way. She is keen to support the customer-focused on-time goal - but this consideration is not applied as an input to judgements about overall operational safety, which would surely not be much in dispute as the highest level goal. This poor tactical judgement extends to intentional disregard for ATC speed control too - and a failure to maintain situational awareness using the general pattern of R/T exchanges on the frequency or to ask ATC should any doubt exist on the intended recipient of an ATC instruction. Tunnel vision towards the on-time imperative has set in. There is a second very important problem area too. She shows little understanding of the fact that getting the best out of a particular co-pilot may require any one of a range of different approaches, none of which involve being irritated whether or not this is apparent to the other pilot and all of which start at the crew report point for the day's duty. In short, she exhibits a very basic lack of understanding of all the underlying principles of CRM as a means to deliver the real strengths of team working instead of the weakness of undue individuality.

We can observe that whilst the pilots eventually acted together to save the day, the Captain was at the centre of the error chain because of her style of command. So it's not difficult to make what I think is the key safety improvement recommendation here: **The process of selection and initial training for new Captains at B-jet needs a complete overhaul**. Selection and training are closely connected. Successful selection assumes that the training process is capable of delivering new Captains to their first line flying positions in a 'condition' which embraces the fundamental priority of the appointment. Having passed the necessary tests of technical competence, promotion to command also means being equipped so as never to lose sight of the need to bring informed flight management - and the prioritisation which goes with it - onto the flight deck on every trip. Amongst other things, this requires that the concept of CRM be actively embraced.

# By Dragan Milanovski

**Dragan** is ATC training expert at the Eurocontrol Institute of Air Navigation Services in Luxembourg. Most of his operational experience comes from Skopje ACC where he worked for a number of years on different operational posts. Now, his day-to-day work involves ATC training design as well as Initial Training delivery for Maastricht UAC.

All the parties involved in this story seem to have contributed to the event in one way or another. Did someone play the crucial role, or was it just a Friday the 13th on a Thursday when everybody has a bad day?

The young captain still has a few things to learn, not about flying, but how effectively to lead a team. Did she ever try to understand the first officer? Why was he always talking about old times? Maybe he felt more comfortable and/or more confident in his old job. Why?

He was not doing things fast enough. Maybe, he was making sure he did not make an embarrassing mistake (younger captain), or maybe he just thought that was the right way of doing things (culture). Did she say or do anything about his speed? If the speed was really a problem, did she try to help (lead by example or coach)?

Instead, the captain felt irritated, annoyed and blamed the first officer for the delay ("chilly" relationship). On top of that she decided to "bend" the rules a bit (higher speed) while setting her mind on the arrival time. In this state, I can understand why she was not ready to perceive what the first officer was saying, nor ready for the fast change required in the situation.

The poor controller must have been wondering in despair – "What happened? I issued the clearance in time and got the readback correct". Clearly, he could say: "It was the pilot's fault". Little did he know that he played an important role by using the "wait and see" technique. There are several risks associated with this technique, two of which were significant in this situation: distraction leads to a late re-clearance and fast change required from the pilots.

The first action that could have changed the chain of events was when the controller, based on his experience, could see a level off at FL 100 and still decided to continue and wait. The "wait and see" technique works as expected most of the time and it does not require any action, even when it is obvious that there is a very little chance it will work, we keep pushing it to the very end (the hope dies last).

Later he decided to let a relatively unimportant distraction in (VFR flight in the control zone). I must say he did well with the phone call and kept it short. Having promised to monitor the progress of the flight, at that point he could have also stopped the "wait and see" immediately and issued the required instructions. Then another "wait and see" with the number two catching up the number one in sequence… Nevertheless, it was not too late and he still managed to issue the instructions in time. On most other days it would have been good enough and nothing would have happened, but this was not an ordinary day.

Despite all the temptations, my recommendation goes to the controllers using the "wait and see" technique: Before you use it in the future, check the date first, maybe it is Friday the 13th on a Thursday. Stick to the techniques you learned in training and use the experience to build upon. Learn how to use the belt and braces in an efficient way.

How about the private pilot? Having spent many years on different airfields, I saw similar things happening on many occasions. My advice to this guy would be to fill in a flight plan and talk to the ATC, women are more likely to be impressed then. Although, in my time they were not wearing smart Kenzo dresses, or was I on a wrong airfield?

# Next please

## By Anthony F. Seychell

**Anthony Francis** (TonY S) is an experienced ATM safety expert who has both ATC operational and engineering background. He worked previously at Malta Air Traffic Services in a variety of posts, the last being that of Safety Manager. In addition, he has a wide appreciation of flight safety management issues and principles. TonY S joined the EUROCONTROL Safety Security and Human Factors Division in February 2007 as Safety Expert and in May 2007 was appointed as Coordinator of SASI (Support to ANSPs for SMS Implementation) programme, part of ESP Activity Field 1 and providing support to ESP Activity Fields 3 and 5.

Tower AAA123 is ready for departure RWY 36.

AAA123 Roger. Expect departure in 2 minutes due to wake turbulence[4].

How many times have Tower ATCOs faced this situation? Most probably the correct answer would be 'countless'. So for the next two minutes the flight crew can get to admire the runway scenery, the Tower ATCO can deal with some other tasks and all the while the flights are waiting. Pilots are very quick to comment about perceived delays. Now there's this fuel crisis on and the pressure is getting worse to make sure that flights do not wait a minute longer than necessary.

We all know that wake turbulence is a killer but it is an invisible and silent one. Also wake vortices have a life of their own and many ambient conditions affect their decay. ICAO document 4444 lists the minimum radar and non-radar separations to be applied due to wake turbulence.

All of us, be it ATCOs or pilots, have learned about wake turbulence and its effects in our ab-initio courses. However, these courses are long in our past. We have progressed well in our careers and our colleagues consider us to be hotshots. We are known to be quite expeditious and it is the desk-bound people who write procedures.

The least wake turbulence separation is 4NM or 2 minutes. As radar-based separation, this is more than the minimum radar separation on final approach at some of the larger airports.

Wake turbulence separation seems an ideal candidate where ATCOs or pilots may perceive the need for optimisation. Under ideal conditions no ATCO would permit an aircraft to sit for two minutes on his active departure runway. We also have to remember that the timings are from rotation to rotation. There are still plenty of people out there who do not appreciate this. For the approach case, pilots can (and do) nowadays use their TCAS displays to assess separation from the one in front, though the use of TCAS traffic display is not allowed for self-separation. However, they could be tempted to self-adjust their own speed if they thought the (wake) separation were either too great or too little without necessarily telling ATC. Also ATCOs might be tempted to pack the aircraft a bit closer since the 5NM wake separation (Medium behind Heavy) is almost double the normal 3NM final approach separation used at some airports. Imagine the scenario where the pre-sequencing was a bit off and you get a number of such cases where Mediums are following Heavies.

Earlier on I stated that wake turbulence is a killer. Optimisation can be worse if the person doing it is blatantly ignoring, or even downright violating, procedures. It is true that procedures might not be optimal, but they are the best we have and have stood the test of time. The procedures were not just written to make life difficult but because a threat had been identified and mitigation measures were necessary.

To conclude please do not try to improve on procedures on live traffic. Sometimes when cutting corners, one might cut too deep. If you have ideas, comments or suggestions, by all means, pass them on to your supervisors, managers or safety coordinators but use a simulator to try them out.

*[4] The Skybrary web-site: http://www.skybrary.aero/index.php/Wake_Vortex_Turbulence contains more information about wake turbulence and separation standards*

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# Safety and the cost killers

## By Jean Paries

**Jean** graduated from the French National School of Civil Aviation as engineer, and then joined the DGAC for several positions dealing with air safety regulations. He was a member of the ICAO Human Factors & Flight Safety Study Group since its creation in 1988. In 1990, he joined the Bureau Enquêtes Accident as Deputy Head, and Head of Investigations, where he led the technical investigation into the Mont Saint-Odile Accident, 1992. Currently Jean is CEO - of Dédale SA. He holds a Commercial Pilot Licence with Instrument, Multi-engines, Turboprop, and Instructor ratings and a Helicopter Private Pilot Licence.

