N°6 HindSight

January 2008

COLLISION AVOIDANCE

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

THE RUNWAY AND YOU
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EUROCONTROL

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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.

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Human Factors

Air Ground Communication

Other

MUST HINDSIGHT ALWAYS AVOID COLLISIONS?

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

Sit down and relax - I am going to write about collisions of opinions. Should HindSight allow controversial opinions to be published? To answer this question I need to answer another one first - ***What exactly is HindSight?*** The short answer is in the title of my first editorial of HindSight Edition 1 - "HindSight is a wonderful thing". A somewhat longer answer is provided below.

HindSight is an "Aviation Safety Magazine for Air Traffic Controllers". The concept is based on carefully balancing the style, content and scope around the four dimensions in the above sentence. Those dimensions are represented by tensions and are elaborated below:

1. ***Aviation*** Safety Magazine for Air Traffic Controllers.

Air Traffic Control point of view	*VERSUS*	Other points of view - pilots, airports, etc.

2. Aviation ***Safety*** Magazine for Air Traffic Controllers.

What we have learned from the past - lessons learned from investigations, reporting and normal operations	*VERSUS*	What may come in the future - new concepts, procedures, equipment and lessons learned from risk assessment

3. Aviation Safety ***Magazine*** for Air Traffic Controllers.

Presenting the "official" EUROCONTROL position and sticking closely to technical documents	*VERSUS*	Providing a forum for discussion and expression of opinions not necessarily endorsed by EUROCONTROL

4. Aviation Safety Magazine ***for Air Traffic Controllers***.

Delivering to the practitioners the practical "do's and don'ts" that can be used directly in everyday practice	*VERSUS*	Reflecting on what the "theory" says and giving the floor to researchers and scientists.

Now back to the question. Must we avoid conflict? Is there censorship? My belief is that:

HindSight must avoid:
- emotional conflict on a personal level.
- misleading the reader about standard procedures.

HindSight should promote:
- argument based on facts.
- disagreement on matter of opinion.
- healthy and constructive discussion.

Enjoy the reading!

FRONT LINE REPORT: LEFT SIDE, RIGHT SIDE, WRONG SIDE?

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.

It was a quiet Sunday afternoon, late March 1977. Winter in the Netherlands was slowly giving way to spring, and I was driving in my car to Eindhoven Air Force Base where I had recently qualified as an Air Traffic Control Officer. Although it was a weekend, during which no military activities were expected, I had to go to the Tower to facilitate the arrival of a civil business jet from a company that shared the airport with the Royal Netherlands Air Force. Suddenly the radio programme that I was listening to in my car was interrupted for an extra news bulletin: there had been an accident involving two Boeing 747s on the runway at Tenerife, and one of the aircraft was Dutch.

I remember finding this news bulletin quite shocking: even though at the time I had been an ATCO for just a couple of months, I realised that the scenario that had unfolded at Tenerife was a professional nightmare for every ATCO in the world - this was the sort of thing that we were trained to prevent, but here it appeared to have happened with all the dire consequences. For the rest of that day I tried to listen to as many news bulletins on radio and TV as I could, to learn more about the circumstances of the accident. (This was 1977 - Internet and CNN didn't yet exist, so radio and public TV were the main information sources for such events!)

Until that day in March 1977, aircraft collisions to me seemed like something from the past. Admittedly there had been a mid-air near Zagreb as recent as September 1976, but as a member of the troops in a NATO Air Force I sort of accepted that such things would occur in Eastern Bloc countries. Tenerife brought home to me the reality that aviation accidents can occur anywhere in the world.

And indeed aircraft collisions (involving commercial flights) have kept occurring since then, although they still are rare occasions. In 1986 there was a mid-air near Cerritos (Ca, USA), in 1996 a mid-air near New Delhi, in 2001 a runway collision at Milan Linate, in 2002 a mid-air near Überlingen, and in 2006 a mid-air over the Amazon in Brazil.

It almost goes without saying that all those accidents were duly investigated, and the safety recommendations from the investigation reports have undoubtedly contributed to enhancing aviation safety around the world. In fact it was the Cerritos accident in 1986 that resulted in the mandatory carriage of Airborne Collision Avoidance Systems (ACAS), of which the Traffic Alert and Collision Avoidance System (TCAS) is the most widely used application. The 1996 accident near New Delhi resulted in extending the manda-

tory carriage of ACAS to cargo aircraft, since one of the two aircraft involved was a freighter without TCAS.

What the accidents in Linate (2001), Überlingen (2002) and Brazil (2006) have painfully demonstrated is that having TCAS in aircraft does not in itself help prevent a collision. In Linate the accident occurred on the ground, i.e. a situation for which TCAS was not designed. In the Überlingen scenario the TCAS in both aircraft worked perfectly according to specification, but sadly one of the flight crews involved had not received the training to adequately interpret its advisories. And in the mid-air over the Amazon, preliminary findings indicate that the transponder and TCAS of one of the two aircraft was not functioning at the time of the accident, rendering the aircraft electronically invisible to the other aircraft.

