N°5

HindSight

July 2007

WORKLOAD

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

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EUROCONTROL

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ABOUT HINDSIGHT

The main function of the *HindSight* magazine is to help operational air traffic controllers to share in the experiences of other controllers who have been involved in ATM-related safety occurrences. In this way, they will have an opportunity to broaden their experience of the problems that may be encountered; to consider the available solutions; and so to be better prepared should they meet similar occurrences themselves.

Material contained in *HindSight* falls into three distinct classes:

- Editorial;
- 121.5 - Safety Alerts; and
- The Briefing Room - Learning from Experience.

On page 3, you will find a table of contents listing articles under these three headings. Editorial material, such as this article, needs no explanation but a few words on the other two classes may prevent any misunderstanding.

121.5 Safety Alerts

From time to time EUROCONTROL issues Early Warning Messages and Safety Reminder Messages to draw the attention of the ATM community to emerging safety issues. The messages are intended to encourage discussion on the prevalence and seriousness of the issue and on the most appropriate reaction to them. Summaries of some recent messages are included.

The Briefing Room - Learning From Experience

The majority of *HindSight* is taken up with articles concentrating on specific safety issues. These usually comprise a study of an actual accident or incident(s) together with a summary of lessons learned. These articles are coded to reflect the subject material.

Some incidents relate to the performance of ATCOs or the ATM system, while others illustrate pilot errors which can arise from incorrect interpretation of ATC instructions, or other unpredictable situations.

The incidents fall into two categories:

- **Summaries of accident and serious incident reports**

The full report usually runs to many pages, so these reports must be summarised and simplified, concentrating on the ATM-related aspects and passing quickly over (or even ignoring) other issues which have no direct relevance to ATCOs. A reference to the original report is always supplied.

- **Dis-identified accounts of other ATM-related incidents**

Typically, the original reports are not in the public domain; however there are important lessons to be learned from them. The identifying features of the reports are altered without changing the substance of the reports in order to preserve the confidentiality of the reporter.

Lessons Learned

In the articles that follow, only the lessons learned from the featured accidents and incidents are listed.

Knowledge Base

We are compiling a Knowledge Base of all types of ATM-related safety reports, which may be accessed by persons carrying out research on particular subjects. We call this knowledge base **SKYBRARY**. This is a long-term project but we plan that the HindSight magazine should be integrated with it from the outset.

Coding of Subject Matter

To aid 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
- Other

SIX QUESTIONS ABOUT WORKLOAD

By Tzvetomir Blajev
Eurocontrol Co-ordinator Safety Improvement Initiatives and Editor in Chief of HindSight

1. Is it possible to have work without workload? Workload in itself is a very good thing - it is an indication that we still have jobs. And just as in a survival reality show, having some work to do increases our chances of success.

2. Where is the border between workload and overload? Because workload is not bad, we often use the concept of overload for periods that are close to "overheating". Have you noticed that overheating and overload both begin with "over"? This suggests that there is an invisible border that separates normal workload from dangerous situations. The feedback that we receive from studies and investigations of events does not always confirm this. We have become aware of "low-vigilance periods", when the workload is dangerously low. Others point to the post-peak periods as being particularly vulnerable; we might need "gear-shift strategies" to deal with them.

3. Can I be overloaded without realising it? The perception of "being behind the traffic" is still the main indicator for this. But does this make the two synonymous? Can human beings work close to, or beyond the normal boundaries of efficiency and have a false perception of comfort? Am I overloaded if I work in a reactive way, responding to the traffic situation instead of planning it in advance? Can we be trained and successfully learn our own workload status - overload, low vigilance, post-peak - and adapt accordingly?

4. Whose workload are we speaking about? Can we simply talk about ATCO workload, and pay no attention to the pilot's situation? Individual workload matters, but so does the virtual team workload.

5. Are personal or team strategies more effective in mitigating overload? In the cockpit, practices have evolved over the years, introducing task sharing, standard calls and cross-checks. In this way the Pilot Flying and the Pilot-Not-Flying become more reliable and less affected by overload. This is particularly true for those tasks in which the consequences of failure are greatest - altimeter settings, descents, etc. Can ATC adopt a similar approach? Or does the fact that the Planner Controller is working in a future time horizon make him less suitable as back-up for the current tasks of the Executive Controller?

6. Should we talk about workload at all? In his column, Professor Sidney Dekker suggests that we should speak to our union, instead of involving Human Factors specialists.

Some people say that by formulating the right questions you are already some way to answering them. In this issue of HindSight we raise the question of workload. Some of the authors provide their answers. We hope you will enjoy reading them.

WORKLOAD A STRANGE CONCEPT

by Professor Sidney Dekker, Ph.D.

Sidney Dekker is Professor of Human Factors & Aviation Safety at Lund University in Sweden. He gained his PhD 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".

So you're busy.
And then you're not.

Being a controller means handling ebbs and flows in workload. Workload is a strange concept. We in Human Factors have never really cracked it. Sure, when ergonomists were only concerned with physical labour, workload was easier to measure. But for a controller, it's mental workload that matters. And mental implies "subjective," right? Not everybody experiences the same situation in the same way. It depends on experience, proficiency, time of day, familiarity, disposition, and so on.

Workload, then, depends on the person perceiving it. How can we measure mental workload, then? Well, we can't. We can only measure something else. Such as your opinion (this is called, to make it sound official, "a subjective rating"). Or your heart rate. Or the variability in your heart rate. Or brain waves. Scientists have different preferences, and may swear by one method. All measurements, however, are inferences. They may say something about the mental effort you're putting into a task (but they may not). The best strategy is to use a number of different methods. If measurements converge, they may have measured the same thing. This is why many studies that probe your heart rate or brain waves also throw in that "subjective rating".

But enough of this: you are more likely to be at the receiving end of the electrode, not the one screwing it in. Here's a more interesting question: do you experience more mental workload in the simulator, or with the real thing? We actually tested this. Yes, physical measures follow the same pattern in the simulator and the real world. But, you may ask, would I be just as busy in the simulator? Or would you go, "Naaah, this is fake after all." It turns out that when things are quiet, heart rate is lower in the simulator than in the real world. What about busy periods? Here it gets more complex. In the simulator, heart rate increased in advance of "unexpected" events. So the simulator, where people "knew" what they were going to get, made the unexpected less unexpected. With the real thing, the unexpected really was unexpected, and heart rate shot up only once it actually happened. Interesting for the transfer of training from simulator to the real world.

Finally the real question: what is the maximum workload a controller can take? Well, there is no maximum. Oh, for you personally there may be (but then, that will also depend on how much you've slept and how familiar you are with the situation and how experienced and proficient you are). To determine your maximum workload, check with your union, not a Human Factors specialist.

FRONT LINE REPORT: WORKLOAD VERSUS BOREDOM

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.

Six hundred and seventy hits. 670. That was the result of a simple "search" I performed on the Eurocontrol website for the phrase "workload". Mind you, this means there are 670 documents (studies, reports etcetera) accessible on the website that contain the phrase "workload" at least once, so it's not just the total number of times the phrase occurs in the texts. From my perspective as a controller that is a highly impressive number of documents - in fact it makes me wonder why my workload is still as high as I sometimes think it is.

From the earliest days when I started looking around for texts on air traffic control work, I've come across documents dealing with our workload. Many brilliant innovations have been proposed in those documents, and invariably one of the foreseen benefits of the new tool/system/procedure is a reduction in controller workload. We really must be heavily burdened in our jobs, seeing how much effort goes into reducing our workload!

Let's not kid ourselves however. The only reason why effort goes into reducing controller workload is to potentially increase the amount of traffic that can be handled. The total workload therefore will remain roughly the same. This can be illustrated by a simple piece of maths: if the workload per aircraft is 4 and a controller handles 25 aircraft, the total workload of that controller is 100. Now if the workload per aircraft is reduced to 3 but the controller gets to handle 33 aircraft, the total workload will be 99. (This is the optimistic scenario, for there actually is a reduction in the total controller workload from 100 to 99. In the pessimistic, or perhaps realistic, scenario the controller would get to handle 34 aircraft, which brings the total workload to 102).

In reality there is no simple piece of maths to determine controller workload. Every controller knows that workload is not directly proportional to the number of aircraft handled. It can be harder working five aircraft at a given time than twelve some other time. Workload is influenced by factors such as weather, airspace restrictions, aircraft performance, pilot communication skills, coordination requirements and equipment performance, to name just a few (in no particular order). Contextual conditions, in other words.

Yet in many of the studies I've seen those contextual conditions are not considered. The factors that are usually cited include "sector size", "number of aircraft in sector", "number of vertical movements", "number of conflicts", etcetera. In one of the more recent studies I viewed from the 670 docu-

ments on the Eurocontrol website, controller workload was estimated by using a formula comprising the products of a) the time (expressed in seconds) needed to execute routine tasks, level change tasks, and conflict tasks, and b) the number of aircraft, flight levels crossed and the conflict search/resolutions respectively.

Now I'm not setting out in this column to discredit that particular study, but I find the way this formula is made up highly fascinating. "Routine tasks" are something different to "level change tasks" and/or "conflict tasks"? And can a level change not be a way to resolve a conflict? My favourite is the notion of using "the time (expressed in seconds) needed to execute a task" as a factor to determine workload: the longer a controller takes to perform a task, the higher the workload! This reminds me of efforts to express controller productivity in "miles flown per aircraft in the sector": the more direct routings a controller gives, the less productive he/she becomes.

My personal fear is that efforts to reduce controller workload will ultimately result in us just doing more of the same, i.e. handling more traffic in a uniform way, rather than dealing with the many variables we know so well and have grown to love because that's what makes our job interesting. If everything is reduced to just processing huge masses of traffic uniformly, the danger of controller boredom rears its ugly head (I'm throwing in some literary language here in order to help my European colleagues achieve Level Four English or higher).

The Eurocontrol website harbours an interesting document with a 2006 study on the topic "Monotony in ATC - Contributing Factors and Mitigation Strategies", from which I took the following quote:

"Concepts like the synchronization of traffic flows are developed to cope with increasing traffic demands without considering that they might contribute to more uniform and homogeneous tasks evoking monotony. In such cases, even under high traffic density, monotony may occur because of the short action cycles in the task that reinforce the subjective feeling of monotony."

Anyone interested in reading that document should have little difficulty in finding it: the Eurocontrol website only returns four (4) hits when a search on "monotony" is performed.

I submit that from a safety perspective there may be more to gain from an increase in studies into the effects of controller boredom than from even more studies on controller workload.

121.5
SAFETY ALERTS

SAFETY REMINDER MESSAGE SUMMARY

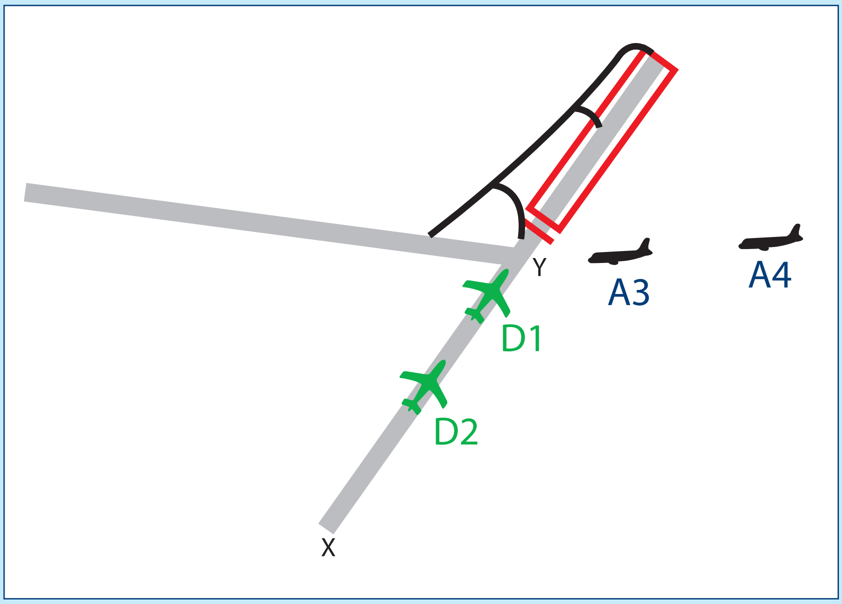
HOLDING POSITION AT RUNWAY/RUNWAY INTERSECTION

Origin: European ANSP
Issued: 29/11/2006

This message relates to:

- Awareness pertaining to the requirement for the consistent application of the ICAO Annex 14 Standards for the marking of Runway Holding Positions.

- Additional awareness that, where a runway which includes at least one runway/runway intersection that is used for taxiing purposes, the standards for the marking of that runway to indicate runway holding positions(s) with respect to the other runway, are described in Annex 14. Where such markings are not applied, ATC must be made fully aware that aircraft/vehicles may not be instructed to hold short of the runway in question.



THE PROBLEM

- Runway X crosses the threshold of runway Y. The last 1500 metres of runway X were closed for work in progress. The end of the available runway length of runway X was a few metres north of the threshold of runway Y and was marked with red obstacle lights. Runway Y was used for both landings and departures. It was after dawn.