### A global race

Because he had lifted the Nissan car-maker company from near bankruptcy and given it industry-leading profit margins in just four years, Carlos Ghosn got the sort of adulation in Japan that is normally reserved for rock stars. But when he took over as the CEO at Renault, French journalists had already dubbed him "the Cost Killer", a rather backhanded welcome compliment. Further evidence of cultural differences... But welcome or not, "cost killing" and productivity are now characteristic of the fierce, global race between companies, regions and nations. Every industry has come under powerful pressure to shorten project realisation time, cut production costs, and also improve quality. Whatever the product or service, anything which is designed, produced, or operated – including ATM – must be done "faster, better, and cheaper".

But can it be safer as well, or even maintain the same level of safety in the face of these changes? It is in fact quite sensible to raise concerns about the impact of economic pressures and "cost killing" efforts on the (operational and occupational) safety of operations. Obviously, safety has a cost. Safety requirements include carefully thought-out fail-safe design with adequate backups and redundancies, high quality equipment maintenance, adequate staffing and training, due consideration of stress, fatigue and other Human limitations in the design of the work environment and processes. None of these conditions come without a cost. Hence killing costs may affect safety as well. On the other hand, there might be some wisdom in the idea that a smart and coherent evolution of a system can win on all fronts. After all, aviation history itself is a nice example of getting faster, better, cheaper - and safer, at the same time. So, which vision is right? What is the relationship between economic pressure and safety?

### Faster, better, cheaper… failure?

To launch this discussion, it might be interesting to draw on the sources. The "faster, better, cheaper" motto was coined at NASA in the early 90s, when stricter budgets from US Congress forced the space agency to demand better performance from small missions with tighter schedules[5]. It ignited a long-lasting debate over the value of the new credo. Many voices claimed that faster and cheaper were obviously not better[6]. The debate intensified when it appeared that the rate of design errors and associated space mission failures was growing. But its supporters argued that the idea still held: when a mission is inherently risky, it's better to have a cheap disappointment than an expensive catastrophe. When the Mars Observer was lost in 1993, NASA had already invested a billion dollars - and all its scientific hopes - into the project. In contrast, the combined price tag for the Mars Climate Orbiter and Polar Lander failure[7] "only" amounted to $235 million. So, as a NASA manager once put it, "If you do a multitude of missions, it's better than if you put all of your resources in one basket."

While it's a bit difficult to imagine a straightforward transfer of such debate to ATM – unlike in space ventures, an accident is not an option in ATM – it is a nice illustration that simple ideas are rarely correct where safety is concerned. Because it emerges from complex interactions across its components, the safety of large systems often has surprising, counter-intuitive properties. More is not necessarily better. Local, isolated efforts to optimise safety generally fail to generate an overall best. Using superficial logic, the introduction of an additional safety net like TCAS onboard aircraft is categorically good for safety… unless, as sadly shown by the Überlingen accident and several other events, its potential interactions with the existing safety process are considered. For similar reasons, the consequences of economic pressures on safety are not straight-forward.



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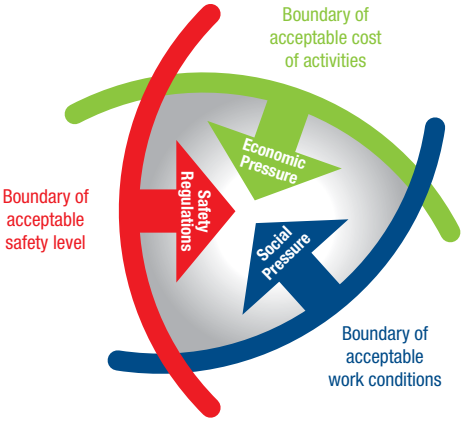
## Several constraints

In fact, safety is one of the three main constraints that shape production activities. The other two are the economic pressure to increase efficiency, and the social pressure from staff striving to win more favourable work conditions. As shown by the picture, borrowed from Jens Rasmussen's work, these three constraints are only partially antagonistic. They delimit a "green area" which is the envelope of acceptable operations. Outside the boundaries of this area, the business cannot survive.




Within the boundaries, the operation represents a compromise between efficiency, safety and comfort. The best way to relax this antagonism and shift these boundaries is a fundamental technological change. When jet airliners were introduced, they simultaneously offered more efficiency, more comfortable work conditions for the crew, and safer flights. Similar improvements occurred within ATM with the introduction of new technologies like radar, transponder, or computer-based flight displays.

## The Long March Towards Quality

But technological revolutions do not happen every day. The overall progress of a system like ATM also results from the confluence of many streams of evolution and improvement: better organisation, better technology, better work processes, better procedures, better training, and so on. Better is the key word. And Quality Management is the key process: clarify the goals, set the proper requirements, do what is specified, monitor what happens, learn from experience, and adapt requirements accordingly.

Is this approach valid for all components of performance? Safety is no exception. Most safety experts would agree that an efficient safety strategy includes the following components: design reliable technology, automate what can be automated, anticipate all work situations (including emergency situations), specify every detail of "the right" behaviour through appropriate procedures, select the "right" operator profiles, train them to follow procedures, monitor adherence to procedures, blame the deviants (intentional violations), detect and explain "honest errors", learn from them and fix the system accordingly.

## Efficiency versus flexibility: Should the desert lizard show the way?

In other words, economic pressures and safety requirements tend to take the same form: rationalisation, formalisation, proceduralisation, automation. Essentially, they both try to reduce the messiness and uncertainty in the system by reducing variety, diversity, deviation, instability. But the side effect is that this also reduces autonomy, creativity, and reactivity. They try to increase order, conformity, stability, predictability, discipline, anticipation, repetition, etc. Achieving this renders the systems more efficient, cheaper, and more reliable… within the confines of their standard environment. They also make it more and more brittle outside the boundaries of the normal envelope. They tend to over-adapt the systems and processes to their standard business and operating environment. This trade-off between efficiency (adaptation level) and flexibility (adaptation bandwidth) is universal. Formula 1 car tires have an incredible grip… within a temperature range of plus or minus 5°C. Competition gliders can fly more than 50 km in calm air from an altitude of 1000m… provided no mosquitoes are squashed on their wings. Desert lizards are so well adapted that they can survive for years without water, but would disappear if the climate changed by a few degrees. Trained controllers can handle up to thirty aircraft in a busy sector… provided all aircraft behave exactly as expected.

Thus rational and formal optimisations of production systems make them better (more efficient, more reliable), possibly cheaper, and generally safer within their adaptation envelope. Unfortunately, they also make them less "**resilient**" outside their adaptation envelope. Resilience is the capability of a system or organisation to maintain its integrity and main functions after a disruption - i.e. an external or internal disturbance that fall outside the scope of adaptive behaviour of that system. Resilience is about how a system can actively ensure that things do not get out of hand. It is not enough that a system like ATM be reliable (so that the failure probability is acceptably low); it must also be resilient and have the ability to recover from disruptions and unexpected degradations. It needs not only well adapted processes and procedures, but also robust yet flexible processes, in the face of disruptions or ongoing production pressures. And the main source of robustness and flexibility is intelligence, at both the individual and collective level, in particular for front-line operators. The system must maintain and safeguard this intelligence at any cost.