Which brings me to another common factor in the New Delhi and Brazil mid-airs: the aircraft were on exact reciprocal tracks. In the old days, when navigation was based on radio beacons
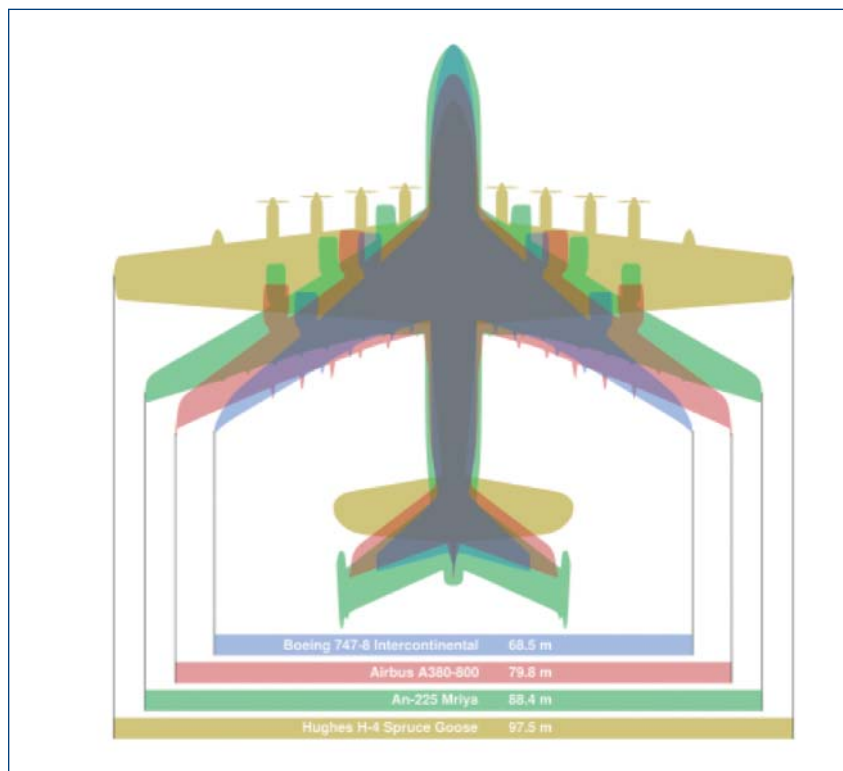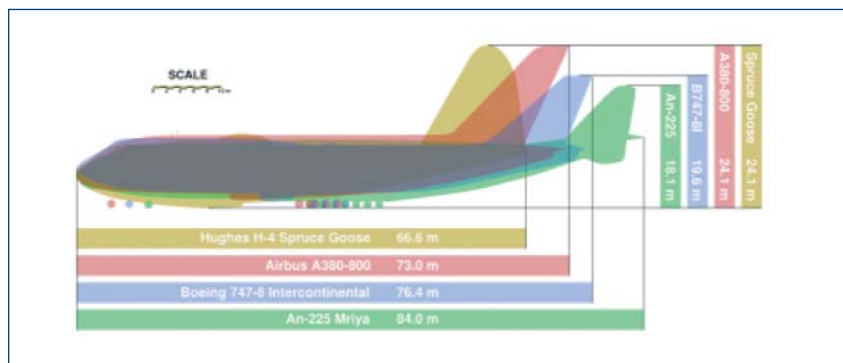
such as NDBs and VORs, it was very rare for aircraft on opposite tracks to pass exactly at the same position. There would usually be some inaccuracy in the navigation systems as a result of which the aircraft would pass each other laterally with some air in between (as well as the vertical spacing applied by ATC). If for some reason the vertical spacing was lost, there was still a good chance the aircraft would not collide because of that lateral inaccuracy. But not so in 1996 and beyond: the on-board navigation systems (INS, IRS, satellite) have become so accurate that aircraft are usually following the exact centreline of the assigned route - which of course removes the unintended-but-very-welcome safety feature of having air between aircraft due to lateral inaccuracy. If vertical separation nowadays is lost for some reason, the chance is very high that the aircraft will collide - the New Delhi and Brazil accidents provide tragic evidence of this.

The Überlingen accident has triggered a discussion about displaying TCAS advisories on the screens of air traffic controllers. At first glance that seems like a brilliant work-around to overcome some of the inherent flaws in the TCAS design, but on giving it some deeper consideration it may not be as simple a solution as it would seem. In my humble opinion, all it will do is shorten the time between the generation of the advisory and informing ATC about it (which currently is done by R/T by the pilots concerned, at their earliest convenience). Other than that it resolves nothing, I think - ATC still doesn't know whether or not the pilots

are following the advisories, and the "downlink" can still coincide with instructions from the controller(s) that may or may not contradict the advisories. So where's the gain?

Another work-around discussion, related to the New Delhi and Brazil accidents, is the one about having aircraft routinely fly "offset" from the air-

way centreline, i.e. a certain distance away from the centreline. Again on first glance most aviators will say this is a brilliant solution to re-create the situation where there is some lateral air between passing opposite aircraft (in addition to the vertical spacing). But here's the catch: depending on which side of the road the car traffic is in their country of origin, pilots will tend to

apply an offset that is either left or right of the airway centreline…. (OK, allow me to explain if you didn't get that: picture two opposite aircraft of which one is flying half a mile left of the airway centreline. Now move the other aircraft half a mile right of the centreline, and see where they both end up!)

And here is some further information on this offset flying: a number of airline pilots are applying this already in real life under their own authority - but apparently without realising the left/right offset anomaly as described above. I'd say some international regulation is required for routine offset flying, and rather urgently too!

In the discussion about offset flying there also appears to be some debate as to the distance to be used in the off-set. One mile, half a mile, less or maybe more - many figures are mentioned. The discussion involves aspects such as disturbance of the traffic picture on the screen of ATCOs, spacing with adjacent routes, and whether or not the offset should be transparent to the pilots (i.e. should the pilots even know that an offset is applied?). I'm not going to offer a solution to the discussion here, but I'd just like to point out that the wing span of the world's largest operational aircraft, the Antonov 225, is just under 90 metres. Theoretically this implies that any distance larger than half that span, i.e. anything more than 45 metres, should do the trick - as long as agreement is reached about appli-cation of the offset on the left or right side.