- Departing aircraft D1 received clearance to hold short of runway Y. Aircraft D1 considered the red obstacle lights to be a stop bar and entered RWY Y. Seeing landing aircraft A3 on short finals aircraft D1 crossed runway Y at the threshold, ran over the red obstacle lights and stopped behind them. Aircraft A3 landed on RWY Y.

- Departing aircraft D2 also received clearance to hold short of runway Y. Aircraft D2 also considered the red obstacle lights to be the stop bar, entered and stopped on RWY Y in front of the red lights. Second landing aircraft A4 was instructed to make a go-around and passed overhead aircraft D2.

- The edge lights on runway X were on, including the marking of the work-in-progress area. The lights on runway Y are difficult to detect from runway X before entering runway Y. At the time of the incident no markings, signs or lights were available on runway X to indicate the holding point for runway Y. The red obstacle lights were considered by pilots to be the stop bar!

- Following the incident, a stop bar and runway guard lights have been installed on RWY X in front of RWY Y.

ICAO ANNEX 14 PROVISIONS

§1.1 Definition. Runway-holding position: "A designated position intended to protect a runway, an obstacle limitation surface, or an ILS/MLS critical/sensitive area at which taxiing aircraft and vehicles shall stop and hold, unless otherwise authorized by the aerodrome control tower".

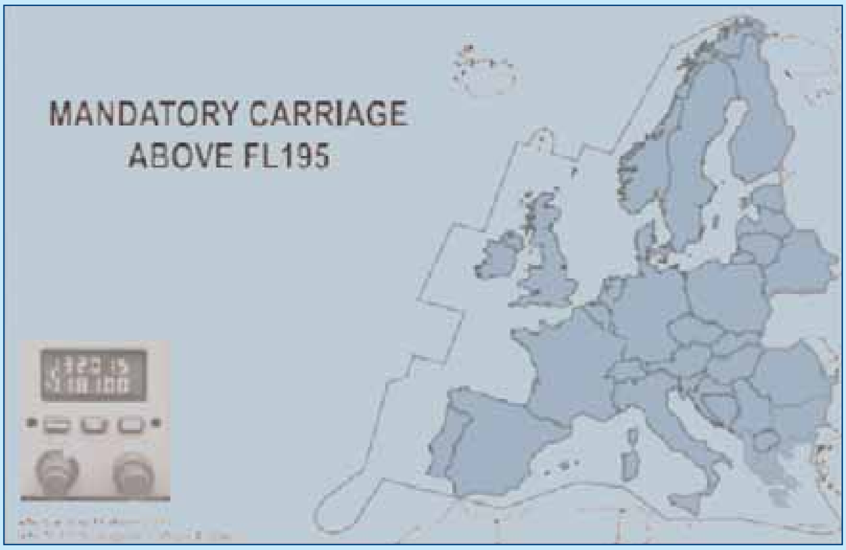
ICAO provisions regarding stop bars refer to holding positions which by definition include runway/runway intersections;

§5.3.19 Note 2. "Runway incursions may take place in all visibility or weather conditions. The provision of stop bars at runway holding positions and their use at night and in visibility conditions greater than 550m runway visual range can form part of effective runway incursion prevention measures".

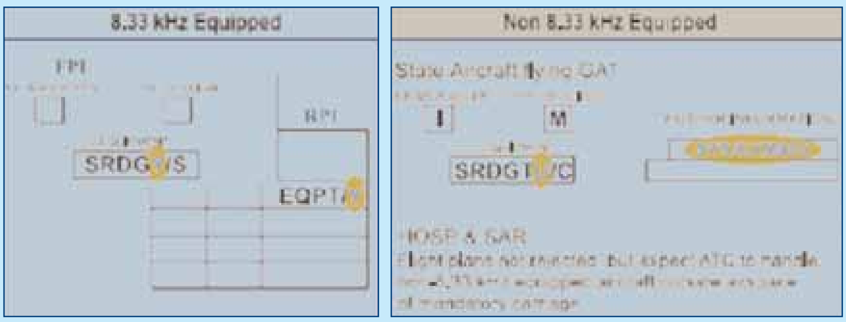
§5.4.2.3 "A pattern "A" runway holding position shall be supplemented at a taxiway/runway intersection or a runway/runway intersection with a runway designation sign".

§5.2.10.7 The runway-holding position marking displayed at a runway/runway intersection shall be perpendicular to the centre line forming part of the standard taxi-route. The pattern of the marking shall be as shown in figure 5-7, pattern A (i.e. pattern "A" = Category 1 holding point, authors comment).

8.33 kHz Procedures Quick Reference



FLIGHT PLAN



CHECKLIST

Before Flight	**"Y" (8.33 equipped) in item 10 of FPL**
Pre-Flight	**Radio configuration and 6 digits selection**
In Flight	**6 digits selection** **Correct phraseology** **Read back VHF channel in full**

CAUTION For new aircraft entering 8.33 airspace for the first time, or for aircraft back into service after maintenance, **BEFORE INSERTING "Y" IN ITEM 10 OF FPL, PILOTS MUST VERIFY AIRCRAFT IS FITTED CORRECTLY.**

PHRASEOLOGY

Circumstance	Phraseology
To request confirmation of 8.33 kHz capability	CONFIRM EIGHT POINT THREE THREE
To indicate 8.33 kHz capability	AFFIRM EIGHT POINT THREE THREE
To indicate lack of 8.33 kHz capability	NEGATIVE EIGHT POINT THREE THREE
To indicate that clearance prevents non 8.33 kHz equipped aircraft entering airspace of mandatory carriage	DUE EIGHT POINT THREE THREE REQUIREMENT

6 and 4 DIGITS PRONUNCIATION

Channel (8.33 kHz / 25 kHz)	Transmitted as
118.000 (25 kHz)	ONE ONE EIGHT DECIMAL ZERO
118.005 (8.33 kHz)	ONE ONE EIGHT DECIMAL ZERO ZERO FIVE
118.010 (8.33 kHz)	ONE ONE EIGHT DECIMAL ZERO ONE ZERO
118.025 (25 kHz)	ONE ONE EIGHT DECIMAL ZERO TWO FIVE
118.100 (25 kHz)	ONE ONE EIGHT DECIMAL ONE

It is essential that pilots READBACK the channel number in full

www.eurocontrol.int/833

INVESTIGATING CONTROLLER BLIND SPOTS

By Dr. Barry Kirwan

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When we talk of 'workload' we usually think of high workload and the strategies we have to adopt to cope with these situations. There is a danger that we may carry over these strategies to low-workload situations with unfortunate results.

Last year I was asked to investigate a series of incidents at a European Air Traffic Control Centre. The incidents were all in en-route airspace, involving losses of separation caused by overlooking an aircraft. However, they were compelling to say the least - in some cases very few aircraft were under control, and the two aircraft were very obvious. So, how could trained and experienced controllers, working in pairs, have missed them? That's what this article aims to explain.

My first port of call was the local investigator, who as usual had done an excellent job in analysing the cases and categorising their contributory factors. The next port of call was the controllers themselves. The safety culture at this centre is such that we did not need to interview controllers separately, and so we interviewed them in two groups. We had a form of incident replay available so each controller could talk over the replay and explain what they thought had happened (including 'no idea how I could have missed it!'). By having several controllers in each session, it enabled them to consider not only their incidents but their colleagues' too. This led to good discussions and the two groups could search for 'systemic' factors, as well as those that were evident in each individual incident.

The next phase was more 'analytical', as I tried to piece together the puzzle, based on what I'd seen and what they

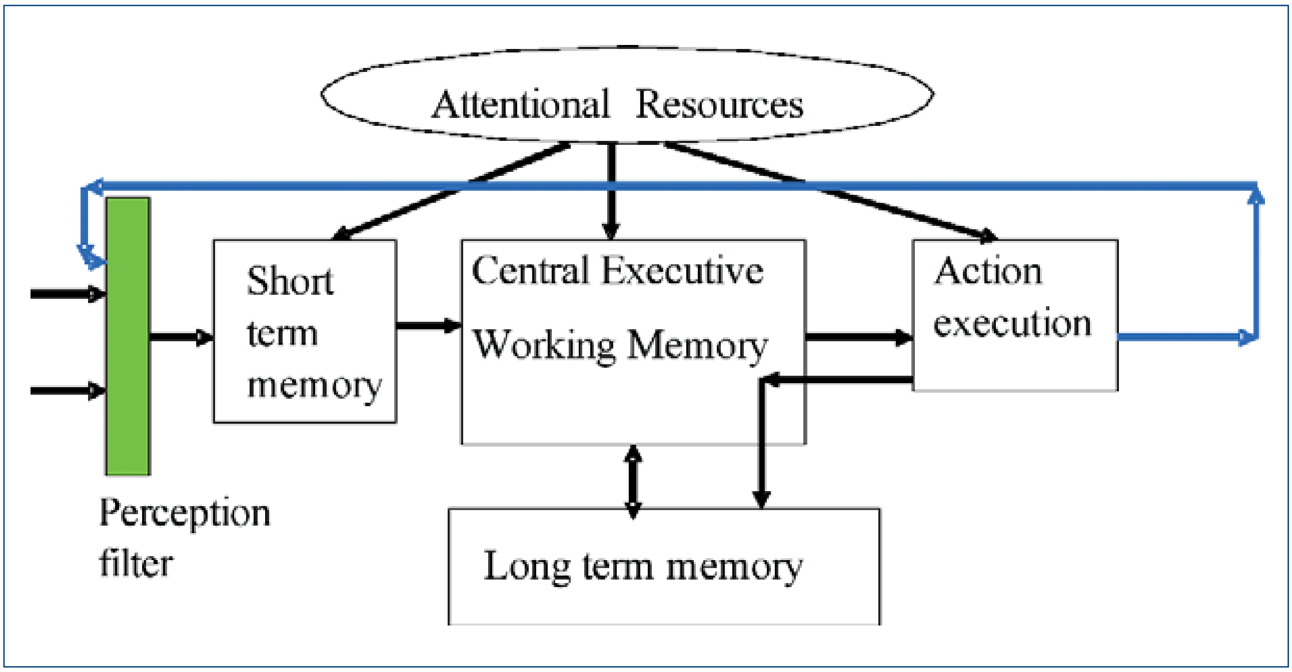


***Figure 1** - Information processing model*

had told me. I relied on one of Human Factors 'models' of how humans work, known as the Information Processing Model, pictured in ***Figure 1***. It's not rocket science, but it's quite useful and doesn't tie your brain in knots!

The model says that an individual (e.g. a controller) first receives information from the environment (e.g. the radar screen or oral information), via perceptual ***filters*** that discriminate between 'noise' and 'signals'. These filters generally operate in an 'unconscious' fashion (e.g. ignoring background voices when talking to someone), but are affected by experience and attention. The information taken in then goes into a 'buffer' called ***short-term memory***, which can hold information only for a limited amount of time (e.g. remembering a call sign such as AFR214). Short-term memory can only hold small amounts of information (e.g. a call sign of AFR21683472 would be difficult to hold in short-term memory very long - try it!) unless it is repeated or refreshed (e.g. by remaining on the radar screen or a strip). ***Working memory*** is where the 'conscious' mind resides, and is sometimes considered as a 'blackboard' upon which we put things (visual or verbal information or ideas, etc.). Working memory is closely related to 'situation awareness', and when we talk of a controller having or holding a mental 'picture', we are referring to the working memory. It is the active part of memory, and includes the capacity to make judgments and decisions. ***Long-term memory*** is by contrast passive, a data-store - it holds all the information and experiences for an individual, such as procedural information (including unofficial procedures, workarounds, short-cuts) and factual information (e.g. aircraft performance characteristics). ***Attentional resources***, particularly relevant to this study, concern the mental resources necessary to remain aware of the key aspects of the task (what we refer to as vigilance), and the resources necessary to concentrate. Lastly, the model refers to ***action execution***. In ATM this is usually a physical action (e.g. a mouse click; opening up a track data block menu, etc.) or an oral communication to a colleague or aircrew.

Okay - so we have a model - so what? Well, this is what I did with it.
The analysis of the incidents suggested that they were happening via what may be called ***'layered situation awareness'***. Layered situation awareness relates to the need to handle significant traffic and their demands, against a background of other traffic. The controller, in order to deliver high capacity and a quality service, focuses on traffic that are demanding, e.g. a need to climb or descend, or be at a certain XFL, but before that, remaining at a cruising altitude as long as possible. The controller therefore mentally suppresses, or in the extreme case 'filters out', certain aircraft under control as well as those which are not under current control - those that are relatively 'invariant' in their passage across the sector (e.g. they are staying at cruise level). This approach to controlling traffic is borne from a proactive strategy that is continually looking ahead, playing 'a more complex game' than in lower-workload centres. This more complex approach is partly proactive, partly opportunistic, and is focused on giving an excellent service; but it means the controller is thinking ahead much of the time, rather than focusing exactly on what is on the radar screen at the time. The end result is that what you see is no longer what you get.