*[5] Employees were cut from about 25,000 to 18,500 over 7 years.*

*[6] See for example Dekker SWA (2005) Ten Questions about Human Error. Lawrence. Erlbaum, Mahwah, p144.*

*[7] In September 1999, a failure to convert between metric and English units condemned the Mars Climate Orbiter to an unexpected end, while a software flaw contributed to its sister ship (Mars Polar Lander) crash landing in December (the software erroneously detected a landing when the landing gear deployed, and prematurely shut down the engines).*

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# Safe, orderly and expeditious flow of air traffic

## By Christian Faber

**Christian** works at EUROCONTROL as an ATFCM expert in the Operations Division of the Central Flow Management Unit. During his career he has acquired experience in many domains of aviation: German Air Force, ab-initio ATCO student, aviation charting, private pilot, and flight planning expert. Christian is currently in charge of Operational Incident Investigation and Quality of Service at CFMU.

### "Safety First" from a Flow and Capacity Management perspective

"To ensure a safe, orderly and expeditious flow of air traffic" is the essence of what Air Traffic Controllers learn at the beginning of their career, probably on one of the first days of their training.

Most of us understand "expeditious" to mean "done with speed and efficiency", but fast and efficient may lead to an unsafe situation. From a Flow and Capacity Management point of view the terms "safe" and "expeditious" are somewhat contradictory, even though they proceed from the same source.

The aviation world has changed dramatically over the last 20 years and we are faced with challenges, such as the continuing increase of air traffic in the face of limited capacity. On top of that we are experiencing daily problems such as, lack of staffing, adverse weather, complex routeing schemes, etc. Air Traffic Flow and Capacity Management is expected to prevent congestion in the air and around airports through coordinated management, thereby enhancing safety.

Over the years ATC has evolved to become more service orientated; as a Service Provider, knowing that aircraft operators are faced with economic threats, controllers might conclude:

- Let's climb or descend the aircraft, in order to provide the optimum flight level.
- Let's give the pilot a direct routing, in order to reduce the distance, save fuel, and reduce the environmental impact.
- Let's clear the aircraft for take-off; everybody seems to be ready and it fits nicely into the planning of the departure sequence.

Controllers take a professional pride in providing the "best" service and there is no doubt that cost and flight efficiency are major concerns and amongst the key issues in ATM, but do we consider all the safety aspects?

Across Europe, sectors suffer from delays put in place to protect ATC from receiving more traffic than the air traffic controller can handle safely when other ways to balance capacity against demand are insufficient. However, it still often happens that more aircraft enter these sectors, exceeding the capacities by more than 10%. In those cases we talk about "over-delivery". When investigating those occurrences we find that in most cases flights were:

- not flying at the initial requested flight level; or,
- departing at times different from the original estimated off block time (EOBT) or calculated take off time (CTOT); or,
- arriving in the sector earlier or later than originally planned; or,
- deviating from their original planned route (direct routeing).

On one particular occasion a major ANSP asked CFMU to investigate the over-delivery of a specific sector in their area of responsibility. The capacity of the sector was 40 aircraft per hour but in reality 50 aircraft had entered that particular airspace. It turned out that flights had been re-routed in the air by a previous ATC sector to fly a more direct route. As a result they entered sectors which had not previously been planned and obviously over-deliveries occurred in those sectors.

In another case an upper airspace sector was penetrated by more aircraft than initially planned.

Investigation revealed that many of the aircraft were flying above their requested flight level. An analysis of the updated profiles indicated that they had climbed to higher flight levels approximately 300 to 400 nautical miles before entering the sectors concerned.

Did the pilots and controllers anticipate the consequences of a higher flight level on the traffic demand of a sector downstream on the route? Was the original flight plan realistic? Is all information available and utilised by Air Traffic Controllers to provide a safe service to the aircraft operators and pilots?

The examples above show that there can be considerable impact, if the initial and intended trajectory of flight is modified on an "ad hoc" basis. Following the initial plan is becoming more and more critical to safety.

### What are the solutions?

One ANSP is about to implement a system which will detect the actual flight level of aircraft long before they enter their sectors. In the case of a deviation from the expected flight level an alert is raised at the relevant working position, which triggers a corrective action.

There may be other technical solutions, but the start of any solution must be understanding and awareness of the impact of our actions on the network. An increase of traffic goes hand in hand with an increased potential risk of overloading Air Traffic Controllers; adherence to flight plan, flight levels, routes and ATC slots becomes critical. In this light the "expeditious" flow of traffic is not always safe; instead we might have to consider an "optimised" flow of traffic which balances flight efficiency and safety.



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# Trying too hard?

## By Captain Ed Pooley

**Captain Pooley** is an experienced airline Captain who for many years also held the post of Head of Safety for a large short haul airline operation. He now works as an independent air safety consultant and is currently acting as Validation Manager for the safety web-site - SKYbrary.

London Heathrow is in many respects a typical parallel runway operation. As many readers will be aware, it's a very busy airport except during the middle of the night and for some years now, there's been an ongoing debate about whether capacity could be increased by using each of the two parallel east-west runways for both take offs and landings. To date, however, the traditional model of designating one of the runways as the landing runway and the other as the take off runway has prevailed. For local area noise abatement purposes, westerly operations are conducted using regular changes of runway designation at (usually) three hourly intervals. Easterly operations, where there are less widespread noise abatement concerns, involve the continuous designation of the northerly runway for landings with the southerly one for take offs.

As I know from personal experience, the TWR controllers at the airport have a long record of routinely combining safety and efficiency in the standard of their 'production' and they are well used to completing whole shifts with little or no break in the continuing maximum rate flow of traffic arriving and departing. Despite this, they have also long been known for their willingness to fit in a landing on the take off runway (and occasionally a take off on the landing runway) whenever this is judged possible and will eliminate the need for a particular aircraft to cross an active runway en route to or from a parking stand or otherwise significantly reduce its ground taxi or waiting time.

We can all appreciate that experience and professionalism are the key to judging when these runway switches can be achieved. Very, very occasionally it goes wrong to the extent of creating a real hazard to aircraft safety. I'm going to take us briefly through one such occasion in the hope that it will usefully illustrate the challenges of choosing to increase the production pressure in an already highly pressured environment and highlight the reduced scope for sub-optimal decision making which is implicit in a truly professional acceptance of the challenge…

It was early afternoon and the shift had just changed over. With easterly operations, the Air Departures Controller, fairly recently qualified as a TWR On-the-Job-Training-Instructor (OJTI), was already in position controlling 09R take offs when a student trainee arrived and advised that they had been scheduled for supervised controlling in that position. The changeover was carried out and the trainee began work uneventfully with the OJTI observing as mentor. At 1355hrs the radar controller positioning arriving aircraft onto the parallel runway 09L asked if it would be possible to fit in a British Airways 747-400 landing on the Departures runway. (Whilst this aircraft could save considerable taxi time and avoid crossing an active runway by such a switch, the initiative was that of the radar controller as the flight crew had complied with their company policy not to request switches at Heathrow). Despite the considerable queue of departing aircraft, a number of which had been given "line up and wait in turn" clearances, the trainee accepted the proposal without comment with an intention to briefly interrupt the departure flow.

At 1403:20, with no prior ATC speed control having been requested by TWR, the arriving British Airways 747 checked in with the TWR frequency on finals at a range of 6nm. The trainee TWR controller had an Aer Lingus aircraft waiting to go and this was cleared take off at 1403:50 having been held so as to achieve a 2 minute separation from the preceding wide-body because of potential SID conflict with the previous departure. A Lufthansa aircraft then moved onto the runway as previously cleared and was advised to be ready to roll immediately upon receipt of clearance and did so when the clearance was issued at 1404:40 - the specified minimum departure separation at Heathrow is 1 minute. At this stage, a further aircraft, a British Midland Airways A321, still held a conditional line-up clearance. Having observed traffic at 2 nm on their TCAS (but not visually) as the Lufthansa aircraft began to roll, this crew queried their line up from the holding point but it was immediately confirmed by the trainee at 1404:50 and the British Midland aircraft began to enter the runway.