45 metres roughly equals 0.025 NM, so even if the regulators were to knock themselves out and opt for an offset that is four times the required mini-mum, the distance would be 0.1 NM. This number is far less than any of the numbers I've heard used in the current discussions. It would hardly disturb any ATCO's traffic picture, and it would hardly interfere with any spacing requirements for adjacent routes. Feel free to enter this viewpoint in any discussion on offset flying you may find yourself involved in, and don't forget to insist on agreeing to all apply the off-set on the same side of the centreline!

THE APPLICATION OF OFFSET TRACKS IN EUROPEAN AIRSPACE

by Roland Rawlings

Roland Rawlings is Navigation Manager within DAP/APN and as such is responsible for Navigation Strategy including the aviation applications of GNSS. This work addresses navigation issues for all phases of flight.

In his editorial Left Side, Right Side, Wrong Side? Bert Ruitenberg draws attention to a safety concern that has arisen out of the improved performance of aircraft navigation systems, which allows aircraft to maintain tracks with a degree of precision that was unimaginable until recently.

The raw GPS position performance is now better than 10 metres, and with automatic coupling, the accuracy with which an aircraft follows a defined track can be within the dimensions of the airframe. This leads to a concern as to the operational safety, especially since, at cruise altitudes, a vertical separation of 1,000ft between opposite-direction aircraft cannot be confirmed visually.

A solution which has already been implemented unofficially by some pilots is to offset tracks by a small amount in order to ensure lateral separation in the event of a flight level error. This action termed Strategic Lateral Offsets, and for simplicity termed just "offsets" in this article, should not be confused with tactical offsets applied by ATC to support ATM functions such as aircraft overtaking manoeuvres. The procedures for such offsets have been developed for remote and oceanic operations. However, the applicability of such offsets for high-density operation such as

makes up the majority of ECAC operations has not hitherto been studied. As a result no review has been undertaken of the implications of such offsets and there exists no standard advice to pilots on such offset applications.

Calls for increased use of offsets intensified after the 29 September 2006 mid-air collision in Brazil between a Boeing 737-800 and an Embraer Legacy 600 Business jet. The crash occurred while the two aeroplanes, which were being flown in opposite directions, were on the same route and at the same altitude. With previous generations of navigation capability the navigation inaccuracies meant that there was only a very small probability that such an error would result in a collision. Today, with the improved lateral and vertical accuracy, the risk of a collision resulting from such error is significantly higher.

EUROCONTROL has recently undertaken two studies to address these concerns with regard to ECAC airspace. These are:

1. an investigation of the operational and technical implications of the introduction of offset routes on aircraft onboard equipment, including a review of the capability of existing FMS equipment; and,

2. a safety study to identify the lateral overlap risk for opposite-direction traffic taking into account GPS lateral accuracy as well as potential mitigations.

For the purpose of those studies, seven bidirectional routes within the ECAC airspace were selected. The reason for only selecting bidirectional routes is that for single-direction routes the risk of collision due to a vertical error is very low, since when the flight level orientation scheme is employed aircraft will have 2000 ft vertical separation, and when all flight levels are employed the low speed differential between aircraft flying in the same direction provides the risk mitigation.

It is important to note that in the core area of ECAC only 10% of routes are bidirectional, the others being single-direction. The routes studied are the seven busiest bidirectional routes (more than 100 flights in one direction per day) within the ECAC airspace. Outside of the core area and below FL

290, a greater proportion of routes are dual-direction but the density of traffic is low.

One day's worth of traffic from seven segments of these routes was gathered and an investigation was made as to the aircraft onboard equipment used on those routes and the navigational accuracy. This data was used to undertake a risk analysis for opposite-direction traffic.

The studies identified the following points:

1. Investigation of the implications of the introduction of offset routes on aircraft onboard equipment.

- At present almost 20% of aircraft in ECAC cannot carry out automatic offsets and software upgrade (after delivery) is expensive. For instance, by creating offset routes, the number of waypoints will also expand;

this could create memory/database problems. In proposing offset routes there is a risk of exceeding database capacity.

- Where there is an offset capability, for all but a small percentage of aircraft the offset capability is for a minimum offset of 1 NM. Only a small number of FMS types can perform offset increments from 0.1 NM

Note: Red: routes with more than 100 flights per day in one direction
Orange: routes with between 50 and 100 flights per day in one direction
Green: routes with between 20 and 50 flights per day in one direction

Bidirectional routes in Europe with more than 20 flights a day

- There are a large number of ways in which the offset is implemented and this impacts the continuation of offset during and after a turn and the application of offset on SIDS and STARS. For example some systems continue offset during a turn or on entry to STARS whilst others cancel the offset. The differing implementations of entry and exit of offsets (automatic and/or manual, intercept/rejoin angle, etc.) could result in aircraft flying offsets where this is inappropriate.

2. Lateral overlap risk estimation and mitigations.

- The lateral overlap risk has been estimated from the combination of the probability of lateral overlap and the opposite-direction passing frequency. In such estimations, it has been assumed that over 80% of the aircraft would be using GNSS-based navigation. The estimation has then been compared against the upper bound of the global system performance specification for RVSM, showing that this has been exceeded.