This theory explains the incidents at busy times. However, in order to explain the incidents which took place during low workload periods, it needs to be expanded. The first additional aspect is that this way of working carries over into low and/or medium workload times after a busy period, when the vigilance 'resources' of the controller are lower or even depleted. Therefore, this filtering process may become 'second nature', and so be more likely to continue to operate when the controller is tired or the normal required vigilance level drops. It can also operate when the controller is less experienced, and has not yet had what may be called a 'correctional' incident (one that teaches controllers not to go too far when being 'proactive').

The evidence for this theory is primarily in the incidents reviewed, where aircraft under control were clearly in conflict but were overlooked. Generally speaking, it is as if the controller has certain aircraft (the main 'players' according to the controller's strategy) that are in focus, whereas the others are out of focus. In terms of the model presented earlier, the ones in focus are in the working memory, and the rest are not (at least they are not 'active' - they are treated as 'noise' rather than signals). When tired or preoccupied, it is possible for 'secondary' aircraft to fall out of focus too, even if the traffic level has dropped, since there is little demand to stimulate the controller.

What about the second controller or

co-ordinator? Well, it appears that in the incidents reviewed, this defence is not always working in 'post-peak' situations. In busy periods there are definitely 'two pairs of eyes', but afterwards, when the traffic level drops, there is a need for a recovery period, probably for both controllers, and so the two pairs of eyes no longer work together. This is not helped by the general lack of training in air traffic management for low traffic and post-peak strategies. This may signal the need for a more proactive approach by controllers and supervisors in low traffic scenarios, and their general minimisation via methods such as collapsing sectors etc.

I used a Swiss Cheese diagram to try and capture the various factors we found in these incidents, as shown in ***Figure 2***. Here's a summary of what it is saying:

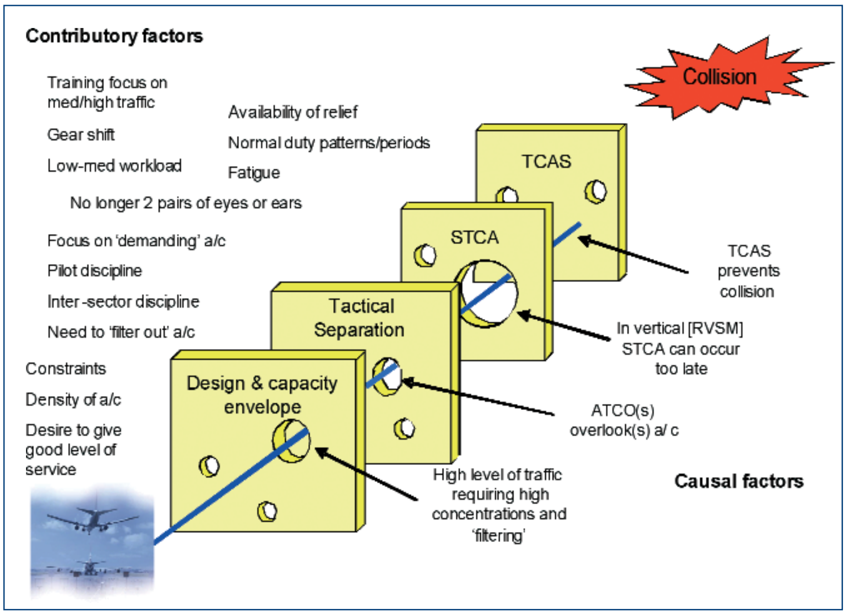


***Figure 2** - Characterisation of the incident pattern*

SUMMARY OF ANALYSIS

The analysis suggests that there is an awareness problem whereby controllers work at different 'layers', filtering out aircraft at less important layers. In non-busy periods (where vigilance may decline), or when the controller becomes preoccupied with a problem (therefore occupying all the available vigilance resources), this may lead to overlooking an aircraft, even if in the central area. The 'second pair of eyes' is not a strong enough barrier to detect all such omissions, and STCA may occur too late to be effective in conflict avoidance in the vertical dimension (thus leading to a reliance on TCAS).

The causal factors are relatively straightforward, but there are many contributory factors. This means there is no clear single 'magic bullet' solution. Instead a set of counter-measures was proposed, for example:

CONTROLLER

- Give controllers training for low and 'gear-shift' (e.g. a sharp decline in traffic level) workload patterns over extended periods (e.g. >2hours). This will enable controllers to develop more robust working practices for these types of duty periods.
- Develop 'defensive control' strategies and training.
- Give refresher training (busy and non-busy traffic) without STCA (with standard separation).
- Develop individual and team-based guidance on detection and recovery from attention/vigilance lapses.
- Develop guidance on optimal and permissible duty times according to workload patterns.

TECHNOLOGY

- Downlink Selected Flight Level to STCA parameters.
- STCA utilise CFL information input by the controller.
- Adaptation of tools such as Medium Term Conflict Detection.

ORGANISATION

- Develop a suite of low vigilance counter-measures: rest pauses; role rotation; sector collapse; etc., and an associated supervisory checklist for maintaining a 'sharp watch'.
- Ensure sufficient human resources: availability of spare controllers.
- Improved ATM discipline: ensure only 'clean' a/c are handed over even within internal sector boundaries; develop a common under-

standing and practice to give a safe and reasonable quality of service; and develop approaches to reinforce pilot discipline.

- Take TRM to its next logical stage of Threat and Error Management (TEM), determining the day-to-day risks and best ways to mitigate them.

If such incidents as these continue (they have abated for now), then it suggests that (European) ATM has a serious problem, and perhaps we need to review capacity, quality of service, and their impacts on safety more precisely. My belief is that controllers in the front line, and the supervisors and investigators who support them, are best placed to tell us how close to the unsafe edge of the ATM 'performance envelope' we really are. What we in Safety, Human Factors, and System Design could do with however, is more feedback from controllers on exactly where those 'edges' are.

The TEM approach in particular may offer a linking structure to a number of the counter-measures (both organisational and human-focused), and give controllers themselves more 'control' over their safe performance. At the same time, the potential benefits from advances in safety nets and conflict probes should be realised to give further safety assurance. The third main area is to develop low vigilance recognition processes, by the individual controllers, their team-workers, and their supervisors. A more flexible approach to rest pauses and 'vigilance resources management' needs to be developed and supported by management in terms of assuring that relief is available.

Whilst this incident pattern is disconcerting, it offers a chance to take positive steps towards enhancing safety management at the operational level, and generally improving safety culture in a tangible and demonstrable way.

For more information concerning Human Factors, Team Resource Management and other matters discussed in this article refer to the EUROCONTROL Human Factors web-site: *http://www.eurocontrol.int/humanfactors/public/subsite_homepage/homepage.html*

WORK IN PROGRESS

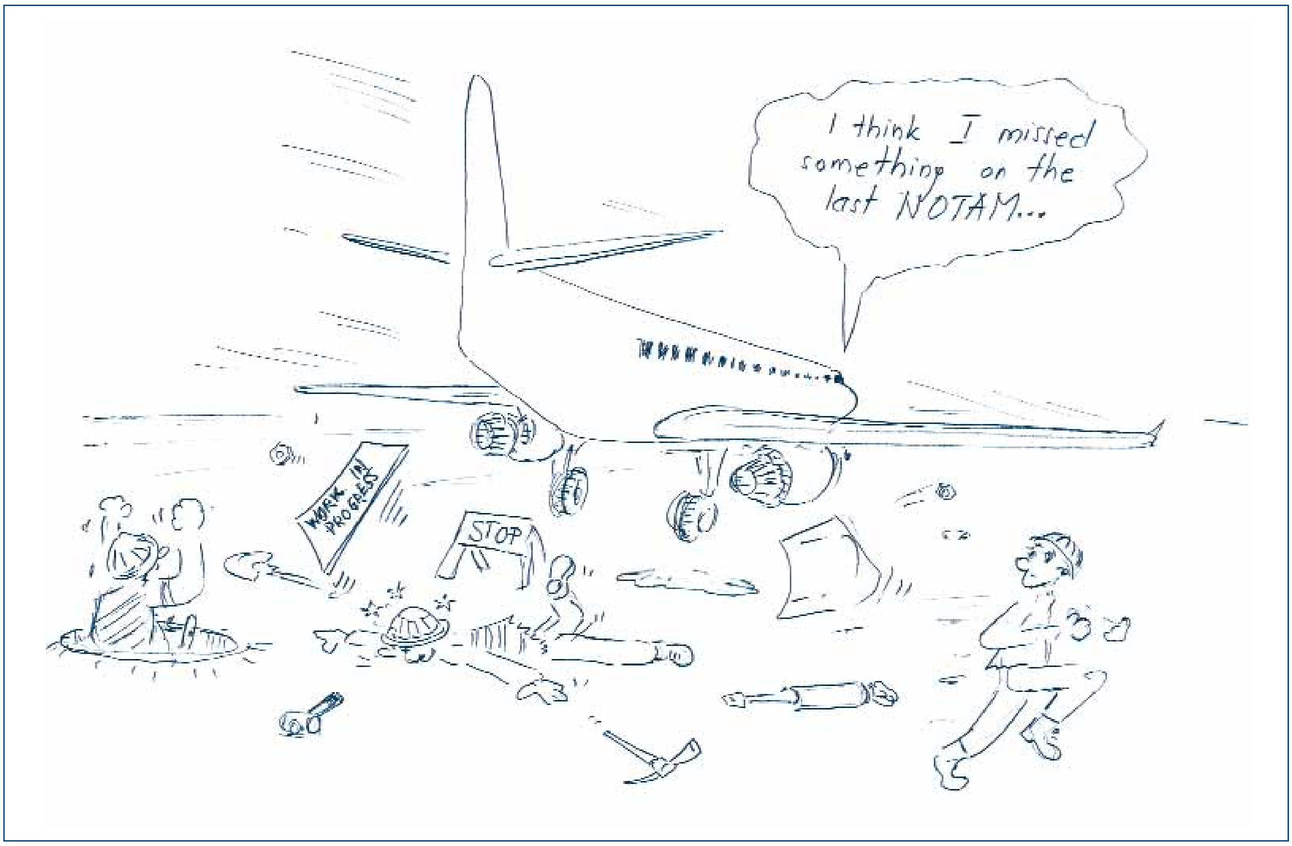
A Boeing 737 was due to depart Manchester on a flight to Greece with seven crew and 190 passengers on board. The scheduled departure time was 1355. At the time, there was work in progress on runway 06L. This involved several large vehicles removing rubber deposits from the 24R threshold. This had the effect of reducing the available runway length for take-off. This information was contained in a NOTAM and also broadcast on the ATIS.

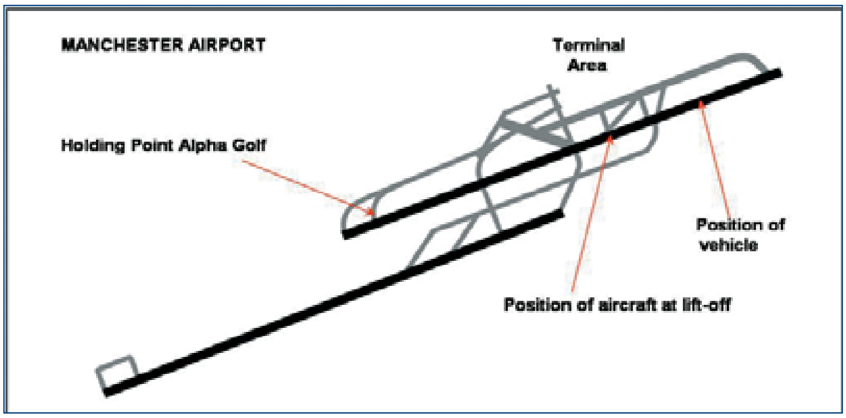
Company procedures required the flight crew to report for duty one hour before scheduled departure time. The co-pilot arrived at 1240 and started preparing for the flight. He received a telephone call from the commander saying that he would be a little late arriving due to traffic. To save time, the co-pilot checked the flight plan, destination NOTAMs and the weather in order to calculate the required fuel load, and passed this information to the aircraft refuellers. However, he did not check for NOTAMs relating to Manchester.

The commander arrived about ten minutes late and checked the co-pilot's fuel calculations; but he did not check the NOTAMs either, deciding instead to read them at the aircraft (in the event, neither pilot read the relevant NOTAM.) The crew walked to the aircraft where the co-pilot carried out the external aircraft check while the commander programmed the Flight Management System. On re-entering the aircraft the co-pilot listened to the ATIS and wrote the runway in use and departure weather in the flight log. He did not note the work in progress. Afterwards, the commander could not recall listening to the ATIS himself.

At 1339 the co-pilot requested departure clearance and was asked if they could accept the reduced take-off distance. The co-pilot replied "YEAH FROM ALPHA GOLF ..." apparently unaware that the reduced runway length was due to the work in progress at the other end of the runway. The commander and co-pilot then independently calculated the take-off performance based on the full length of the runway from holding point Alpha Golf.

By the time the aircraft pushed back, both pilots were aware that some work





was being conducted on Runway 06L, largely as a result of listening to ATC communications with other aircraft, but they apparently believed the work was either at the threshold end of Runway 06L, or in the stop end area, and that in either case it would not affect their performance requirements.