The trainee, having good reason to believe that his mentor was content with the plan, then issued the next aircraft in the departure queue with their "line up and wait after the landing 747" clearance. The British Airways 747 crew then saw the British Midland A321 begin to line up as the mentor at last realised that matters were going to be, at the very least, difficult and took over control of the radio at 1405:10. He advised the 747 to continue and at 14:05:20 told the British Midland A321 to "power up against the brakes" and continued the transmission with "you're cleared to take off" - 15 seconds before the minimum one minute departure separation had been reached. Meanwhile the 747 crew realised that their only safe option was going to be to go around and as they were beginning the transition, the mentor followed the A321 take off clearance almost immediately (1405:30) with a cancellation of it and instructed a go around by the 747. The A321 was able to stop after only a short distance as the 747 transitioned to a climb over the top of it. The go around instruction/commencement occurred when the 747 was at about 165 feet agl and the lowest height reached as it commenced go around in the vicinity of the A321 fail fin (just under 39 feet high) was later found to have been 118 feet……

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The Investigation found that what started out as an attempt to be helpful turned into a near disaster because:

(1) an effective plan to achieve it was not made [poor mentoring];

(2) when it became clear that it was too late for the plan being followed to work, no action was taken to resolve matters safely [poor judgement and poor mentoring];

(3) the eventual intervention of the mentor was initially still focussed on achieving the flawed plan [poor judgement].

Why did this happen when the Investigation found that this 'helping hand' almost invariably occurs uneventfully? The Investigation found no reason to criticise the performance of either the trainee controller or the flight crews involved. It found that the hazardous situation could be attributed entirely to the action - and the inaction - of the mentor who had failed on this occasion to act with the professionalism that he had previously displayed and which would reasonably be expected of qualified and experienced controllers carrying out this task.

What does all this tell us about production pressure? It certainly says that there is a time and place for adding to the pressure by trying to boost efficiency. It also suggests that working as an OJTI when, as was found to have applied in this case, less than 100% enthusiastic and engaged in the process, is conducive to inappropriate judgements. The trainee in this case relied upon the mentor for timely proactive guidance but did not get it. The eventual take over by the OJTI was too late and initially made matters much worse by continuing to try and get the unworkable to work. This is perhaps the key point - if a plan isn't working and can't be revised to maintain the original objective then it should be abandoned before safety is compromised. As always, tactical management under production pressure must be a matter for individual controllers and nobody should under-estimate the importance of this personal responsibility.

If you wish, you can see the official UK AAIB Inspector's Report into this 'Serious Incident' on SKYbrary[8], where you will, as you might expect, find lots more about the selection, training and working practices which were associated with the OJTI system at Heathrow at that time which I have chosen not to dwell on here.

[8] http://www.skybrary.aero/index.php/B747%2C_LOS%2C_London_Heathrow_UK%2C_2000



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# Situation Awareness, projection and the problems of degraded modes in ATM maintenance activities

## By Professor Chris Johnson

**Chris Johnson** is Professor of Computing Science at Glasgow University in Scotland. He heads a research team that focuses on the identification and analysis of systems failures across safety related industries. Over the last decade he has worked with organisations as diverse as NASA, the US Army and the UK National Health Service. He has worked on ATM related projects for more than a decade and is currently investigating the importance of safety culture in the systems engineering teams that are often called upon to 'fix things' when failures occur.

In the early 1990s, the US military were involved in a remarkable series of experiments intended to find out how good we are at anticipating when we need to sleep. In these experiments, army personnel who had been on night duty were asked to predict the likelihood of falling asleep in the next two minutes. The majority, who did fall asleep, failed to predict that this would happen. In other words, fatigue prevented them from accurately estimating their need for sleep.

In the same way, maintenance staff and systems engineering teams often go to extraordinary lengths to maintain underlying infrastructure. Often, those who are most directly involved in maintenance operations are the least able to accurately identify the risks and hazards that can arise during those procedures. This desire to support ATM operations can compromise safety unless it is carefully monitored.

Over the last two years, I have coordinated a survey of best practice in how ANSPs deal with what are termed 'degraded modes of operation'. These degraded modes are defined as occurring whenever ATM services continue to be provided without the support of critical components of the underlying systems infrastructure. Many service providers use minimum equipment lists to identify when such situations occur. However, in many cases systems engineering teams will struggle to support operations even though items on these lists may be temporarily unavailable. In extreme cases, loss of services has reached an unacceptable level.

The aim of the Degraded Modes project has been to identify the reasons why individuals and teams struggle to maintain levels of service even when critical elements of their operational infrastructure have been lost through system failures, maintenance activities or scheduled updates. This is an important topic because 'coping strategies' have been identified in the causes of both the Linate and Überlingen accidents. In both accidents, we were surprised that so many people worked so hard to maintain levels of service when they might have suspended operations in order to preserve system safety.

At Linate, there was a breakdown in communication between the groups responsible for the maintenance of the infrastructure and the operational staff. The gradual degradation of taxiway signage, the loss of critical runway lighting systems and the failure to update the analogue ground movement system gradually removed critical infrastructure support from the ATCOs. The ANSV investigators[9] found that these latent failures made the degraded operating modes more serious under reduced visibility; they found it 'remarkable' that the radar and lighting systems had not been improved in the months and years before the accident. Such observations are symptomatic of communications problems between maintenance management and teams of operational staff who must continue to maintain levels of safe service in the face of failures. At Linate it was particularly difficult for aircrews to use existing documentation to gain an accurate understanding of the operational environment.

Crucial markings between taxiways were indicated by yellow signs indicating the name of each route and by lines leading in the appropriate directions. However, the yellow line indicating the path of one taxiway had been partially obscured by black paint to cover an old path that had been modified. In consequence, the Jeppesen charts used by the crews did not provide accurate information about the state of the taxiways.

Similarly, the BFU report into the Überlingen accident[10] argues that the degraded infrastructure at ACC Zurich had a profound impact on the causes of the accident. "The radar system was being operated in the fallback mode and the optical Short Term Conflict Alert was not available; the telephone system was not working properly; the technicians working in the control room added to the controller's stress; operating two workstations with two different sectors from radar screens set to different scales was an additional strain and would probably not have been accepted by a supervisor although traffic flow was low; the ATCO could not use a headset as he was operating radios of two workstations.

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The regulatory authority had already voiced concern about SMOP (Single Manned Operation Procedures). The general work conditions during the night shift and the additional strains of the night of the accident did not meet the requirements for SMOP" [page 92 of the English language version of the report].

Most of the previous work on 'degraded modes' of operation has been on operational teams of ATCOs, as they maintain service provision under degraded modes of operation. The novel aspect of our present project is that it focuses on the systems engineering teams that are responsible for maintaining the integrity of the underlying ATM system infrastructures. In particular, we have identified the problems in 'projection' or the anticipation of the impact that systems engineering changes will eventually have on operational staff. For example, we interviewed one team in an ACC where engineers had two backup banks of processors. The active system was labelled by a placard warning technical staff not to take this unit off-line as it would directly compromise service provision. During one maintenance period, an engineer moved the placard so he could access the fallback processors. His co-worker then mistakenly shut down the active system. The systems engineering team and safety management group responded by placing both processor banks in separate locked cages. All was well until, a problem arose with the primary unit and the key for the cage could not be brought down to the maintenance staff in time to prevent a 'contingency' from occurring. In both of these incidents, there was a failure by maintenance teams to anticipate or project the consequences of their actions in moving the placard and in restricting access to the processors.

## Key recommendations:

A key finding from our work is that we do not need to reinvent a series of novel or expensive techniques to address some of the problems created by degraded modes of operation for systems engineering teams. In contrast, we argue that techniques, which are already used to train operational staff, should be extended to support technical and engineering activities:

### Simulation and problem-based training tools for systems engineers.

Many of the incidents that have been reported to the project could usefully be incorporated into simulation exercises for systems engineers that enable them to develop appropriate planning and communication skills, just as the same scenario and problem based training techniques are already used for operational staff. These techniques are already widely used by some ANSPs but are completely unheard of in other ECAC states.