- The effect of two track offsets to the right of the flight direction on the probability of lateral overlap for opposite-direction traffic has then been examined. Very small offsets of 0.1 and 0.2 NM were found to reduce the probability of lateral overlap for aircraft on the same track by a factor of approximately three. A further factor of approximately two can be gained using

offsets of 0.5 and 1 NM. An overall factor of approximately seven is obtained for offsets of 1.0 and 2.0 NM.

- However, it is important to note the following:
  - a similar or even a larger decrease in risk can be expected from replacing the bidirectional routes by pairs of unidirectional routes, which reduces the passing frequency;
  - the use of direct routings, a common practice in the core part of ECAC, reduces the risk of lateral overlap by the lateral dispersion of traffic;
  - in an ECAC environment, offsets would not significantly change the system safety as crossing traffic generates the dominant risk;
  - in many parts of ECAC, route spacing is at or close to the minimum that can be supported by the navigation performance requirement. The application of offsets in this situation would increase the risk associated with the passing traffic on the neighbouring track. This is particularly important considering the offset capability of the large majority of RNAV systems today is a minimum of 1 N mile.

Nevertheless, in view of the fact that there does remain an operational risk, albeit low, it would not be appropriate to ignore a potential means for risk reduction. However, the contribution to safety will be relatively small and care

must be taken to ensure that offsets are not applied where they would be detrimental to safety.

CONCLUSION

The safety analysis demonstrated that the use of offsets in an ECAC environment has a very small effect on the safety risk owing to the preponderance of the risk arising from crossing traffic. However, there could be a risk reduction through the use of offsets when they are applied correctly. In addition they do provide better visual cues to the pilot as regards the separation of aircraft.

As a result, there appears to be no intrinsic reason why offsets cannot be supported if it can be confirmed that correct application can be assured.

Since the use of offsets could influence system safety there is a need to develop criteria enabling the identification of where and how offsets can be safety employed, and any limitations that need to be applied. It will also be necessary to define operational procedures and training requirements for their application to ensure that such offsets can be employed in a safe manner.

ACCORDINGLY, THE FOLLOWING STEPS ARE PROPOSED BY EUROCONTROL:

- That the number of bidirectional routes should be further reduced. This is already the target adopted by the Route Network Development Subgroup of the

Airspace and Navigation Team and the findings summarised above give fresh impetus to this work.

- That the remaining bidirectional routes should be further studied to establish whether offsets could be applied without reducing safety. Specifically this would need consideration of the wide variety of implementations of offsets and the impact of applying offsets on these tracks and on neighbouring tracks. It would also need to study the impact on safety of failing to correctly cancel offsets in areas where offsets reduce system safety.

- That if after review it is deemed appropriate to allow offsets in specific situations, the following will need to be developed by the appropriate Subgroup of ANT:

  - development of implementation rules;
  - development and publication of ATC and Pilot Procedures;
  - development of guidance material on the application of Strategic Lateral Offsets;
  - preparation of Pilot and ATC awareness material.

I agree that this new "offset" concept has created an opening for VLJ community!

THE SUNSHINE IS BACK

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).

Disclaimer: *Although being based on a real incident, the characters in the story are completely made up by the author. Any similarity with the persons involved is entirely coincidental.*

THE INVESTIGATOR

It was winter; she walked alone in the endless forest. The sound from her boots on the dry snow was comforting; it brought back memories from her childhood. It was not a lot of snow, just enough to cover the ground and make the pine trees look like in a Disney movie. She loved walking by herself, it helped her to relax, she worked in a beautiful city, but it was a city filled with noise and stress; she preferred the countryside. Her phone rang, in a second all the peacefulness was gone; she needed to return to Stockholm.

THE INBOUND CREW

"Why is white chocolate white, cocoa isn't white is it?" He thought about this just before landing. Now they had vacated the runway and they contacted the ground controller. The controller cleared them to their stand at the south of the airport, and instructed them to hold before intersection Alfa. On taxiway Zulu southbound he instructed the first officer to switch off the left engine, he saw an aircraft crossing Alfa ahead of him, from Terminal 2 to the outer taxiway, and another on the apron, well to the left of a parked aircraft close to Alfa. He could see the follow-me waiting at the entrance of the south ramp. The aircraft that crossed his taxiway ahead of him turned north on the outer parallel taxiway, suddenly he passed an aircraft on the left, close…

THE GROUND CONTROLLER

The atmosphere in the tower was slow but focused; everything was like a normal day. He had been a controller all his life and was very experienced. While other people would love every second in tower, he thought of it as just another routine day; in fact he sometimes even complained about the need of being there. He worked on one of two ground positions; the traffic was average, nothing special ever happened; another day closer to retirement. A few conflicts to sort out, easy job, the same job he did day in day out.

THE OUTBOUND CREW

"Why is the sun always shining in Stockholm?" the first officer thought to himself, the weather having been brilliant every time they had visited in the last few months. He never had time to visit the city; he liked coming here and the people he met were always very nice and professional. Perhaps next summer when it was warmer; outside it was minus 4.

Five minutes later all his thoughts were focused on the flight; they push backed and requested taxi instructions for departure. They received and read back the instruction for runway 08, it was not via the published standard route but via intersection Alfa; they did not complain, it was a shorter route. The captain was taxiing the aircraft. Just before leaving the apron, approaching Alfa, the first officer suddenly saw an aircraft coming from the right on taxiway Zulu: "it is not stopping, STOP!" he shouted. It passed three metres ahead of them.

SUMMARY

Three aircraft were taxiing out from the ramp. It is believed that the inbound flight crew saw number one and three, but not number two, the conflicting aircraft (hidden behind an aircraft parked on gate 59G). Although the read-back was correct and they were very familiar with the airport, the pilots on the inbound aircraft did not hold as instructed before Alfa. The aircraft passed, without braking, a few metres in front of the second outbound aircraft, which braked hard to avoid a collision. The follow-me vehicle waiting at the south ramp, clearly visible ahead of the inbound aircraft, may have contributed to flight crew's distraction.