When the co-pilot responded to his line-up clearance he added "WE'RE TAKING OFF FROM ALPHA GOLF". From the CVR replay his voice suggested that he had some doubts about the runway entry point clearance but the ATCO took this as a statement of intent and replied "IF YOU'RE HAPPY WITH THAT THAT GIVES YOU SIXTEEN SEVENTY METRES" to which the co-pilot replied "ROGER." The aircraft then entered Runway 06L and commenced the take-off run.

Runway 06L is built on sloping ground and it is not possible from the AG entry point to see the far end of the runway from the cockpit of a Boeing 737. On cresting this rise, the pilots saw vehicles ahead of them on the runway. At that point, as the aircraft's airspeed was close to rotation speed, a normal rotation was carried out. The aircraft passed very low over the vehicles on the runway and continued its departure. ATC did not comment on the incident either then, or on their return to Manchester. Consequently, as they believed nothing untoward had occurred on the take-off, no report was made. In fact, subsequent calculations suggest that the aircraft passed within 56 ft (17 m) of a 14 ft (4 m) high vehicle (see illustration).

The serious incident was reported to AAIB seven days later. The subsequent investigation revealed that further incidents had occurred during the course of the work, the most significant being on the night before the above incident. On this occasion ATC had instructed three commercial passenger aircraft to go around after they had knowingly positioned them to land on the reduced length runway. The crews of all three aircraft were unaware of the reduced length available and, when informed, stated that it was insufficient for them to be able to land. The closest of the aircraft, a Tristar, was at a range of 2.5 nm when instructed to go around. These incidents were also considered in the subsequent AAIB investigation.

The investigation found that the serious incident which triggered the investigation resulted from non-adherence to established procedures by the flight crew, rather than a failing in the procedures themselves. The pilots correctly determined the aircraft's take-off performance for a take-off from Runway 06L had it been at full length, but this was incorrect at its reduced length.

In fact, the data supplied to pilots by most aircraft operators permits the calculation of take-off and landing performance only for standard runway lengths as published in the AIP. When runway work affects the declared distances, operators may produce performance information for their pilots, but they do not normally do so when the work is to be of short duration, especially when an alternative runway is available. On this occasion, the operator did not do so, therefore the pilots had no means of determining take-off performance from Runway 06L at reduced length.

The report identified additional concerns regarding the planning and management of the rubber-removal operation. They, too, largely centre on non-adherence to established procedures. These included the following findings, which influenced the outcome of events:

- Hazard analysis conducted by the airport operator prior to the incidents did not include all hazards associated with the rubber-removal operation.
- No documented hazard analysis was conducted by Manchester ATC.
- The Operational Advice Notice relating to the rubber-removal operation, published on the day work commenced, contained only limited briefing information.
- Manchester ATC did not publish a Temporary Operating Instruction relating to the rubber-removal work.
- The request for NOTAM action was applied for by the airport operator approximately three hours prior to the commencement of the rubber-removal operation.
- Commencement of reduced runway operations coincided with the ATC shift change.
- There was no blanking of runway lighting in the work-in-progress area of Runway 06L during reduced runway operations.
- There was confusion between Manchester ATC and the airport operator operations staff over the planning restrictions in force limiting the operating time permitted for Runway 06R/24L.

Readers are recommended to read the full incident report, which will be found on the UK AAIB web-site: at *http://www.aaib.gov.uk/sites/aaib/publications/formal_reports/3_2006_g_xlag.cfm* .

COMMENT FROM JON PROUDLOVE, GENERAL MANAGER ATS MANCHESTER AIRPORT

Following on from the AAIB report there has been a significant amount of activity at Manchester.

Key to the ANSP/Airport Operations relationship has been understanding the gap that exits between the ANSP and Airport company safety cases. In that gap is in fact the daily operation and consequently the way in which ATC and the Airport interact at an operational level is absolutely essential.

Manchester Airport now demonstrates industry best practice with regards to integrated safety management. Key elements are joint open reporting (understanding those issues that have the potential to develop into incidents), joint instructions to ensure consistent instruction and a weekly Operations/ATC meeting that reviews all reports and issues. When necessary the meetings conduct joint hazard analysis for future works. Joint safety action tracking is now maturing as well as an integrated investigation process.

All of the above has not only significantly enhanced the safety processes at Manchester Airport but is undoubtedly changing culture. Challenge and be challenged within a just culture is the foundation of our relationship.

TCAS AND STCA - NOT JUST ANAGRAMS

By Stanislaw Drozdowski

Stanislaw Drozdowski is an ATM Expert at EUROCONTROL HQ in Brussels, working in the area of ground and airborne safety nets. Previously, he worked as a system engineer with Northrop Grumman and as an Air Traffic Controller in Poland and New Zealand.

INTRODUCTION

Pilots and controllers are provided with a set of automated tools (safety-nets) to alert them to imminent loss of separation. These are Short Term Conflict Alert (STCA) in ground ATC systems and Traffic Alert and Collision Avoidance System (TCAS)[1].
Implementation details of STCA vary widely between ATC systems. They include different algorithms, warning times and type of alerts. STCA does not provide controllers with advice on how to resolve a conflict - this decision is always made by the controller.
TCAS, in contrast, operates according to uniform, world-wide ICAO standards. TCAS produces vertical collision avoidance advice in the form of Resolution Advisories (RAs) which pilots are required to follow. TCAS is widely considered to be the last resort safety net against mid-air collisions.

TCAS and STCA operate in a similar time scale and, therefore, are sometimes in "competition"; avoiding actions required from pilots by TCAS and controllers may differ. This can cause confusion at a time when prompt action and a clear distribution of responsibility between pilots and controllers is most needed.
The aim of this article is to recap the basics of TCAS operation and to raise controller awareness, so the potential interactions between TCAS and STCA can be better understood.

TCAS - HISTORY AND CURRENT STATUS

The development and implementation of airborne collision avoidance systems was very much driven by aviation accidents. The first conceptual research was initiated in 1956 after a mid-air collision over the Grand Canyon. The 1978 collision between a Boeing 727 and a Cessna 182 over San Diego led the FAA to start the development of airborne collision avoidance systems.
Eight years later, another mid-air collision occurred over California - a DC-9 collided with a Piper. Following this accident, the phased-in mandate of TCAS began in the USA. This was followed by a world-wide mandate.
In Europe, from 1 January 2005, all civil fixed-wing turbine-engined aircraft with a maximum take-off mass over 5,700 kg, or capable of carrying more than 19 passengers, must be equipped with TCAS II version 7.0. Additionally, many state and business aviation aircraft are also equipped.

The initial implementation of TCAS (known as TCAS I) only gave information about surrounding traffic and did not provide any collision avoidance advisories. The capability to produce collision avoidance advisories was added to the next version of TCAS (known as TCAS II). TCAS III, the future-generation system which will produce horizontal avoidance advice, has also been foreseen. However, due to the TCAS limitation in horizontal tracking, the TCAS III system will remain in the area of theoretical development for many years to come.

TRAFFIC ADVISORIES AND RESOLUTION ADVISORIES

Two types of alert can be issued by TCAS II - TA (Traffic Advisory) and RA (Resolution Advisory). TAs are intended to assist the pilot in the visual acquisition of the conflicting aircraft and prepare the pilot for a potential RA.
If a risk of collision is established, an RA will be generated. Broadly speaking, RAs tell the pilot the range of vertical speed at which the aircraft should be flown during the RA. The visual indication of these rates is shown on the flight instruments. It is accompanied by an audible message indicating the intention of the RA.
Some RAs simply tell the pilot to initiate a climb or descent ("Climb, climb" or "Descend, descend"). However, the majority only require a reduction or continuation of the aircraft's current vertical speed (respectively, "Adjust vertical speed, adjust" or "Monitor vertical speed").

[1] TCAS II version 7.0 is the only commercially available implementation of the ICAO standard for ACAS (Airborne Collision Avoidance System). For the purpose of this article, the terms TCAS and ACAS should be considered as synonymous.

It needs to be pointed out that TCAS works independently of the aircraft navigation or flight management systems. While assessing threats it does not take into account the ATC clearance, pilot's intentions or autopilot inputs. RAs seek to achieve collision avoidance by establishing safe vertical separation (300 - 700 feet), rather than restoring a prescribed separation.

Every second, the effectiveness of an RA is evaluated and, if necessary, the RA may be strengthened, weakened, or reversed. For example, an initial RA may require a descent, but once a safe vertical separation has been established, the RA may weaken (i.e. require the pilot to reduce the vertical speed that has been established to comply with the initial RA). This serves to minimize the possibility of a large diversion from the flight path. Conversely, if a safe vertical separation is not established as the result of the initial RA, the RA will strengthen (i.e. it will require an increase of vertical speed), or will reverse its direction (from climb to descent or vice-versa).
Typically, for "Climb" and "Descend" RAs a rate of at least 1500 feet per minute is required. That may increase if the RA is strengthened. Other RAs may require a reduction of vertical rate (to between 2000 and 500 feet per minute or to level-off). A pilot should respond to the initial RA within 5 sec., and within 2.5 sec. to reversed and strengthened RAs.

The surrounding traffic is shown to the pilots on a TCAS traffic display. The display purpose is to provide the crew with general traffic awareness and it must not be used for self-separation as TCAS horizontal tracking is limited. TCAS can track up to 30 aircraft but its range is limited to 14 NM.
RAs will only be generated against aircraft that have their Mode S or Mode C operational. If both aircraft are TCAS equipped, the RAs will be coordinated through the Mode S link (i.e. TCAS will ensure that the RAs on each aircraft are issued in the opposite sense). Also, TCAS is designed to deal with multi-aircraft encounters.

TCAS has much better "knowledge" of surrounding traffic than any ground radar system. Every second, it interrogates the Mode C and Mode S transponders of nearby aircraft. Based on the replies received, TCAS will calculate the time needed to reach the Closest Point of Approach (CPA) between the two aircraft. For Mode S equipped aircraft, altitudes are processed by TCAS in 25-foot increments.

In contrast, Air Traffic Controllers see the traffic picture on their radar screens updated every 5-12 seconds (so the traffic picture is always "historic") and the altitudes are presented in 100-foot increments. Having much more current and precise information than is available to ATC, TCAS is normally better positioned to provide effective last-resort collision avoidance.
TCAS operates on relatively short time scales. The maximum generation time for a TA is 48 sec. before the CPA. For an RA the time is 35 sec. The time scales are shorter at lower altitudes (where aircraft typically fly slower). Unexpected or rapid aircraft manoeuvre may cause an RA to be generated with much less lead time. It is possible that an RA will not be preceded by a TA if a threat is imminent.
An RA will be generated only if the intruder aircraft transponder is transmitting altitude. Otherwise, only a TA can be generated. Aircraft without an operating transponder will not be detected by TCAS. Moreover, TCAS RAs will be suppressed when stall or ground proximity warnings are generated in the cockpit and descent RAs are not issued close to the ground.

COMPLYING WITH RAs

Pilots are required to immediately comply with all RAs, even if the RAs are contrary to ATC clearances or instructions.

If a pilot receives an RA, he/she is obliged to follow it, unless doing so would endanger the aircraft. Complying with the RA, however, will in many instances cause an aircraft to deviate from its ATC clearance. In this case, the controller is no longer responsible for separation of the aircraft involved in the RA. This is why the pilot is obliged to report the RA to ATC as soon as possible.
When the pilot reports an RA, controllers are not allowed to modify the aircraft flight path until the pilot reports returning to the current air traffic control clearance. Traffic information may be provided as appropriate. Controllers, however, should take into account that traffic information may distract or confuse the pilot.
Currently, the pilot report is the only source of information available to the controllers to notify them that an aircraft is deviating from the ATC clearance. However, due to a high level of workload in the cockpit, pilot reports of an RA are often delayed or fragmented.

TCAS will announce a "Clear of Conflict" message when the aircraft diverge horizontally. Following that message, pilots are required to return to their last clearance or instruction and report this action to ATC.

TCAS - STCA INTERACTIONS

Both TCAS and STCA operate in a similar time scale. Alerts are independently generated by both systems and - as no connection exists between them - they are not coordinated. An STCA alert will most likely prompt the controller to issue an avoiding instruction. Controllers must remember that, depending on the time to the CPA, TCAS might have already identified the conflict and issued or be about to issue an RA.

Although, as mentioned above, pilots are specifically mandated to follow RAs and ignore ATC instructions during the RA, everyday experience shows that in some cases pilots will choose to follow the controller's instructions rather than the RA, or will hesitate, delaying a prompt reaction to the RA and jeopardizing collision avoidance.

It is a natural reaction for controllers to take action to restore the separation when they recognize a hazardous situation. In the majority of cases, a vertical instruction will restore the separation quicker than a horizontal one. However, controllers should remember that when two aircraft are in close proximity, a TCAS RA might have already been issued or be about to be issued and any ATC vertical instruction may contradict the RA and unnecessarily confuse the pilot. If, for whatever reason, the pilot decides to follow ATC rather than the RA, that would further deteriorate the spacing between the aircraft.

Until the RA has been reported by the pilot, the controllers cannot know whether the situation is being resolved by TCAS. If controllers are not aware of an RA, and if they are providing the aircraft with instructions for avoiding action, horizontal instructions are more appropriate as they will not adversely affect any vertical manoeuvre required by TCAS RAs.