### Low-Cost Operational Risk Reviews.

In many of the incidents that we have reviewed an initial risk assessment identified the hazards that might arise during maintenance and systems engineering operations. However, these assessments were seldom revised as problems arose during the performance of complex engineering tasks. In some cases, this meant that the risk information was barely worth the paper that it was written on. Other organisations, in particular the US Army, have developed simple easy-to-use risk assessment forms that encourage maintenance teams to consider the consequences of their actions as they work on an engineering problem.

### Closer Integration of Operations and Systems Engineering.

There is a growing divide between systems engineering and operational staff in some ANSPs. This divide includes, but is not limited to, pay differentials and terms of service; it also includes differences in background and in education. This divide is corrosive to safety culture. Some engineering teams have described ATCO's as the 'David Beckham's of ATM' who

**'hang up their headphones and go home while we work late'.**

Conversely, operational staff criticise engineering teams who care more about the performance of their networks than they do about the problems of Air Traffic Management. It is difficult to underestimate the importance of this divide. Future plans for Single European Skies rely on more extensive integrated systems that will require significant maintenance if degraded modes of operation are not to have an adverse effect on safety.

*[9] For a synopsis of the report and link to the original ANSV report see http://www.skybrary.aero/index.php/MD87%2C_WX_RI%2C_Milan_Linate%2C_2001*

*[10] For a synopsis of the report and link to the original BFU report see http://www.skybrary.aero/index.php/B757%2C_LOS%2C_Uberlingen_Germany%2C_2002*



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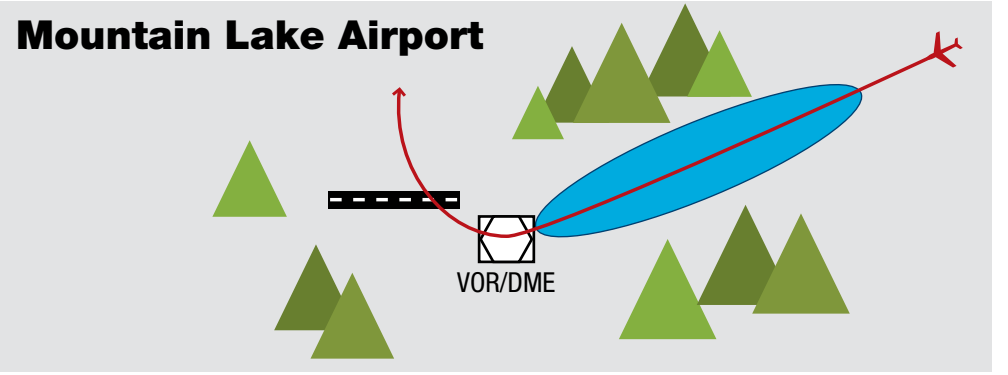
# The consequences of commercial pressure can be fatal

## By John Barrass

**John Barrass** served for 20 years in the UK Royal Air Force and Canadian Forces in a variety of flying, instructional, and command appointments. Now an established aviation consultant, John is the current editor of SKYbrary.

A few years ago now, a young flight safety manager came to ask for my advice. He wanted to know if there were statistics available which showed how often aircraft diverted from any given airport. He wanted to see if he could demonstrate that aircraft from his airline diverted less often that other airlines. I wasn't able to help much but I was intrigued to know why he wanted this data. This is his story, a story of how commercial pressure can influence safety culture in a negative way with disastrous consequences. The story is true but has been altered to protect the source.




The airline operated a small number of aircraft from a regional airport in the mountains which we shall call "Mountain Lakes". The airline operated a number of different types but, because of the performance challenges of operating into Mountain Lakes, all of the aircraft based there were of the same type and were not found anywhere else in the airline. Many of the pilots had been with the airline for a long time, had set up home in Mountain Lakes, and had no wish to be based anywhere else.

The only instrument approach to Mountain Lakes was a VOR/DME approach over a lake. The minimum descent height was 500 feet, and in the event of a missed approach there was a challenging procedure which took the aircraft back to the hold, avoiding quite high surrounding terrain. The missed approach procedure was reviewed and it was decided, for obstacle clearance reasons to raise the minimum descent height to 800 feet. The crews complied with the new procedures. One evening, an experienced pilot descended on the approach to 800 feet, failed to see the ground and diverted to a nearby larger airport. The passengers were then carried by bus to Mountain Lakes, a journey of three hours. The CEO of the airline received numerous calls from irate passengers complaining about the bus journey and he reacted angrily, dismissing the pilot concerned. Over the months that followed this event, there were no diversions. The CEO was pleased to hear that his airline had a reputation for getting into Mountain Lakes when competitors diverted. The young flight safety officer believed that pilots were flying below minimums in order to avoid diverting, because they were frightened of losing their jobs.

There was a twist to the tale. When I asked the pilot how sure he was that this was the case, he told me that recently he had flown as a co-pilot into Mountain Lakes and, when the aircraft came to the minimum descent point, the captain put his finger to his lips to signify silence, and continued to descend to the "old" MDH of 500 feet, whereupon they became visual with the airfield and landed without incident. I asked him if he had reported the incident; he had but his complaint had not been well received and he had been told to "mind his own business". A more experienced flight safety officer, with support from the airline management, might have been able to challenge this attitude but the young man was also concerned about his job. He therefore decided to try to highlight the existence of the problem to authorities indirectly, without it being obvious that he was the source of the information – hence the analysis of diversion data. He did not succeed.

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Why would pilots do this? Well, these were a capable group of pilots, very familiar with the terrain around Mountain Lakes, who were also very familiar with local weather phenomena. When put under commercial pressure, and you can't get much more pressure that the threat of losing your job, the pilots considered the situation pragmatically. It had always been safe to fly to 500 feet in the past, and the reasons for raising the MDH to 800 feet were, they considered, not entirely justified. They therefore started to use, unofficially, a MDH of 500 feet. There were fewer diversions, the CEO was happy, and nobody felt they were doing anything unsafe.

But things change. What can start as a safely managed if unofficial operating procedure becomes, over time, no procedure at all. Why stop at 500 feet if the MDH is 800 feet? Over time, the logic of the argument to continue below MDH was lost on many of those involved. The issues were not discussed and the airline management were unaware of this now unsafe practice. Disaster occurred when one of these pilots flew an approach in bad weather at an unfamiliar airfield. He descended below MDH without comment from either pilot and hit a hill. The accident report talks about Controlled Flight Into Terrain, but this was more than yet another CFIT accident, it was also a consequence of commercial pressure and a poor airline safety culture.

I would hope that this story that I have recounted is extreme but there are numerous anecdotes that suggest that, in small ways, pilots are often put under undue commercial pressure. An example is the programming of flight schedules which can barely be achieved in the crew duty day; a technical problem, slight delays in loading, traffic delays all conspire to create a situation where the pilot is under pressure to extend the crew day. One pilot told me that he was often asked by ops staff, when flying a notoriously tight schedule, to extend his crew day - as he put it "extending the crew day is a matter for my discretion NOT the dispatcher".

Efficiency and profitability can be achieved without compromising safety; it's just a matter of professionalism, imagination, a culture of safety, and leadership from the top of the organisation. Passing commercial pressure onto the people engaged in the safety critical functions of an operation can be all too convenient for management and commercial staff; awareness of this needs to be acknowledged and actively discouraged.

Keeping an airline operation profitable, especially in difficult economic times, is a real challenge. Everyone in the company needs to work together to ensure that the operation is efficient. Commercial awareness is of course important; pilots need to factor commercial considerations into their decision making always and maintain a safe operation; it is not easy to get the balance right.