Why did this happen, and how can it be prevented in the future?

The investigation board recommended:

- A clearance should not be given to a holding point or gate with an instruction to hold at an intermediate point: the clearance should be to the intermediate point instead.

- Controllers should not deviate from standard taxi routes unless absolutely necessary.

CHANGES TO ICAO RULES REGARDING TCAS RAS

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.

In the last issue of HindSight, in my article about TCAS and STCA (see TCAS and STCA - not just anagrams, HindSight 5, July 2007, page 19) I remarked that ICAO rules concerning RA reporting would change in the near future. ICAO has now published the changes that will become applicable on 22 November 2007. Below is the summary of the changes to ICAO PANS-ATM (Doc 4444) and ICAO PANS-OPS (Doc 8168).

PHRASEOLOGY

The first change concerns the RA report phraseology. The new phraseology is:

"TCAS RA"

The controller response to the RA report is an acknowledgement ("Roger").

This change was implemented to simplify RA reporting. Previously, pilots were required to include the direction of the movement in their RA report (i.e. "TCAS Climb" or "TCAS Descend"). That sometimes led to ambiguous situations as no phraseology existed to report the most common RAs (Adjust Vertical Speed) and pilots often improvised their reports creating extra confusion in the situation that was already stressful for the controller. For example, "Adjust vertical speed" RAs calling for the reduction of the climb rate due to

another aircraft above were sometimes reported as "TCAS Climb". In fact the aircraft was still climbing but at a lower rate. This gave the controller a false indication that the TCAS resolution was telling the pilot to continue the climb towards the other aircraft. That caused, in some cases, the controller to issue an instruction during the RA, resulting in confusion on the flight deck and prolonged radio exchanges.

On the other hand, controllers should note that the new phraseology may limit their awareness as to the direction of the movement of the aircraft responding to the RA.

The pilots are now required to explicitly announce the TCAS "Clear of conflict" message when the conflict is over:

"CLEAR OF CONFLICT, RETURNING TO (assigned clearance)"
or
"CLEAR OF CONFLICT, (assigned clearance) RESUMED"

The controller response to the "Clear of Conflict" report is an acknowledgement ("Roger") or provision of an alternative instruction.

The clear indication of RA termination will now allow the controller to recognise when the RA is completed and when he/she can start issuing clearances or instructions to the affected aircraft.

In the event that the controller issues a clearance or instruction contradictory to the TCAS RA, the flight crew will follow the RA and inform the controller:

"UNABLE, TCAS RA"

The controller response to that RA report is an acknowledgement ("Roger").

Previously, the "unable" phraseology included the direction of the RA (e.g. "Unable, TCAS climb") - this change is in line with the RA reporting changes as described above.

WHICH RAs MUST BE REPORTED?

The second significant change concerns the types of RAs that must be reported. Previously, the pilots were required to report all RAs to ATC. With the change applicable on 22 November 2007 the pilots will report only those RAs that require a deviation from the current ATC clearance or

instruction ("As soon as possible, as permitted by flight crew workload [the pilots shall] notify the appropriate ATC unit of any RA which requires a deviation from the current air traffic control instruction or clearance").

This change should eliminate reports of RAs that are not significant for ATC, i.e. those not leading to deviation from the current clearance. That should cover the majority of RAs issued to the fast climb or descending aircraft approaching their cleared level while another aircraft is immediately above/below. ICAO believed that these reports caused unnecessary workload for the flight crews and for ATC and has therefore excluded them from the reporting requirement.

It should be noted that in some cases pilots may have difficulty to determine whether the RA is requiring a deviation from the current ATC clearance.

WHEN DOES THE CONTROLLER CEASE TO BE RESPONSIBLE?

A change has been made clarifying the controller responsibility during an RA. Now, the defining moment when the controller ceases to be responsible is the departure from clearance or pilot report of an RA.

The amended paragraph 15.7.3.3 now reads:
"Once an aircraft departs from its ATC clearance or instruction in compliance with an RA, or a pilot reports an RA, 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 RA. 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."
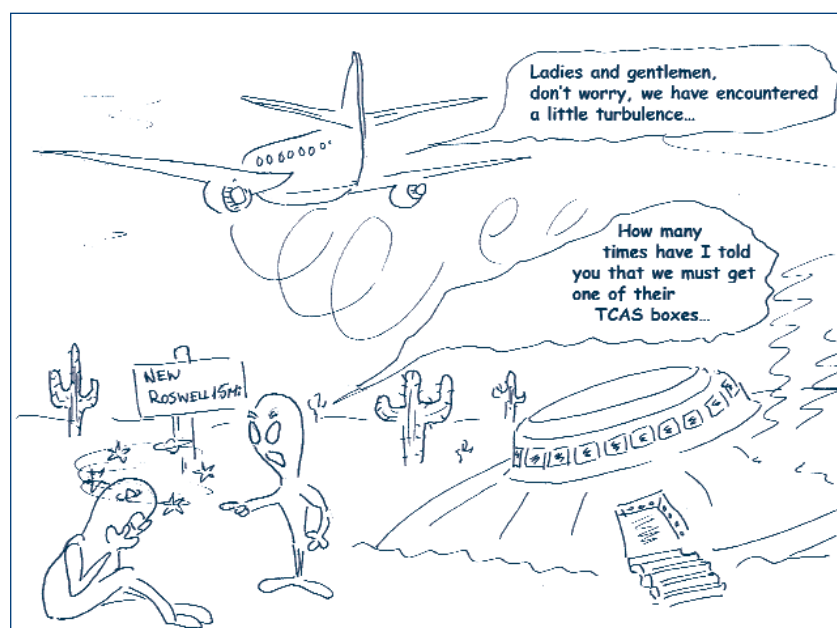
PROVISION OF TRAFFIC INFORMATION