UNNECESSARY ALERTS?

Another example of TCAS - ATC interactions is the so-called "nuisance" or "unnecessary RA". Often, pilots and controllers report that they have encountered an RA that was not really necessary and the separation would have been maintained without the RA. As TCAS does not know the ATC clearance or pilot's intentions, an RA will be produced based on the extrapolation of the aircraft's trajectory. These "unnecessary" RAs usually occur in cases of fast climbing or descending aircraft just before the cleared level is reached. To minimize the likelihood of unnecessary RAs, a recommendation has been issued to the pilots to reduce the vertical rates one flight level before the level-off.

Many controllers see these RAs as a nuisance. However, it must be remembered that they can be qualified as "unnecessary" or "nuisance" only in hindsight. As we know very well, traffic situations can develop quickly and unexpectedly. Some alerts that initially appeared unnecessary, in many cases "saved the day".

To minimize the likelihood of these RAs, controllers are advised to provide traffic information to aircraft climbing or descending above or below other aircraft. That should increase crews' situational awareness and may prompt the pilot to reduce the vertical speed. Also, controllers may want to apply a horizontal off-set to avoid level-offs above/below another aircraft. That is especially important if both aircraft are climbing and descending, as the combined vertical rate would increase the chance of RAs being generated.

FORTHCOMING CHANGES

There are two important forthcoming changes in the TCAS area to which we would like to draw readers' attention.

First, an amendment to ICAO regulations is pending that will require pilots to report only those RAs requiring a deviation from ATC clearance. We will inform the readers when this change comes into effect.

The second change concerns updates to TCAS logic that would produce reversal RAs in cases when the intruder aircraft is not following the RAs. Additionally, it has been identified that a significant proportion of the most common RAs (i.e. "Adjust vertical speed, adjust") are flown incorrectly. Several factors that contribute to these incorrect pilot reactions have been identified. Despite efforts made, this problem seems to be difficult to address through training and, therefore, changes to TCAS logic are currently under investigation that will replace this RA with another, more intuitive one. When this work, expected to take a couple years, nears completion, we will provide an update to our readers.

[2] To address this problem, an automatic downlink of RAs to controller working position is under investigation.

POINTS TO REMEMBER

- Pilots are required to follow RAs. ATC instructions/clearances must be ignored once the RA has been issued.
- Controllers will not know about RAs until notified by the pilot.
- An RA may or may not command the pilot to deviate from the current ATC clearance.
- For avoiding action, horizontal instructions are more appropriate as they will not adversely affect any vertical manoeuvre required by TCAS RAs.
- Traffic information and horizontal offset may reduce the likelihood of "unnecessary RAs".

ADDITIONAL SOURCES OF INFORMATION:

ACAS II Training Brochure
http://www.eurocontrol.int/ra-downlink/Library/ACAS_training_ver20.pdf

EUROCONTROL ACAS bulletins
http://www.eurocontrol.int/msa/public/standard_page/ACAS_ACAS_Safety.html#Bulletins

FAA's Introduction to TCAS II version 7.0 brochure
http://www.arinc.com/downloads/tcas/tcas.pdf

EUROCONTROL Safety Nets page
http://www.eurocontrol.int/safety-nets

REMINDERS

ICAO Doc. 4444
ATC vs. TCAS...

15.7.3.3 Once an aircraft departs from its clearance in compliance with a resolution advisory, the controller ceases to be responsible for providing separation between that aircraft and any other aircraft affected as a direct consequence of the manoeuvre induced by the resolution advisory. The controller shall resume responsibility for providing separation for all the affected aircraft when:

a) the controller acknowledges a report from the flight crew that the aircraft has resumed the current clearance; or
b) the controller acknowledges a report from the flight crew that the aircraft is resuming the current clearance and issues an alternative clearance which is acknowledged by the flight crew.

15.7.3.2 When a pilot reports a manoeuvre induced by an ACAS resolution advisory (RA), the controller shall not attempt to modify the aircraft flight path until the pilot reports returning to the terms of the current air traffic control instruction or clearance but shall provide traffic information as appropriate.

PHRASEOLOGY

FOR AVOIDING ACTIONS...

12.4.1.8 e) ***TURN LEFT (or RIGHT) IMMEDIATELY HEADING (three digits) TO AVOID (UNIDENTIFIED) TRAFFIC (bearing by clock-reference and distance).***

12.4.1.8 f) ***TURN LEFT (or RIGHT) (number of degrees) DEGREES IMMEDIATELY TO AVOID (UNIDENTIFIED) TRAFFIC AT (bearing by clock- reference and distance).***

REPORTING RA...

12.3.1.2 r) ... after modifying vertical speed to comply with an ACAS resolution advisory... ***[callsign] TCAS CLIMB (or DESCENT).***

12.3.1.2 z)... when unable to comply with a clearance because of an ACAS resolution advisory...
[callsign] UNABLE, TCAS RESOLUTION ADVISORY.

12.3.1.2 x) ... after returning to clearance after responding to an ACAS resolution advisory
[callsign] TCAS CLIMB (or DESCENT) COMPLETED (assigned clearance) RESUMED.

FINALLY IT WAS SNOWING

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 (DAP/SSH).

THE CONTROLLER

He was sitting resting, with a cup of coffee in front of him. The last hour in the tower had been hectic; finally the winter had arrived with heavy snowfall and reduced visibility. Until recently the temperature had been well above average; whether it was due to global warming or not, he did not really care; he was more interested in planning for next weekend in Paris. He loved Paris, and the French ladies have a special style and class. There are more of them in Paris than at home, perhaps because Paris is in France? It was time to return to the tower; outside it was all white. He knew the next hour would be intense even in good weather.

THE OPERATIONS MANAGER

The Operations Manager was in a bad mood; he was normally a very positive person (in any case that's how he saw himself). The new Controller Surface Movement Radar HMI[3] was creating problems. A combination of lack of training and technical support for tuning the system resulted in label-swapping and false tracks. Anyway, they had to live with it and hopefully solve the problem later. They called it A-SMGCS[4]; he was not sure about the correct definition, but since no one else knew either, he stuck to it. He looked out of the window, the snowfall was increasing; he did not like the snow.

THE PILOT

The aircraft was de-iced. The snow was still falling. He tried to calm down after the stress of check-in. Since the staff car-park had been moved half-way to the nearest town, this was always a hot topic for debate. If you wanted to find some common ground, you could always complain about that. He instructed his first officer to ask for an intersection departure; although it was snowing the braking action was good. The other pilot requested push-back plus intersection departure. The push-back started; "call you back for departure via XX". They started taxiing and half way out towards the holding point they were sent over to the runway controller. They could see several other aircraft and hear them on the frequency too; at least two aircraft were ahead of them and probably several behind. Just when they expected they would have to wait in the queue, they received clearance to line up. With two aircraft ahead, they assumed the controller wanted them to use the requested intersection for line up; otherwise how could they overtake the others? He turned left for the intersection; the red stop bar was still on so he slowed down to stop.

THE TOWER

The design in the tower made it difficult to coordinate properly; the distance between the controllers was a limiting factor. This was a problem even with low traffic but now it was a very obvious stress factor. The traffic was increasing, his frequency was very busy. The ground controller sent him three aircraft in one go, of course this resulted in blocked transmissions and more frequency congestion (when would pilots learn to listen before transmitting, he thought without any kind of self-criticism). He looked on his HMI, outside he could not see anything. Following a departure clearance to an aircraft already on the runway, he instructed number one on the taxiway to line up. Suddenly number three in the line turned towards the runway, towards the departing aircraft.

WHY?

A labelled SMR[5] is **NOT** an A-SMGCS. It could be an excellent tool but it is only permitted to be used to assist the controller's outside visual view, never to replace it. This is especially important in high workload situations when label-swapping can bring fatal consequences.

In addition to the SMR, A-SMGCS requires a cooperative system, normally Mode S Multilateration. This provides the controllers with accurate safe labelling. Procedures allowing the controllers to replace the outside visual view with the HMI when appropriate were delivered and accepted by ICAO EANPG (European Air Navigation Planning Group) in December 2006 for incorporation in ICAO Doc. 7030.

[3] Human Machine Interface
[4] Advanced Surface Movement Guidance and Control Systems
[5] Surface Movement Radar

WORKLOAD - THE VIEW FROM THE FLIGHT DECK

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.

The modern air traffic control centre is designed and staffed with the controller in mind. Much thought and effort is expended to make working conditions comfortable and the work flow fairly uniform. Of course, peaks and troughs do occur, but these can be compensated for to a large extent by good management. For example, sectors are consolidated or “band-boxed” when work is slack and extra staff are held in reserve to cope with those busy periods. Then again, work schedules are designed so that the controller has rest periods when he can forget, even if only for a few minutes, about the pressures of his workload.

Much has been done, too, to make the pilot’s working conditions more comfortable, but there is nothing that can be done about high workload periods - they occur, mostly at predictable times, but there is no reserve pool of pilots in the cabin to help out when they do occur! Of course, there are periods when the workload is light, especially in the case of long-haul pilots, but the working day is usually long and fatigue can be a real problem. So it is a great help to pilots if controllers understand when the busy periods are and take them into account as far as possible when issuing instructions.

From a more general point of view, it should be clear that if a pilot says “Standby” it is usually because his/her hands are full with other, more important matters which he/she needs to deal with before responding to the call from ATC. This may be true even at times when the workload is not particularly high, because an interruption to a checklist makes error (like missing a vital check) more likely, or it may be necessary to restart the checklist, wasting time for all concerned.

Of course, the ATCO also has busy periods and times when an immediate response is essential - but at other times, it may be possible for instructions - re-clearances etc. - to be issued in good time so that an immediate response is not essential.

Now let’s look at when those busy periods arise. In normal circumstances, it is when the aircraft is close in time to takeoff or landing. To be precise, both pilots on the flight deck have their hands full from the commencement of preparation for departure until the end of the initial phase of the climb, and throughout the descent until the aircraft is safely on the ground. These are the predictable periods, but an abnormal or emergency situation can arise at any time and always creates its own pressures.

You might be asking yourself, “If most high pressure situations can be predicted, why can’t the pilots plan their workload to take them into account?” Well the simple answer is that they can, and they do, because otherwise they simply would not be able to get the job done. But an unexpected problem, like a late descent clearance or a runway change, can mess up all their plans. So it is probably worthwhile looking at what the pilot actually has to do in order to understand why it is so important.

Let’s look at the routine of a typical airline engaged in short-haul operations in Europe. The day starts when the pilot reports for duty, normally one hour before scheduled departure time. One hour is not long, but time is money and the pilots’ maximum duty hours are laid down by law, as well as by union agreement. Extra time at the start of the day means reduced flexibility to deal with delays later on, and might even result in lost schedules.

At the airport, the pilots brief - weather and AIS and a quick review of the computer flight plan - then walk to the aircraft; with modern security demands this walk may take some time. Some form of physical check of the aircraft is usually necessary, especially on the first flight of the day and in icy weather, before the aircraft paperwork is checked and signed for; while one pilot does the outside check the other com-

mences checking and setting up inside the cockpit.

Then the pilots check the ATIS and calculate the takeoff data based on the expected take-of runway, weather and aircraft weight; this is a critical calculation so both pilots must check that there are no errors. Then they brief for the takeoff and initial climb-out. Finally, the route, including the SID, is entered in the FMS and if the passengers are on board and the cabin crew are happy, the aircraft is ready for taxi.

From now on until after takeoff, a change in the runway will mean that the crew must re-calculate the takeoff data and re-brief the departure. This is even necessary following a change from the left-hand to the right-hand of two parallel runways, because runway data (length, slope, obstacles, etc.) is never the same; also, SIDs are often completely different. Many accidents have occurred when pilots have rushed or missed out these checks. While all this is going on, the pilots must complete their pre-takeoff checks so that they are ready for an immediate departure as soon as they are given clearance.

Also, the new route must be entered in the FMS. There is no spare time to absorb this extra work or the departure slot will be missed with resultant delay and knock-on effect on the rest of the day's schedule, so please tell all pilots on frequency as soon as a runway change seems likely so that this high-pressure period is not made worse.

All this takes place while the aircraft is approaching the runway. If the runway is changed, the taxi route will also change increasing the pressure under which the pilot is working and the possibility of a serious error; for example, the captain may take a wrong turning, unnoticed by the co-pilot who is re-programming the FMS, and a runway incursion may result. Almost as important, the pilots will be starting a long and busy day in an unsettled frame of mind due to the rushed procedures.

Once on the runway, the pilots may not be quite ready for takeoff. There may be some final settings to make and in bad weather, they will want to have a quick look at the weather radar; so if you require an immediate takeoff, do confirm that the pilots can accept this before clearing them onto the runway.