# Preventing the drift into failure: How do we know when we get it right

by Anne Isaac, Victoria Brooks, Nicola Jordan and Magnus McCabe

**Dr Anne Isaac** is the Human Performance workstream lead for NATS, based at the corporate headquarters near Southampton. Victoria Brooks is a Senior Research Analyst with NATS, also based at the corporate headquarters near Southampton. Dr Nicola Jordan is a Senior Research Analyst with NATS, based at the Swanwick Air Traffic Control Centre near Southampton. Magnus McCabe is a Safety Improvement Specialist, also based at the corporate headquarters near Southampton.

Although there have been many changes over the last fifteen years – ANSPs and managers now have to pay much greater attention to achieving maximum efficiency – for operational staff the priority remains safety. It is important under these new and increasing pressures to continue to support our controllers and to help them achieve high productivity without prejudicing safety.

It has become necessary for some ANSPs to reorganise their operations to achieve greater efficiency, and there is a danger that in so doing their system may have become over complex and risk-prone. The challenge today is to make what is already an exceptionally safe system even more reliable.

ATC operational staff do their best to provide a safe and efficient service. But in their desire to help there is a danger that they might sometimes complicate a situation which the pilots would prefer to remain simple and uncomplicated. Incident analysis reveals that the many variables which controllers have to deal with often make their decision-making more complex and prone to error.

The most common types of error involved in loss of separation are those concerned with perception and consequent decision-making or planning. For example, the controller may fail to see the aircraft on radar, or may not detect the conflict on radar or on strips; wrong decisions may result from assumptions about aircraft performance and co-ordination with other units, and are influenced by the weather.

This simple analysis reflects not only information from all over the ATM world; similar observations are made in other safety-critical industries such as nuclear power, medicine and other transport systems.

To understand how changes in the ATM system have affected the operational staff, we need to understand what is happening and take steps to deal with it. Day 2 Day Safety Surveys (D2D) conducted by trained operational staff can reveal some interesting trends in behaviour. By watching and talking to the different teams it is possible to make more sense of the statistics already known from investigation.

Instead of confining observations to incidents and errors, observing what works well and how ATCO's and their teams manage difficult or risky situations can help us plan better for increases in traffic and changes in procedures and technology.

In practice, D2D reveals four main situations which operational staff do not seem to recognise as being risky. These situations are distraction, time pressure, On the Job Training and handover. The last two categories are not surprising and some of their associated causal factors are well known, however the first two categories may need some more explanation.
Distractions, which are almost always job related, cause the operational staff to juggle too many tasks with resultant increase in workload. Some of these tasks include:

- taking over the tasks of other controllers for short period
- helping other colleagues in an emergency or when a pilot makes a non-standard request
- taking phone calls whilst checking other information
- doing tasks in rest breaks which can interfere with the next operational session

Symptoms of time pressure include the desire to:

- execute a plan early and to 'keep things going'
- 'do it all' although it would obviously be better to split the sector to help the rest of the team
- provide a good service to the aircraft by keeping a climb or decent going
- help out other colleagues when they see problems, despite their own workload

Data from a set of D2D Surveys are shown in the diagram below. This can reveal differences in our underlying behaviour and the opportunities that exist to use tried-and-tested techniques to protect ourselves in risky situations.

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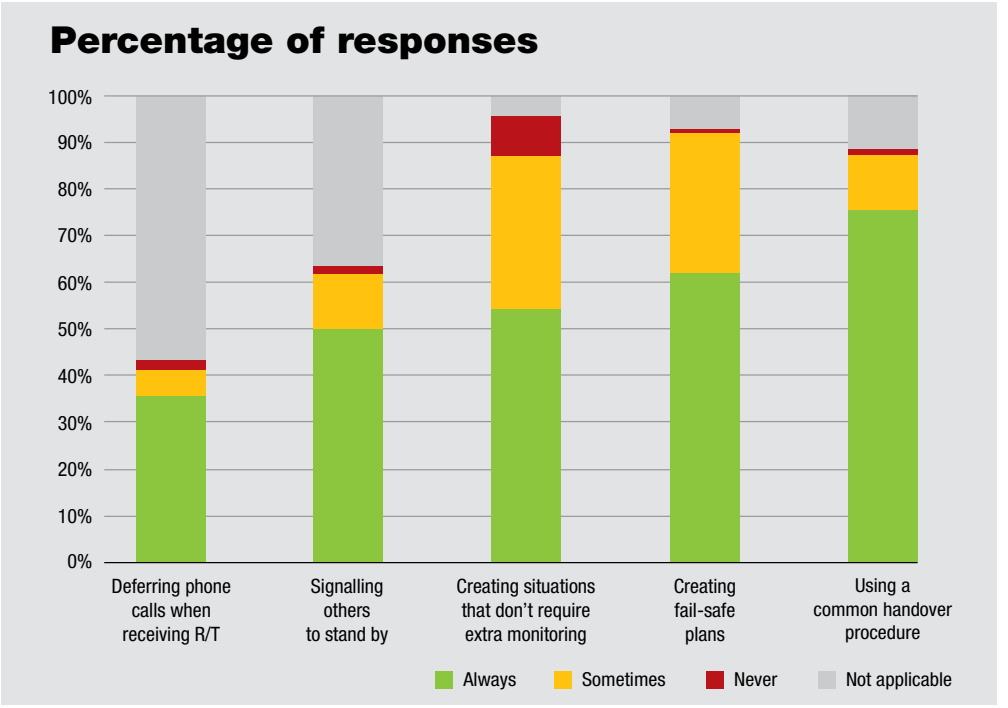


In this study, the incidents encountered were all familiar; however, it was the operational staff themselves who gathered the information about daily good practice and who suggested the mitigation and changes within the system to make an even safer operation.

The data from D2D was reviewed by safety teams at other ATC units and was cross-referenced with the unit's incident data. This helped them to formulate action plans to target the key areas which were identified.

At one unit, a pattern of errors was originally believed to have been caused by problems with strip management. However, review of the D2D observation data, discussion with data analysis experts and Human Factors specialists, and – most crucially – the close involvement of operational controllers from the sectors concerned, led to a different conclusion. With this assistance the unit was able to identify visual scanning patterns of both radar and strips as being the root of the problem. As a result, work commenced on Eye Movement Tracking experiments to determine the sector 'hot-spots' and to identify Best Practice techniques to protect controllers form the most common errors.

The results also confirmed the value of D2D. The overwhelming majority of flights enjoy an entirely safe and incident-free experience: if we relied for information solely on accident and incident reports we would miss many important lessons. D2D observations allow us to see the good techniques controllers employ – and how often they employ them. They help us see when techniques are difficult to employ and may suggest when those that work well may be adapted for use in other areas.

A further important benefit results from the fact that the observations are made by fellow controllers, while the solutions found are developed by operational staff – often the controllers' own colleagues. Those involved experience a sense of safety 'ownership' which leads not only to enthusiasm for driving safety improvement, but also to a related strengthening of the unit's Safety Culture. Safety Culture, of course, is a subject deserving its own separate article. Nevertheless, it is already evident that those units which have committed to D2D observations are already benefiting from developing the next generation of techniques aimed at keeping their decision-making straightforward, defending themselves against common errors, and thereby raising the standard in safety performance.



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# A close encounter of a most unwelcome kind

## By Ian Wigmore

After thirty years flying with the Royal Air Force, **Ian Wigmore** commenced a career in civil aviation, working for two airlines before joining ERA as Air Safety Manager. He currently works as an aviation consultant specialising in airline safety. He is Editorial Secretary of HindSight and was until recently the editor of SKYbrary.