Until now, controllers were required to provide traffic information to the aircraft responding to the RA. This requirement has been removed as it is believed that at that point ATC traffic information provides little added value to the flight crew and might be distracting. Moreover, traffic informa-

tion may be inadvertently inaccurate as the position and altitude information are delayed in surveillance processing. In some case controllers found issuing traffic information difficult due to the proximity or overlap of the aircraft labels and symbols on the screen. Also, traffic information and the visual acquisition of the intruder could prompt the pilots to stop responding to the RA. The amended paragraph 15.7.3.2 reads as follows:

"When a pilot reports an ACAS resolution advisory (RA), the controller shall not attempt to modify the aircraft flight path until the pilot reports "Clear of Conflict".

Note - the most important principle of this paragraph remains in force - once an RA has been reported, the controller shall not attempt to modify the aircraft flight path, until the pilot announces "Clear of Conflict".

121.5
SAFETY ALERTS

SAFETY REMINDER MESSAGE SUMMARY

VISUAL MISIDENTIFICATION OF AIRCRAFT LIVERY

Origin: Aircraft Operator
Issued: 26/04/2007

THE PROBLEM

When being provided with local traffic information by the aerodrome or ground controller, confusion and ambiguity have been reported as regards the aircraft livery of the traffic in question.

- When issuing local traffic information in the aerodrome control service (including the use of conditional clearances), ICAO PANS-ATM provides that the aircraft type represents an integral element. PANS-ATM also provides, in the context of essential local traffic, that the traffic is to be described "so as to be easily identified". To this end, controllers often provide, in addition to the aircraft type, the name of an aircraft's operating agency or the operating agency's corresponding radiotelephony designator, e.g. "FOLLOW THE BRITISH AIRWAYS A340".

- As a result of recent developments in areas of commercial cooperation among many aircraft operating agencies, liveries of commercial aircraft are often no longer entirely consistent with the expected liveries of their operating agencies.

The photographs below illustrate this point well. In either case, it would be hard to decide immediately which aircraft the instruction "FOLLOW THE LUFTHANSA" or "FOLLOW THE AIR CANADA" applied to.

POTENTIAL SOLUTIONS

- For these reasons, ATC must take particular care, when describing aircraft in local traffic information, particularly as regards the use of conditional clearances.

- Therefore, where it is deemed by ATC necessary, as a means of providing additional clarity, to refer an aircraft's operating agency name or radiotelephony designator in either local traffic information or during coordination between control positions in the aerodrome control tower, ATC should ensure (preferably by visual observation) that the aircraft's livery is in fact consistent with the livery that would be expected for the aircraft in question.

- Regarding conditional clearances, controllers and pilots will recall that they are required to visually identify the aircraft/vehicle causing the condition. It is of utmost importance that this identification procedure is carried out correctly. There must be no doubt as to whether the correct object has been identified.

REQUEST FOR SUPPORT MESSAGE SUMMARY

GUARDING 121.5 MHZ

Origin: European ANSP
Issued: 12/06/2007

THE PROBLEM

A European Air Navigation Service Provider, within the context of a significant number of "loss of communication" events, shared the findings made locally:

- There is no firm requirement for aircraft to guard 121.5 MHz except for designated areas, long over-water flights and areas where there is a risk for interception; however, there is a recommendation to do so.
- As regards aeronautical stations, they are required to guard 121.5 MHz.

ICAO PROVISIONS IN ANNEX 10 VOLUME II

5.2.2.1.1.1 Aircraft on long over-water flights, or on flights over designated areas over which the carriage of an emergency locator transmitter is required, shall continuously guard the VHF emergency frequency 121.5 MHz, except for those periods when aircraft are carrying out communications on other VHF channels or when airborne equipment limitations or cockpit duties do not permit simultaneous guarding of two channels.

5.2.2.1.1.2 Aircraft shall continuously guard the VHF emergency frequency 121.5 MHz in areas or over routes where the possibility of interception of aircraft or other hazardous situations exist, and a requirement has been established by the appropriate authority.

5.2.2.1.1.3 Recommendation - Aircraft on flights other than those specified in 5.2.2.1.1.1 and 5.2.2.1.1.2 should guard the emergency frequency 121.5 MHz to the extent possible.

5.2.2.1.3 Aeronautical stations shall maintain a continuous listening watch on VHF emergency channel 121.5 MHz during the hours of service of the units at which it is installed.

SUPPORT REQUESTED

Readers were requested to share their national and company provisions regarding monitoring of 121.5 MHz.

RESPONSE

Responses were received from a wide range of operators and ANSPs:

- two operators stated that it was company policy to monitor 121.5 MHz continuously;
- 12 operators stated that company policy was to guard 121.5 MHz whenever feasible;
- only one operator reported that it was company policy not to monitor 121.5 MHz;
- several operators pointed out that it was often necessary to reduce the volume on the emergency frequency below the normal audible threshold due to interference or inappropriate use of the frequency. Sometimes, pilots forget to restore the volume to the normal level when the distraction has ceased and on one occasion, this contributed to loss of communication and subsequent interception of an aircraft;

Note: Interference or inappropriate use of the emergency VHF frequency should always be reported to the appropriate national authorities. [Ed.]