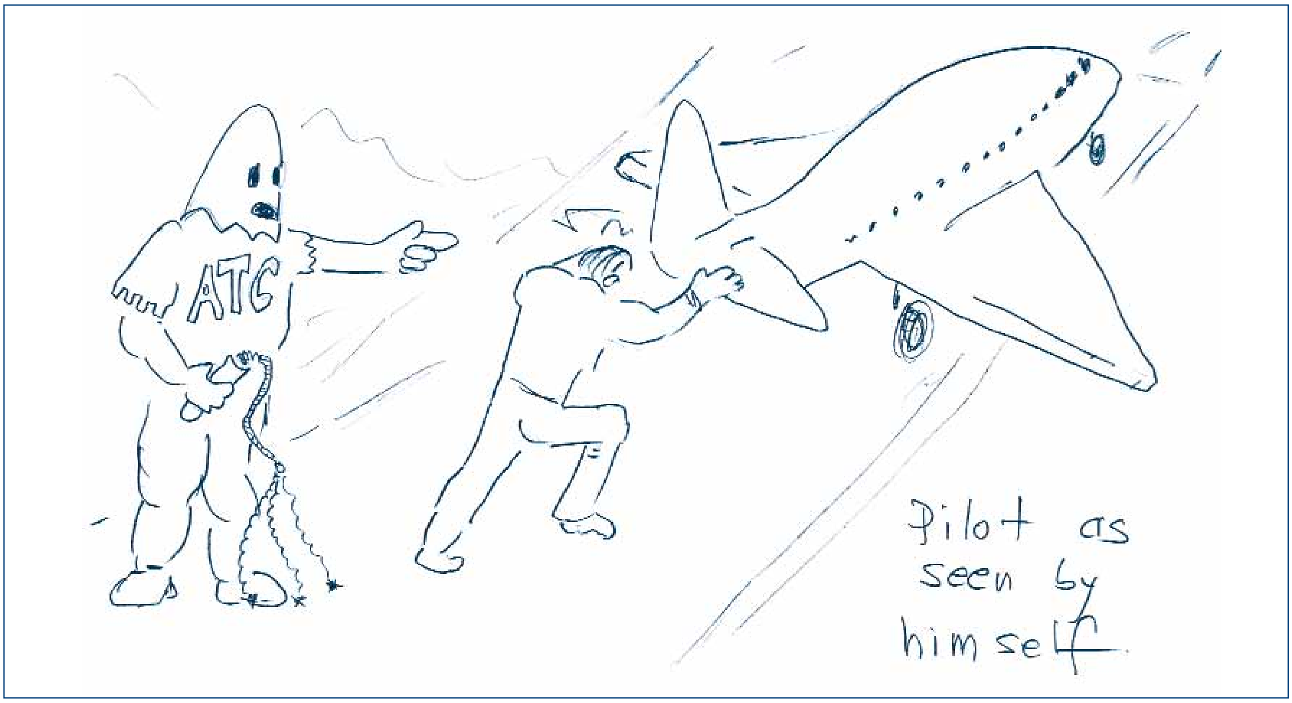
Even if the take-off is on the planned runway and the departure details are not changed, the initial climb is a busy period. Noise abatement procedures involve high climb rates and precise obedience to departure routes. At the same time, the pilots must carry out a series of equipment checks and other procedures, while also listening out for the expected climb clearance. The high climb rates make it harder for pilots to level the aircraft quickly and increases the chance of a "nuisance" TCAS alert, so allow as much time as you can when passing clearances.

Let's skip now to the arrival phase: the situation is much the same as for the departure, only reversed. If anything, the workload is higher, even in fine weather conditions, but in bad weather this especially so.

The pilots check the ATIS, note the landing runway and base their landing calculations and briefing on this. If the runway must be changed, they should allow time to re-calculate the landing data and re-brief the approach (including the go-around procedure, which is usually different for each runway.) If the runway is changed late on, the pilots are likely to feel under pressure to comply with the instruction without going through the full procedure. This is very dangerous, so please give maximum warning of a runway change and don't give a late change if you can possibly avoid it.

Two other ATC instructions that often cause problems are delayed descent clearance and a requirement to maintain a high speed until late on the approach. A stabilised approach is generally considered to be essential for a safe landing, but it is very hard to achieve if the speed cannot be reduced until late in the approach. This may result for either of the reasons mentioned above. Most operators require pilots to go around if the approach is not stabilised, and this is a complete waste of time for everybody concerned. Of course, some pilots consider it a badge of honour that they land from the first approach whatever difficulties are thrown at them, but this can be very dangerous. Please do not add to their difficulties in this way unless it is absolutely essential.

Having landed and taxied to the stand, the story is not over. The pilots cannot relax for they must start thinking of the next sector. Some operators demand a turn-around time (blocks to blocks) of as little as 20 minutes, so there is not time for relaxation. The next sector must be planned and prepared for, while at the same time being interrupted by visits to the flight deck by the handling agent, the engineer, the refueller operator, and many more - perhaps even a friendly steward wondering if they would like to eat (no chance of that!). Meanwhile, the aircraft is being unloaded cleaned and replen-



ished, security checks must be carried out before the passengers board and at length, the final manifest and load sheet is passed to the captain and the aircraft is again ready for push-back.

So far, I have been talking only about normal circumstances. Abnormal circumstances usually arise due to aircraft unserviceability and may result in an emergency situation. Of course, when a MAYDAY is declared, everything is done to ensure a safe outcome. But pilots are often reluctant to declare an emergency or even tell you about a fairly minor unserviceability, partly because there are always people listening in to radio messages who are quick to inform the newspapers of what they hear. Sadly, the papers are all too ready to print an exaggerated story, which is bad for the airline. So please bear in mind that when a response from a pilot is slow in coming, or is not quite what you expected, the pilots may have extra problems about which you know nothing.

One final thought: Situational awareness is rightly considered to be very important in accident prevention. This is particularly so close to terminal areas where aircraft routes are close to each other and an error by one pilot (or even by a controller) can have immediate and dangerous consequences. Pilots maintain situational awareness by listening to the other traffic on the RTF. This is one reason why observing good communications discipline is so important. If a message is passed using non-standard phraseology or in a different language, it will be difficult for other pilots on frequency to understand, diminishing their situational awareness and increasing their workload in equal proportion.

Now, here's a thought: wouldn't it be great if all controllers could sit on the flight-deck with the pilots for a day and talk through the problems together? Most airlines would be happy to let you do this because they would understand the benefits to be gained. Ask one of the airlines based at your location what they think. I'm not suggesting that you should give up a rest day to do this, but it is worth asking your manager if he/she can give you a day off now and then when the opportunity arises. Perhaps it would help if you if you show him/her this article.

At some airports the departure clearance is issued to the pilot after start-up which is also aggravating factor.

A BUSY MORNING AT HEATHROW

The following account is based on the UK Air Accident Investigation Board Incident Report EW/C2005/06/03 dated June 2006. Much technical detail has been omitted from the report for the sake of clarity and brevity.

The complete report may be viewed at *http://www.aaib.gov.uk/publications/bulletins/june_2006.cfm*

An Airbus A320 departed on a scheduled passenger flight to London Heathrow Airport with an unserviceable No 3 Air Data Inertial Reference Unit (ADIRU). The aircraft is fitted with three ADIRUs, which provide vital information for the flight deck instrument displays and automatic systems. Nos 1 & 2 serve the pilots' instruments and No 3 is a standby. The aircraft was allowed to depart in this condition as Nos 1 & 2 ADIRUs were both serviceable, but as a precaution, the commander and co-pilot reviewed the Flight Manual Abnormal Procedures whilst en route, in case a second ADIRU became unserviceable.

Following an uneventful transit, the aircraft was given radar vectors and became fully established on the ILS approach to Runway 09L at LHR. At appropriate points, flap and landing gear were extended. As the landing gear locked down, a partial failure of the No 1 ADIRU was indicated. The failure caused several of the automatic systems to become inoperative and much of the commander's flight instrument information was lost, with only the ILS localiser and glideslope, airspeed and altitude indications remaining. At the same time, the mode of operation of the aircraft's flight controls changed and several other components of the aircraft system became unavailable.

Suddenly, an unremarkable, routine flight became anything but routine; although at this point, only the flight crew realised this. The commander handed over control of the aircraft to the co-pilot, whose instruments were functioning normally, and the ILS approach was continued.

About one minute later the aircraft started to deviate from the glideslope and localiser. The altitude continued decreasing and by about 300 ft radio altitude, when the airspeed was 130 kt, it was well below the glideslope. At this point the Enhanced Ground Proximity Warning System (EGPWS) gave a "glideslope" warning. The deviation continued to increase and a second EGPWS "glideslope" warning was given.

As the crew continued their approach, ATC advised that they would receive a late clearance to land. When the aircraft was at about 250 ft radio altitude a third EGPWS warning was given. The commander then decided to go around in order to attempt to restore the instruments but, before he could do so, ATC instructed the aircraft to go around as the preceding aircraft had

not yet cleared the runway. The commander acknowledged this instruction and called, "GOING AROUND, REQUEST A HOLDING PATTERN OVERHEAD CHILTERN OR OCKAM TO RESOLVE A LITTLE FAILURE," but ATC were not told what was wrong. The go-around proceeded and the landing gear retracted normally. At this point, the EGPWS warning ceased.

The controller became concerned that the aircraft was drifting south of the runway extended centreline and advised the crew of the missed approach procedure, but did not acknowledge the commander's request to enter a hold. He then transferred the aircraft to the Intermediate Approach Controller. Following the frequency change, the commander again requested radar vectors and said, "WE REQUIRE A FEW MINUTES TO RESOLVE A LITTLE ...NAVIGATION FAILURE ..." The controller asked for the message to be repeated, possibly due to the commander's heavily accented English, and subsequently acknowledged the request.

The co-pilot carried out the go-around and, in accordance with the prescribed procedure, turned the aircraft onto a heading of 040° and climbed to an altitude of 3,000 ft. The flaps were retracted, following which the aircraft was radar vectored downwind and instructed to climb to 4,000 ft. The Intermediate Approach Controller instructed the crew to fly at 220 kt and offered them 23 nm (track miles) to touch down. The commander accepted the distance but requested a speed of 180 kt, to give more time to address the problem. This was agreed by ATC.
The crew carried out the check-list procedure and considered taking action to restore the No 1 ADIRU. However, the weather at LHR was deteriorating with the cloud base reported by another pilot at 350 ft aal. With the No 1 ADIRU fault and the No 3 ADIRU unavailable, the aircraft was limited to carrying out a CAT 1 ILS approach with Decision Height 200 ft aal. The commander decided to expedite the landing, accepting the flight instrument display limitations that he had, and did not attempt to carry out the ADIRU reset procedure, which would have delayed the aircraft's arrival.

A short while later, ATC asked if the aircraft had a problem. The commander reported that the aircraft had had "a double inertial reference failure" but the controller did not understand the significance of this. The A320 commander then stated that they were able to perform a CAT 1 ILS approach only. About two minutes later, he transmitted a PAN call requesting assistance for a radar-vectored approach to Runway 09L, explaining the aircraft had suffered a navigation problem. ATC did not respond initially, due to a double transmission, but another aircraft brought it to their attention. Following this, the aircraft was vectored to a position 23 track miles to touchdown.

In attempting to deal with the problem with the No 1 ADIRU, the flight crew turned the instrument off. The checklist procedure did not call for this action, but the crew recalled from their review of abnormal procedures in the Flight Manual that there were circumstances when this was required. The commander attempted to find the relevant text in the Flight Manual but was unable to do so before ATC instructed the aircraft to turn onto base leg.
The crew's decision to switch off the No 1 ADIRU with the No 3 ADIRU unavailable caused the loss of further information from the commander's instrument displays. The landing gear normal extension system was also rendered inoperative, but it was successfully lowered using the emergency gravity (free fall) extension system. Also, the nosewheel steering system became inoperative. Accordingly, the commander advised ATC that he was not sure if the aircraft would be able to clear the runway after landing.

By this point, the condition of the aircraft had degenerated so that the flight crew workload was exceptionally high. Many of the normal flight deck indications were absent, the mode of flight control was unfamiliar, and several of the normal aircraft functions were inoperative. Added to that, the weather at the destination and the alternate airfield (Gatwick) was deteriorating.

As the aircraft was radar vectored onto an intercept heading for the localiser, the commander upgraded his PAN to a MAYDAY, transmitting, "ON FINAL, MAYDAY FROM THIS MOMENT, WE CANNOT PERFORM A GO-AROUND, AH FINALS 09L," in order to ensure priority. The MAYDAY element of this call was not heard by the controller. This was probably due to a combination of the commander not announcing the MAYDAY using the standard protocol and his heavily accented English. As a result, the airport Rescue and Fire Fighting Service was not brought to Local Standby. However, ATC switched traffic ahead onto Runway 09R to provide a clear approach and, due to his reduced airspeed, also radar vectored a following aircraft to the north.

When the crew advised ATC that the aircraft was fully established, control was transferred to the tower controller who advised that there was traffic on the runway to vacate. The crew responded that "WE HAVE AN EMERGENCY," which the controller acknowledged. Landing clearance was given for Runway 09L a short time later. The aircraft touched down at an airspeed of about 134 kt and began to decelerate. Some 50 seconds later, when the ground speed was about 50 kt, the aircraft made a right turn, using rudder and asymmetrical braking, onto the adjacent taxiway. The aircraft came to a stop and the parking brake was applied; the crew then requested a tug to tow the aircraft to the stand, and no doubt, gave a long sigh of relief!