Even the most pessimistic estimates predict that in spite of rising fuel costs the volume of air traffic will continue to grow and will double within the next 20 years. Although new airports are constantly being built, the majority of flights travel to and from the same destination airports. The ever-increasing traffic density in the terminal areas creates a need for improved equipment and procedures, and increased manning levels to maintain adequate safe separation between aircraft. Inevitably, these essentials lag somewhat behind their need – it takes time to recruit and train new staff, to install new equipment or to develop new procedures.

Airports have commercial imperatives just like any other business. Although it is undoubtedly true that flight safety is the first of these imperatives, the airport must survive against the competition provided by its neighbours. This means that air traffic control must strive to achieve and maintain the optimum levels of traffic flow. It is an essential part of the air traffic controller's job to expedite the flow of arriving and departing traffic based on ICAO standards and recommended practices.

Airlines, too, have commercial imperatives, and just like airports, safety comes first. But pilots are realists and understand well that any unnecessary cost will reflect on their airline's bottom line. They have seen other airlines go out of business because they were unable to compete commercially and they do all they reasonably can to enhance the profitability of their employers. So they are always ready to cooperate wholeheartedly with measures intended to improve the traffic flow, provided they can do so safely.

However, controllers do occasionally ask for rather more than is reasonable; and human nature being what it is, pilots do sometimes accept unreasonable requests in situations where it might be prudent to refuse. Thus production pressure on the ATCO is reflected into production pressure on the pilot. The following incident is an example of this reality.

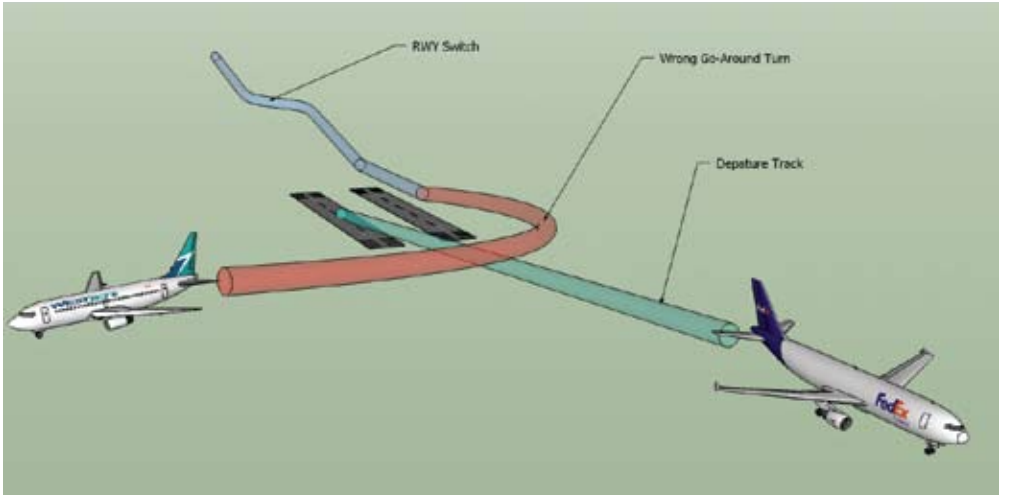
The airport concerned was at an elevation of 1000ft. It had two parallel runways – let's call them 09L/27R and 09R/27L. The passenger terminal lay to the north of the runways while the freight terminal lay to the south.

The ground to the east of the airport rose steeply so a turn soon after departure was necessary. To deconflict traffic when both runways were in use, departing traffic on 09L turned to the left after take off while that using 09R turned to the right. The turn point was defined by passing over an NDB (BBB). There were ILSs on both runways, the initial approach fix being a VOR (AAA) located about 7nm from touchdown. Missed approach procedures followed similar patterns, the missed approach point for non-precision traffic being the NDB.

The volume of traffic visiting the airfield was growing rapidly on this winter evening when our story begins; in fact it was very busy indeed. ATIS stated clearly which runway was in use for takeoff and for landing, but controllers often had to switch from one runway to the other to accommodate the traffic, and there were always problems with aircraft having to taxi across an active runway to or from the passenger or freight terminal.

A Boeing 737-300, callsign B-line 238, was cleared to descend to 4000 ft QNH. The crew had copied the ATIS code Papa (300 BKN, 1000 OVC, W/V 120/5, QNH 1015, takeoff runway 09R, landing runway 09L) and had briefed for an ILS on Rwy 09L. They expected to be vectored to the localiser in accordance with normal procedures before they reached the IAF. This was in the days before TCAS was mandated and none of the aircraft involved in this story were TCAS equipped.

This was a typically busy day. There were several aircraft awaiting takeoff and another stream being vectored for landing. The aircraft were of mixed types: mostly narrow-bodied jets but with some turboprops amongst them. The Approach and Tower controllers were working closely together in order to optimise runway use,

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switching from one runway to the other when the need demanded.

The Approach controller picked off B-line 238 at 4000ft:

*B-line 238 descend to 3000ft QNH 1015, turn right 080 radar vectors for ILS Runway 09R, you are number three to an A320.*

The first officer read back the clearance, then re-set the ILS and nav-aids and re-programmed the FMS. The pilots changed to the Rwy 09R plate and the captain re-briefed the approach; then as the aircraft levelled at 3000ft he instructed the first officer to report level.

The Tower controller could see an aircraft waiting to cross the northern runway, meanwhile an A300 freighter was approaching the southern runway for departure. If he switched the 737 to 09L there would be enough time to get the aircraft across the runway and the freighter could depart on 09R. The only problem was the Dash-8 on the ILS to 09L.

The crew of B-line 238 were approaching the VOR and were just about to start the landing checks when the Approach controller asked:

*B-line 238 can you accept a switch to Rwy 09L please?*

The captain sighed: "tell him OK."

*Approach B-line 238 affirmative.*

*Thank you 238. You are clear for the ILS Rwy 09L. Call Tower frequency 111.11 MHz.*

The captain re-tuned the ILS; the aircraft turned to intercept the localiser; the FMS indicated approaching the glideslope so the captain called for landing gear down and the aircraft began to descend; then the first officer checked in:

*Tower B-line 238 fully established on the ILS 09L.*

*Roger B-line 238, continue, you are number two to a Dash-8 four miles ahead.*

With the checks complete, the first officer began to look for the runway. At about three miles he began to see the approach lights intermittently and by two miles he could see the runway clearly – and the aircraft which had just landed still on it. "It's going to be a close thing if that Dash-8 isn't quick clearing the runway." He told the captain. Then as the aircraft approached 200 ft he called: "Decide."

The captain looked ahead and seeing that the runway was blocked called: "Going around." At the same time he pressed the go-around button, then as the aircraft reached 500 ft he turned right onto 150 and continued the climb.

*Tower B-line 238 going around.*

The first officer reported.

.....

The approach control breathed a sigh of relief. He had seen the 737 turn the wrong way and for a few seconds that seemed like hours had watched the blips on his radar corresponding to it and the departing A300 merge.

Cleared by Tower, the first officer checked in:

*Approach B-line 238 on the go-around heading 120 for DDD*

*Roger B-line 238, turn right heading 180, climb to 5000 ft.*

Then with the two aircraft safely separated, the controller asked the pilots to call him after landing. When the captain rang, he pointed out the error and its results and informed him that he would be filing an ATC Incident Report.

You can bet the pilots discussed the incident afterwards, and the captain was not very complimentary about the first officer's monitoring of his actions. The crew filed a Mandatory Occurrence Report and the local authorities initiated a review of the case. Analysis of the radar traces revealed that the aircraft had passed within 100ft vertically and 150m horizontally of each other. The incident was classified as a Class A AIRPROX: a Serious Incident, and a formal investigation was conducted.

The investigation had no difficulty in deciding that the pilots had turned the wrong way during the go-around, following the missed approach procedure for Rwy 09R instead of 09L. This was because they had not properly re-set their equipment and re-briefed the approach when the runway was changed the second time.