- some operators also monitor other frequencies when possible, e.g. 123.45 in remote geographic areas;
- all aircraft operating in U.S. airspace are required to maintain a listening watch on frequency 121.5;
- some operators reported that monitoring of 121.5 or 123.45 had enabled them to assist, or be assisted by other aircraft following loss of communication;
- the use of ACARS often enables the emergency frequency to be guarded continuously because the second VHF radio is not required for weather broadcast, etc.;
- one ANSP stated that in their region, emergency calls are responded to by the Flight Information Centre, who coordinate response with other stations if necessary. For operational reasons, the monitoring of 121.5 MHz is not compulsory for other national Aeronautical Stations;
- one responder commented that, if a significant number of losses of communication occur, efforts should be focussed on finding the reasons for the losses of communication and appropriate remedial solutions.

SAFETY REMINDER MESSAGE SUMMARY

CALL SIGN CONFUSION

Origin: European Safety Programme
Issued: 09/10/2007

THE PROBLEM

- There have been an increasing number of similar call signs instances reported to EUROCONTROL. The reports are provided within the voluntary safety incident reporting and data sharing initiative.

- The use of similar call signs by aircraft operating in the same area on the same RTF frequency often gives rise to potential and actual flight safety incidents.

- The danger of an aircraft taking and acting on a clearance intended for another is obvious. The following are some of the potential outcomes of such a situation:
  - the aircraft takes up a heading or routing intended for another;
  - the aircraft commences a climb/descent to a level to which it has not been cleared;
  - the aircraft leaves the appropriate RTF frequency;
  - in responding to a message, the aircraft blocks a transmission;
  - the intended recipient does not receive the clearance, and fails to take up the desired heading or routing, or fails to climb or descent to the cleared level;
  - the controller misunderstands the intentions of aircraft under his/her control;
  - the controller issues a clearance to the wrong aircraft, and/or fails to issue a clearance to the intended aircraft;
  - the workload of controllers and pilots is increased because of the necessity to resolve the confusion.

- Recognising the risk associated with similar call signs EUROCONTROL is investigating the possibility of implementing system solutions aimed at removing the risk potential as early as the flight planning phase and by involvement of CFMU.

European Action Plan for Air Ground Communications Safety

- While pursuing long term strategy for removing the hazard at the source, we would like to remind the Aircraft Operators, ANSPs and national authorities about the recommendations and best practices contained in the European Action Plan for Air Ground Communications Safety available on:
  http://www.eurocontrol.int/safety/gallery/content/public/library/AGC_action_plan.pdf

- Training and awareness material is available on www.allclear.aero.

SAFETY WARNING MESSAGE SUMMARY

LEVEL RESTRICTIONS - AMENDMENTS TO ICAO PANS-ATM

Origin: EUROCONTROL Airspace Network Planning & Navigation
Issued: 26/10/2007

AMENDMENT TO ICAO PANS-ATM

- There was a potential for unintended level deviations due to flight crews and controllers interpreting the continued validity of level restrictions differently.

- To ensure an unambiguous understanding of the PANS-ATM provisions pertaining to the validity/applicability of level restrictions, new procedures (ref.: PANS-ATM paragraphs 6.3.2.4, 6.5.2.4, 11.4.2.5.2.5 and Chapter 12) were developed (applicable on 22 November 2007).

- Some elements of the procedures are outlined below.

CLIMB ABOVE LEVEL PUBLISHED IN SID

- When given a clearance to a level higher than that specified in a SID or initially cleared, follow the published profile unless restrictions are specifically cancelled. Example of phraseology to cancel level restrictions could be:

  First transmission

  "CLIMB TO 6000 FEET KODAP 1 DEPARTURE"

  Second transmission

  "CLIMB TO FL 210 LEVEL RESTRICTIONS KODAP 1 DEPARTURE CANCELLED".

DESCENT BELOW LEVEL PUBLISHED IN STAR

- Follow the published vertical profile of the STAR unless specifically cancelled by ATC and always apply minimum levels based on terrain clearance. Example of phraseology to cancel level restrictions could be:

  "DESCEND TO 5000 FT LEVEL RESTRICTIONS KODAP 1 ARRIVAL CANCELLED".

LEVEL RESTRICTIONS ISSUED EXPLICITLY BY ATC

- In all cases, level restrictions issued explicitly by ATC in air-ground communications shall be repeated by ATC in conjunction with subsequent level clearances in order for such level restrictions to remain in effect. Example of phraseology which would have the effect of cancelling level restrictions could be:

  First transmission

  "CLIMB TO FL 210 CROSS ALPHA AT FL 100 OR BELOW"

  Second transmission

  "CLIMB TO FL 250"

DISPLAYING ACAS RAS TO THE CONTROLLER: A HUMAN FACTORS PERSPECTIVE

by Doris Dehn

Doris Dehn is a cognitive psychologist specializing in Human Factors in Air Traffic Management. She has worked at the Institute for Aeronautics and Astronautics at the Berlin University of Technology, the National Aerospace Laboratory of the Netherlands, and is now a Human Factors Expert at EUROCONTROL.

Downlink of ACAS Resolution Advisories (RAs) for display to the controller - commonly referred to as RA downlink - is a topic most controllers will have an opinion on. On one side of the spectrum, there are those who maintain that RA downlink creates more problems than it solves. On the other side, there are those who would like to see RA downlink implemented as soon as possible. What can be said about RA downlink from a human factors perspective?