So when you are sitting at your console on a busy morning, with the air full of arriving and departing aircraft all trying to get their calls in and stepping on each others' transmissions as a result, and generally making life difficult by not using standard RTF phraseology, etc., spare a thought for the pilots. Modern aircraft are complicated, highly automated pieces of machinery, designed to help the pilot fly with maximum ease and efficiency. They are extremely reliable, and usually everything works as it should. But when something does go wrong, the consequences can be unfamiliar - complex and confusing. If a failure occurs in a high workload situation (like on the approach to land), even a highly trained and very experienced pilot can make a mistake and, as in this case, make a difficult situation even more difficult.

You are not a mind-reader, and it is not your fault if for one reason or another you do not always receive all the pilot's messages; but you can use your experience, like the controllers did in this story, to know when everything is not going as planned. You may spot the deviations from normal smooth flight; the unexpected radio messages, perhaps with some excitement or nervousness in the voice that tell you that the flight crew may be in difficulties. If you do, you may be able to help the pilots cope with a dangerous situation.

EFFECTIVE COMMUNICATION IN THE AVIATION ENVIRONMENT: WORK IN PROGRESS

By Anne Isaac, Ph.D.

Anne's early experience in ATM and airline operation was followed by six years with the Human Factors team at EUROCONTROL, where she was associated with the development of tools and techniques to help identify human error and risky performance in the ATM environment, as well as developing the Team Resource Management (TRM) concept for European ATM. Anne now heads a team in Human Factors integration within the Division of Safety in NATS, UK.

Effective communication is a basic human requirement and in the aviation environment an essential pre-requisite to safety. So why do we continue to get it so wrong? - and we do get it wrong about 30% of the time. In a recent radio telephony survey it was found that 80% of RTF transmissions by pilots were incorrect in some way. However pilots are not the only ones in the communication process, and there are some startling statistics from the air traffic controllers as well:

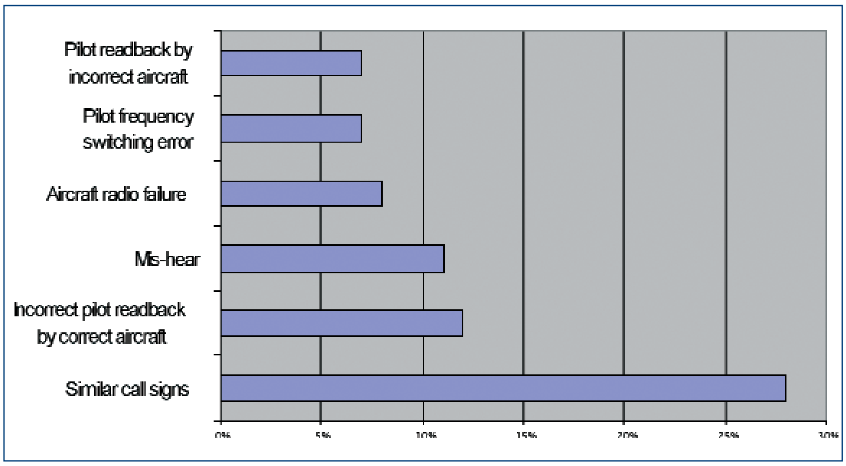
- 30% of all incident events have communication errors, rising to 50% in airport environments.
- 23% of all level-bust events involve communication errors.
- 40% of all runway incursions also involve communication problems.

None of these statistics are surprising when we realise the demand we place on the verbal communication process, and most of us know some of the obvious traps: call sign confusion, the problems with native language, the use of standard phraseology and the increasing traffic and complexity leading to frequency congestion and overload, as well as a high percentage of technical failure of the communication system itself. However, what might not be so obvious is the complexity of effective communication and the aviation culture which reinforces operational staffs' trust in other colleagues.

The following graph indicates the most numerous problems, however this only illustrates half the story.
Perhaps more importantly we should ascertain the most serious issues caused by these activities and the context in which they are likely to increase the risk to the system.

The leading events, which encompass some of the above issues are: mis-hearing information over the RTF, often caused by incorrect pilot read-back of information (but by the correct pilot) and transmission and/or recording of incorrect information by either the pilot or controller. In all cases the problems are embedded in the complexity of the communication process itself. In order to transfer information, both the person sending and receiving the information must be able to formulate, listen, hear and interpret the message correctly as well as verify the information for completeness, and at any of theses stages things could go wrong.

The most risky situation is when one of the parties does not identify or recognise an error, since then they are unable to recover from the situation themselves. Some of these risks are embedded in the way we ascertain



information from equally qualified colleagues.

We tend to ask confirmatory questions to solve a problem when we are unsure in these situations. The example below is taken from the Danair 1008 air accident at Tenerife:

Co-pilot : gosh, this is a strange hold, isn't it?
Captain : yes, it doesn't ...., it doesn't parallel the runway or anything.
Co to Engineer : it's that way isn't it?
Engineer : that is a 3 isn't it?
Co : yes, well, the hold is going to be there, isn't it?

Captain to Co : did he say it was 150 inbound?
Co : inbound, yeah
Captain : well, that's...................................,
I don't like that
Co : they want us to keep going all around, don't they?

Another very risky situation, in terms of the above issues, are conditional clearances. Conditional clearances are used on the understanding that both parties are assured of the message they hear. Since most of the information which is found in the conditional clearance information is standard and known by both parties, it is very rare for one of the parties to question part of this communication. Usually you will hear the person receiving the message say, "Oh he must have said that, or she must mean this". This situation is made more risky when the actual communication is correct but incomplete. Almost all runway incursion incidents which involve conditional clearances are also the result of incomplete communication strings. This is particularly risky for both parties since an incomplete transmission is not so easy to pick up as an incorrect transmission.

Another example regarding communication and feedback to colleagues within the aviation industry is the issue of seniority and expertise. Air traffic control assistants as well as cabin crew believe that it is not their place to question or challenge a colleague who is more qualified or in a position of seniority. The following example illustrates this and had fatal consequences.

On March 9th 1989, an Air Ontario Fokker F-27 was getting ready to take-off from a small airport in Northern Ontario. Take-off was delayed as the tower waited for a small private aircraft to land. It had been lost in a spring snow storm. Whilst the aircraft waited for take-off clearance, several passengers took note of the accumulation of snow on the wings. One of them brought it to the attention of the flight attendant, who assured him that there was nothing to worry about. Many of the aircraft's occupants were concerned about the snow, but no one, including the flight attendants, thought it appropriate to say anything to the flight crew. When asked about this during the course of the investigation, the one surviving crew member, a flight attendant, stated that she did not feel it was her job to inform the pilots of potential problems. She had never been trained to question an area that in her mind was clearly a pilot responsibility.
Moshansky, 1992.

Since then both the development of Crew and Team Resource Management activities have enabled clarification and challenge to be an acceptable part of this working environment.

One of the most prevalent errors in all aviation communication is information which is mis-heard or not heard at all. The reasons for this are again many and varied, which is why ICAO and National Air Navigation Service Providers train their operational staff to use standard radio telephony. So why don't we stick to these rules? Research would indicate that there are several human traits which make following rules more problematic. Firstly people, even controllers, assistants, pilots and aerodrome drivers never believe they could be involved in a serious incident or accident. The fact that these events, compared to the number of aircraft movements, are relatively rare, helps to perpetuate this belief. This trait is not exclusive to aviation professionals, we all believe the best when we step outside into the hazardous world, not appreciating we could be the victim of many and varied serious incidents.

Secondly, having developed standard phraseologies, individuals as well as Centres, Units and even National Providers and Airlines believe, because they are different, they need to apply for an exemption or change to the rule. These changes are rarely associated with a study to establish the reason for the changes and the best consequent solutions. Again it is rare that procedure specialists would ask the advice of the human performance specialists about how humans process both written and spoken information. This often leads to the use of incorrect phraseologies being delivered in the wrong order. Some of these risky words and phrases have been identified as follows:

- In turn - intended sequence is unclear;
- Next exit - who's next are you referring to;
- Pull forward - clearance is not clear;
- One hundred and eleven hundred - as in flight level;
- Three digit numbers ending in zero - heading often confused with flight level;
- Similar sounding letters and numbers - B,G,C, D and 3;
- Made a ... interpreted as Mayday;
- Holding position interpreted as hold in position;
- Climb to, two thousand - action, followed by qualifier.

Many other errors are made because of the problems of expectancy. Because we use standard phraseology, we often expect to hear a particular request or reply in a familiar situation. If the message we receive is distorted in some way, such as due to other noise or cut off, it is easy to assume we heard what we expected to hear instead of confirming the message. Hearing what we want to hear, guessing at an insignificant part of the spoken message, and filling in after the fact, are commonplace. We also reconstruct parts of messages unintentionally - and we do so with the utmost confidence that we hear what we actually reconstructed, not what was said.

Another reason for the prevalence of information which is mis-heard or not heard is associated with interruption and distraction. Usually a verbal message or phone call will interrupt almost any activity, and by the time we realise that this interrupting message is of little importance, it is too late to retrieve the activity we were engaged in when the message or phone call started. This results in the two tasks, whether they were verbal (receipt of a message) or another action (scanning, writing) being incomplete. When two activities compete for our limited working capacity we usually end up losing all the communication channels, and have to start again.

This problem is particularly obvious when working under a high task load. Task load is dependent on work load (the sheer volume and complexity of traffic) and contextual conditions such as:

- Weather;
- Experience;
- Fitness;
- Time on position;
- Stress.

Task load is a personal experience, different for everybody and depending on many things. The limitations of the human information processing system are first observed in our ability to communicate. Overloading this system inevitably leads to less effective communication due to tunnel vision (and tunnel hearing), reduction of scanning cycles, less investment in time to execute feedback and a rising temptation to fall for the trap of expectation bias. This results in more incorrect information which leads to further incorrect communication, and finally decisions and actions which are error-prone. We all have a tendency to dismiss the need to invest time in effective communication when it is most needed; under high task load.

The main issues which have been identified during incident investigation and safety trend analysis are the following:

- Pilot reads back incorrectly and the controller does not recognise and correct the error, often since it is from the correct pilot;
- Pilot reads back correctly, however this is followed by an incorrect action on the flight-deck;
- Pilot reads back correctly however the controller records the information incorrectly, resulting in a subsequent error.

Statistics would also suggest that controllers can often pick up errors in communication more quickly than pilots. Cardosi, in her 1997 study, recorded the fact that controllers correct 50% of pilot read-back errors on ground control frequencies and 89% on en-route frequencies. The reason for this is possibly because not only do controllers have more and varied R/T communication to deal with, but also because they are constantly tested for their proficiency in these skills.

Well, having explored some of the traps that cause humans to make errors, what are the solutions? These, like the traps themselves, are not easy to manage and implement since the communication process itself is highly complex. However, here are some tips for both pilots and controllers which may help:

- Use clear and unambiguous phraseology at all times; challenge poor RTF;
- Try to avoid issuing more than two instructions in one transmission;
- Be aware that you tend to be less vigilant when speaking in your native language;
- Always insist on complete and accurate read-backs from pilots;
- Set the clearance given, not the clearance expected;
- Both pilots should monitor the frequency whenever possible;
- On frequency change, wait and listen before transmitting;
- ATC instructions should be recorded where possible;
- Use standard phraseology in face-to-face telephone coordination;
- Monitor all read-backs, try to avoid distractions - especially the telephone;
- When monitoring messages - write as you listen and read as you speak;
- If you are unsure, always check!

The European Action Plan for Air-Ground Communication Safety contains more information and advice on effective communication. Copies may be obtained by completing the form on the EUROCONTROL web-site at http://www.eurocontrol.int/safety/public/standard_page/documentation_distrib.html

BREAKING THE RULES

By John Barrass

John Barrass is an experienced aviator who served 20 years with the Royal Air Force and Canadian Forces in a variety of command, instructional and flying appointments. On leaving the military, John became Manager Air Safety for ERA. Now an established independant flight safety consultant, John has worked on a number of EUROCONTROL initiatives notably the Level Bust and AGC safety improvement initiatives..

Controllers and pilots are the last line of defence, but they should not be the only line of defence. In this article, John Barrass explains how breaking the rules can sometimes be the safest option for controllers and pilots faced with situations that the rules were not designed for; situations that could perhaps be avoided with better communication and greater acceptance of responsibility by all concerned.

Standard Operating Procedures (SOPs) are there to ensure the highest standards of safety and efficiency. They are the result of years and years of corporate wisdom handed down from one generation to the next. SOPs ensure that standards are maintained across an organisation, they make it easy for someone to move around within an organisation, and they reduce the risk of misunderstanding - for the same reason that we continually highlight the importance of standard phraseology. However, SOPs cannot cater for every eventuality and cannot anticipate every situation that a controller or pilot may face. This is why we still have humans on the flight deck and in front of radar screens - humans are very good at dealing with the unexpected.