The root cause of the problem was that the landing runway was changed at short notice at a fairly late stage in the approach. The investigation revealed that this was a fairly frequent occurrence and that several similar, though less serious incidents had happened before but had not been reported. Many instances of late changes to the takeoff runway were also uncovered. Their recommendations to the ANSP resulted in a complete review of ATC procedures at the airport.

Of course, the crew should have reset their equipment to the revised landing runway – and re-briefed the approach; and the Pilot Not Flying (in this case the first officer), whose primary duty is to monitor the actions of the Pilot Flying (the captain), should have at least corrected the captain when he commenced a right turn after takeoff. That is what SOPs are for and, and if pilots believe they will be unable to comply they should refuse a late switch.



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# Can we ever escape from the side effects of production pressures?

By Stathis Malakis

**Stathis** is employed by the Hellenic Civil Aviation Authority as an Air Traffic Controller holding Tower, Approach and Terminal Approach Radar ratings. He holds a Mathematics degree, an MSc in Air Transport Management and he is currently completing the degree of Doctor of Philosophy (PhD). His PhD thesis is "ATC Decision Making in Emergency Scenarios" for which he was nominated a PhD research grant from EUROCONTROL Experimental Centre.

A few years ago now, a young flight safety man- There are quite a few production pressures in the ATM system. The most important categories include those that spring from safety, capacity and financial targets. These are well documented and constantly communicated from the higher levels of management down to the front-line controllers in the operation rooms. For example typical targets in this category include a reduction of 5% in en-route delays, the containment of the number of serious incidents below 1 per 100,000 movements and the reduction of the cost per flight controlled by 3%. These performance targets are included in the annual reports and the safety, policy and operational documents of any ATM organization. They effectively form the performance yardsticks by which the combined output of ATM organizations, from an ANSP and a large Area Control Centre down to an Approach and a Tower unit are formally evaluated.

The collective processes of fulfilment of the performance targets generate what we call production pressures in the ATM system. Production pressures of this kind are obvious in any type of ATM organisation. Following the standard fashion of doing business, the annual capacity, safety and financial output of an ATM organisation are evaluated each year against the predetermined performance targets; positive or negative deviations lead to appropriate corrective actions through managerial actions and processes.

## "But, are things as simple as they appear?"

Contrary to what is normally expected the answer is No.

Productions pressures are also linked to another type of output, which is hard even for insiders of an ATM organisation to see. When the clearly stated and well documented performance targets intermingle dynamically with the operational, technical and social complexities of the ATC operation rooms and their parent organisations, another type of output is also produced. Production pressures give rise to an unanticipated set of phenomena that are not written in any document and no formal means of communication to the higher levels of management exists. The net result is unpleasant effects that happen in addition to the main effect; or to put it simply, the side-effects of production pressures.

## But what do we really mean by production pressure side-effects in an ATM system?

It is neither possible nor desirable to cover all the side-effects of production pressure in the restricted space of a small article. However addressing even some of them can provide us with a clear view of the magnitude and the severity of the issue. So let's just portray a small set of practical examples:

- A noticeable increase in the operational personnel who choose to work part time in the opeations room. Behind the officially stated reasons (e.g. medical, family reasons) the true reason for the choice of the part-time option is often that an increasing number of operational personnel cannot effectively cope with the shift work rhythms imposed by the increasing traffic levels. Other non-safety related reasons are officially stated, for in reality, the management cannot accept safety as being the true reason. For example a controller cannot state that he/she cannot cope with the soaring traffic levels and has valid reasons to believe that it is no longer safe to provide ATC services.

- Groups of non-operational personnel may treat controllers as "second class workers". When a controller tries something different (e.g. attending a management course or skills development course) the management may refuse, based on the premise that it is not in the controllers' job descriptions. This effectively creates an impression that controllers are not considered fit to advance their careers outside the operations room – with some rare exceptions just to prove the general validity of the rule.

- Groups of non-operational personnel are expected to make real inputs to the operations rooms but controllers are not expected to make real inputs to non-operational groups. Through the various management processes, operational controllers get the impression that almost any non-operational staff can make proposals that directly affect work in the operations room; meanwhile constructive suggestions from the controllers to improve the working of non-operational departments are not encouraged or welcomed.

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• Some controllers who cannot cope with the increase in traffic, display quite noticeable symptoms in their everyday operational and social behaviour (e.g. aggressiveness, lack of motivation). A few years ago, many controllers reported for duty well before the commencement of shifts (especially nightshifts); the tendency today is for more and more for personnel to report for duty at the last minute. To put it simply the constant struggle with high levels of traffic takes its toll on the operational and behavioural patterns of the controllers.

• When someone from the operations room is promoted to a managerial position his/her personality changes immediately. For example in a large Area Control Centre a shift supervisor completely changed overnight when he got the managerial position he had always aimed for. He used to be relaxed during the shift, even allowing fellow workers to go home early; but when he got the managerial position he did not hesitate to officially report a controller when he was just five minutes late on shift.

• Important operational-related tasks are prepared in a hurry to meet managerial requirements. For example a team of instructors quickly prepared a refresher course without having any specific guidelines, using only a minimal set of high-level requirements that were presented by the management. The aim was to meet the directives and the pressing deadlines of the parent organisation and the strict requirements of the quality system.

• Controllers very often sense a strong feeling of isolation from the management. It seems as if the managers only care for numbers, directives and deadlines and are not interested in the real life of an operations room. The increasing distance between management and front line personnel has a direct impact on the motivation levels of the controllers. Distance created by a preoccupation with numbers, directives and deadlines adversely affects the controllers' motivation.

These are some of the real-life vivid examples of the side-effects of production pressures in operations rooms. They convey the message that the side-effects are real phenomena. Some readers may be familiar with a number of them, some may not, but hopefully everyone from front-line controllers to top management can understand that production pressures achieve more than statistics, requirements and deadlines. The living operational context must be taken into account when putting data into a frame for interpretation. If we fail to consider the effects in the operational context, the numbers are reduced to simple algebraic symbols with no meaning other than performing simple arithmetic operations.

Production pressures generate not just the desired effects: meeting targets, requirements and deadlines; but create side-effects while doing so. If the operational context is distorted as a consequence of the relentless pursuit of targets, then many other things may also be distorted. To put it in another way, the statistics may look good, requirements may be fulfilled and deadlines may be met – until an incident or even an accident happens … and then, everyone will discover in hindsight the hidden side-effects of production pressures in the direct or related causes.

By understanding the severity and the magnitude of the issue, three difficult practical questions emerge:

1. How can we effectively map the side-effects of production pressure in the operations room?

2. How can we minimize or even nullify their consequences?

3. How can we impose an efficient mechanism to detect the side-effects of production pressures?

The answers to these questions are neither simple in nature nor insignificant in relation to other important issues in the present and future of ATM system operations.

This article does not pretend to give a clear, concise and universal solution. Answers are difficult and above all too context-sensitive to be explored briefly. The aim is to trigger an initial awareness of this important issue and draw the attention of everyone, from the individual to the parent organisations that bear the responsibility for handling and at the end of the day solving the problem. The true aim is to set in motion those forces within the ATM system that will eventually lead us to the much needed "escape" from the unanticipated and undesired side–effects of production pressures.



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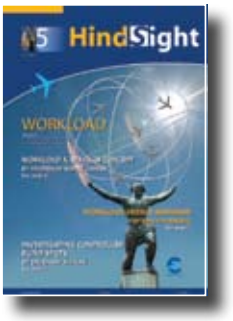


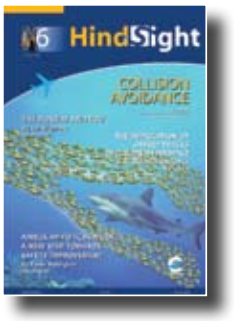



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in Air Traffic Management



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