When a situation occurs which is not covered by SOPs, or for which SOPs are inadequate, then the pilot or controller makes judgements about the right action to take in order to manage the risks. Here is a military example from 1992:

"We were unloading in Sarajevo when I started to see puffs of dirt flying up around the runway. We didn't hear any noise but we guessed it was mortar fire. The captain ordered the rear crew to complete the unloading and immediately started to taxi as soon as the unloading ramp was clear of the ground. He called for everyone to complete their own checks and call ready for take-off. No formal checklist reading, just a call of flaps 50%, trims neutral, and we rolled down the runway. When we landed at our destination, the captain called for the full checklist and pointedly made sure that we did everything by the book"

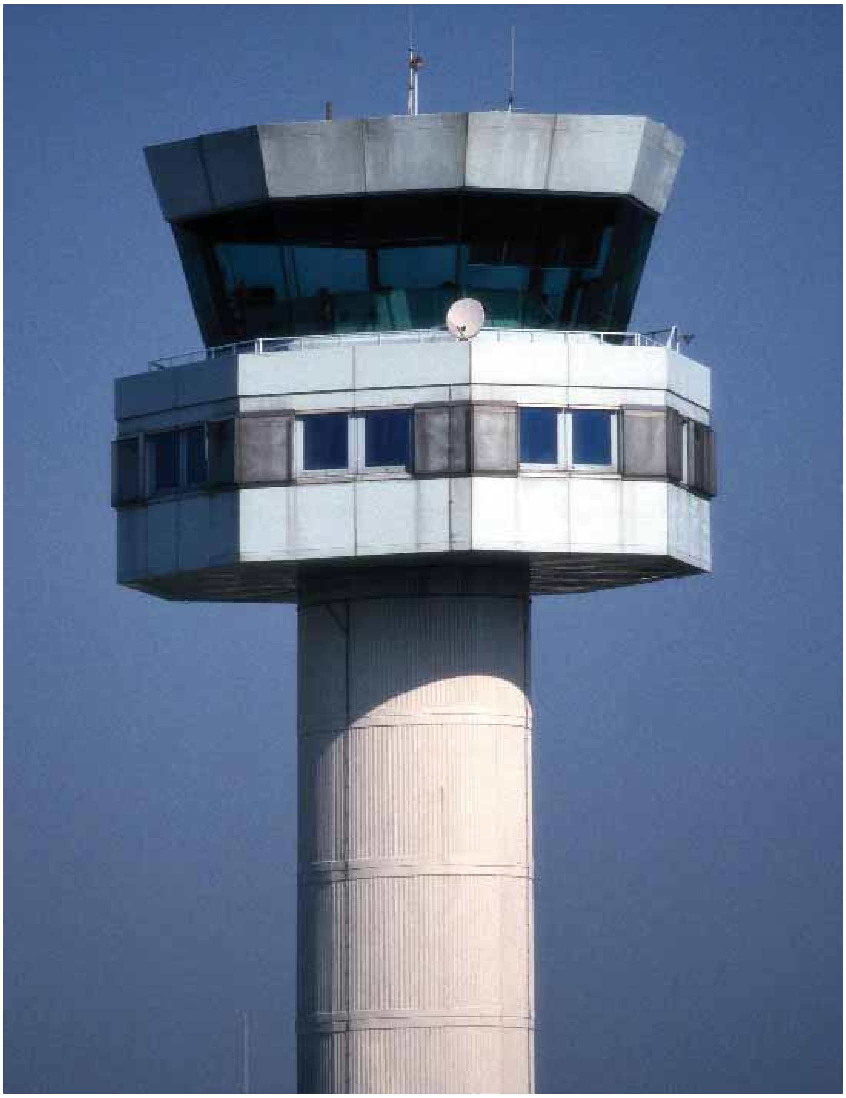
Thankfully the above example is extreme. Most situations encountered by controllers and pilots are far less dramatic, but it highlights the point very well. In an ideal world, when you encounter a situation which is not covered by SOPs, you seek advice from the appropriate authority - that could be the company management, national aviation authority, manufacturer, etc. In that ideal world, a new or revised procedure would be developed.

In the real world, things are a little more complicated; the pilot or controller has to deal with the situation before he can ask the advice of a superior authority. He or she does the best that they can under the circumstances, using their judgement and drawing on training and experience.

Here is a slightly different example:

"At peak times I have to keep separation distances at the minimum. Inevitably, sometimes, the separation is just under 3 miles, maybe 2.8, but it's safe enough. That's the price I pay for getting them in; if I let the separation exceed 3 miles on a regular basis then I end up with a backlog in the stack - nobody would thank me for that would they? And if I end up diverting aircraft because of fuel shortages, then I've made a safe situation less safe."

What is this controller saying? Is she saying that it is OK to break the rules? Doesn't she care about safe separation of aircraft? Well no, she isn't saying that. What she is saying is that, in certain circumstances, it is in the interests of the overall safety of a situation to break a rule. She is making balanced professional judgements based on her experience and knowledge in order to



ensure that all the risks inherent in a difficult situation are reduced as far as is possible at that moment.

What is more worrying is that she appears to be placed in this situation on a routine basis. The real problem with the situation described above is much deeper than questioning the professionalism of the controller. In this case the professionalism of the controller is masking the true problem. It isn't a matter of the SOPs or regulations being wrong or inappropriate; the controller should not have been placed in this situation in the first place. Why was the controller placed in this situation? Is it of her own doing, as a result of lack of concentration or inexperience perhaps, or is she placed in this situation as a result of the actions or inactions of others, such as her superiors or the airport management?

Responsibility lies at all levels and relies on communication and an open safety culture. Planners must consult controllers, and consider the implications of their actions, such as the reality of scheduling to full capacity. Controllers must also highlight to management when they are being forced into situations where they are forced to break rules in order to maintain safety, and managers must listen and have the courage and determination to act to address these issues.

Without communication, and acceptance of the risks that come with change, several things can happen - none of which are safe.

If controllers are forced to adopt non-standard procedures in order to maintain safety, and that situation is not recognised or acted upon by management, then those non-standard procedures may become the norm. Over time, with changes of staff and management, and loss of corporate wisdom, the understanding of why those non-standard procedures were developed is lost and procedures can become viewed as entirely optional - a situation of anarchy is the result, and risk is effectively ignored.
Our leaders need to be able to recognise change, acknowledge risk, and act to mitigate the risks associated with change.

KEY SENTENCE:

"Without communication, and acceptance of the risks that come with change, several things can happen - none of which are safe."

MENTAL MAP SHIFT - AN OPERATIONAL EXAMPLE

By Dan Gurney

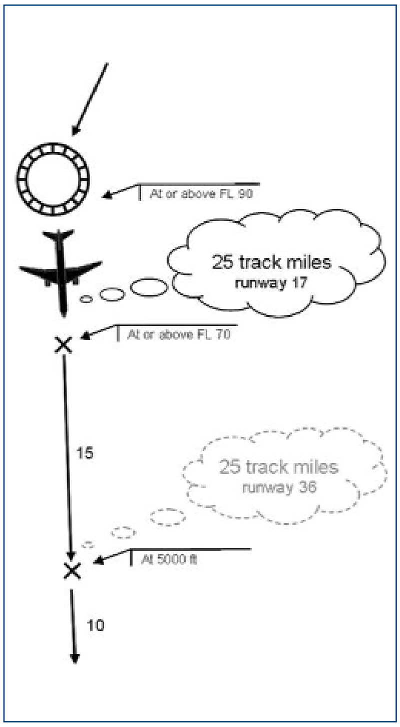
Dan is a retired test pilot and previous Head of Flight Safety at BAE SYSTEMS Regional Aircraft. He maintains a keen interest in flight safety matters. A member of the FSF European Advisory Committee, a contributor to ALAR Tool Kit, the Operators Guide to Human Factors in Aviation (OGHFA), and several industry safety initiatives.

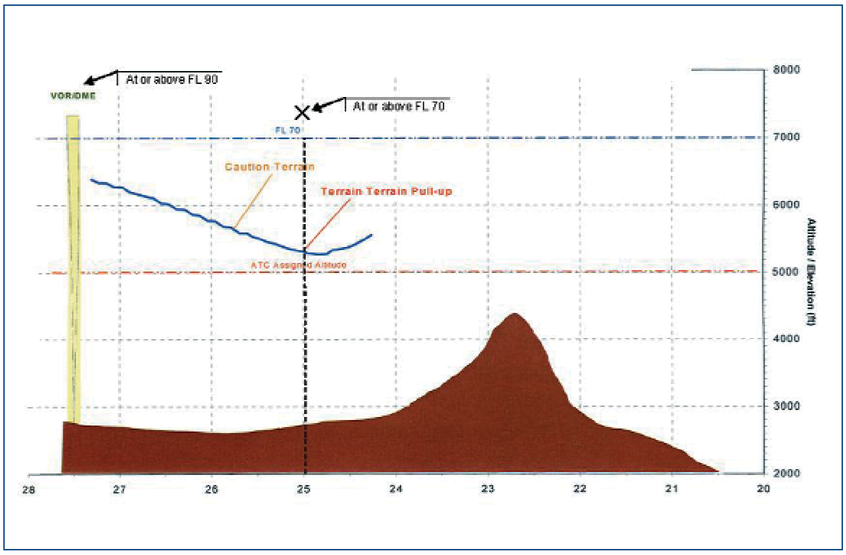
The aircraft was descending approximately 25nm from the airport for an approach to runway 17 - straight in. As the aircraft approached the positioning VOR the controller prepared to clear the aircraft to a lower altitude (FL 70).

At this time a runway change was in progress, to land on runway 35; this distracted the controller. The revised procedure required the aircraft to fly overhead and beyond the runway.

The controller mentally repositioned the aircraft at a point closer to the runway by use of the previous track miles to touchdown (mental map shift). Using this perception of the situation the controller cleared the aircraft to 5000ft. The crew did not cross-check the aircraft position, possibly also distracted by the change of runway or suffering from a similar mental slip. As the aircraft approached 5000 ft an EGPWS 'Terrain Terrain Pull Up' warning was given.

This incident illustrates the potential for error due to distraction, habit, or expectation. The safety defences are to check the mental plan (perception) with the real world, cross-check the aircraft position against the lateral and vertical profiles. Situation awareness is both gained and refreshed by using a systematic scan of real-world parameters; this also redirects mental attention to the required task.





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N°1 HindSight

January 2005

Putting Safety First in Air Traffic Management

HINDSIGHT IS A WONDERFUL THING

By Tzvetomir Blajev
Coordinator - Safety Improvement Initiatives, and Editor in Chief of HindSight

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

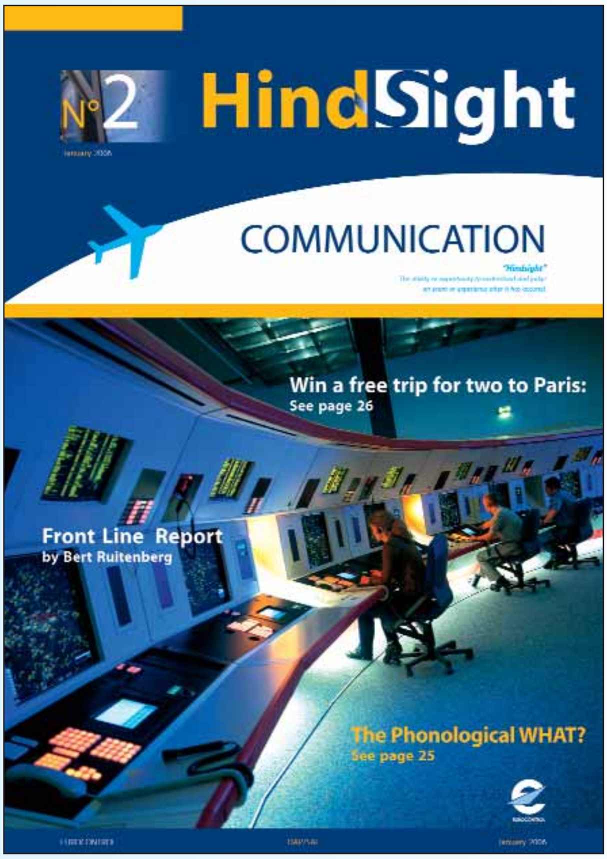
"With the benefit of hindsight I would have done it differently".

How often do we hear responsible people saying these words? Often, it is an attempt to disguise the fact that they had not prepared themselves for some unusual situation. Yet hindsight is a wonderful thing and can be of great benefit if used intelligently to prepare ourselves for the unexpected. There is much to be learnt from a study of other peoples' actions - good and bad.

If we learn the right lessons we will stand a much better chance of reacting correctly when we are faced with new situations where a quick, correct decision is essential. This magazine is intended for you, the controller on the front line, to make you know of these lessons. It contains many examples of actual incidents which raise some interesting questions for discussion. Read them carefully - talk about them with your colleagues - think what you would do if you had a similar experience. We hope that you too will join in this information sharing experience. Let us know about any unusual experiences you have had - we promise to preserve your confidentiality if that is what you wish. Working together with the benefit of HindSight we can make a real contribution to improved aviation safety.

European Air Traffic Management - EATM

EUROCONTROL DAP/SAF January 2005



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

We hope that you will join us in making this publication a success. Please send your message - rude or polite - to:

tzvetomir.blajev@eurocontrol.int

Or to the postal address:
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Putting Safety First in
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