THE PROBLEM: ACAS RAS INITIATE A DRASTIC CHANGE IN RESPONSIBILITY

The existence of an ACAS RA has direct consequences for the tasks of both the aircrew and the air traffic controller: pilots are required to immediately comply with all RAs, even if they are contrary to ATC clearances or instructions. The controller, on the other hand, is not allowed to modify the aircraft flight path "once an aircraft departs from ATC clearance in compliance with an RA or a pilot reports an RA" [ICAO Doc 4444: PANS-ATM, para. 15.7.3.3].

Thus, the occurrence of an RA fundamentally changes pilot and controller tasks and responsibilities. Without an RA (that is, under normal circumstances), the controller's first and foremost task is to ensure separa-tion of traffic by modifying aircraft flight paths. The pilot is required to follow ATC instructions. With an RA, the controller must not try to ensure separation of the aircraft affected any more. The pilot is required to follow the RA and disregard any ATC clearances.
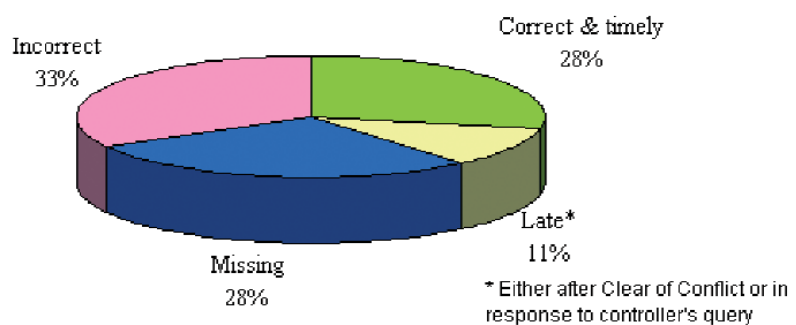
So, how do controllers and flight crew know about this fundamental change in responsibility? For the pilot, it seems to be straightforward: Any RA needs to be followed (unless of course doing so would jeopardise the safety of the airplane). Thus, if an RA is issued, the pilot knows that it takes precedence over the ATC instruction (provided, of course, that they are given appropriate ACAS training).

For the controller, the situation is more complicated: currently, the only way of becoming aware of an RA is via the pilot report. But what if the report from the pilot is incomplete, incorrect, delayed or even missing? This is more than just an academic question - data derived from incident reports published by the Swiss Aircraft Accident Investigation Bureau indicate that only 28% of RAs are reported correctly and in time. The number of RAs that are never reported is equally high at 28% (see graph below).

Unfortunately, there is no quick fix to make pilot reports timely and accurately in all cases. Rigorous pilot training on ACAS procedures will probably help to improve RA reporting,

Analysis of RA reports in Switzerland from 1999 to 2003
[Graph based on data available on www.bfu.admin.ch]

but it is unlikely to sort out the problem completely. For the pilot, an RA is a stressful situation and - for very good reasons - RA reporting has a lower priority than complying with the RA and trying to avoid a collision. Therefore, it is reasonable to assume that there will be always some delayed, incorrect or even missing RA reports.

RA DOWNLINK: A POSSIBLE SOLUTION?

In the light of the above, the potential benefit of RA downlink is rather obvious: it gives the controller more reliable and timely information on an RA. And this information is crucial for establishing that ATC is no longer responsible for an aircraft. One could argue, though, that there is another way of establishing that responsibility has ceased - the controller observes the aircraft depart "from ATC clearance in compliance with an RA". But hang on: how can the controller know that the aircraft departed from the clearance because of an RA (and not for any other reason), if there is no pilot report?

Thus, we are brought back to the initial argument: an RA triggers a fundamental change in pilot and controller responsibility. The only way for the controller to learn about this change is the pilot report, but pilot reports are often delayed, incorrect or missing. In this situation, RA downlink can help the controller to identify that he or she is not responsible for aircraft separation any more.

To be very clear: on the basis of current and new ICAO regulations, RA downlink would not affect the status of con-troller/pilot responsibility. What it can do, though, is to make the controller aware that a departure from ATC clearance is due to an RA and, thus, that the condition for a shift in responsibility has been met.

If the RA downlink occurs before the pilot report or the aircraft manoeuvre (and thus before controller responsibility ceases), it still has a benefit: it informs the controller on the direction of the RA. This makes it rather unlikely that the controller will issue an instruction that contradicts the RA.

So far, the argument is based on a consideration of pilot and controller tasks and the information needed to perform them. But do we actually have evidence for the suggested benefits of RA downlink?

There is, in fact, data that supports the benefits of RA downlink. In a series of EUROCONTROL simulations carried out within the Feasibility of ACAS RA Downlink Study (FARADS) project, it was found that RA downlink increases the controllers' understanding of the traffic situation related to the RA event. And, more importantly, it decreased the number of contradictory clearances to an aircraft involved in an RA encounter. Furthermore, no evidence was found that RA downlink narrows the controllers' attention to the RA event, and prevents them from attending to other traffic in the sector.

SOME CAVEATS AND CONSIDERATIONS

In spite of the encouraging results so far, there are issues related to RA downlink which need further consideration.

First of all, not all RAs require a departure from the ATC clearance and, hence, affect controller responsibility. This is one reason why in the future pilots will limit RA reporting to those RAs that cause a departure from ATC clearance [ICAO Doc 8168: PANS-OPS, Volume I, Part III, Section 3, Chap. 3, applicable as of 22 November 2007]. In order to avoid inconsistencies between pilot reporting and RA downlink, it may be better to restrict RA downlink accordingly.

Another concern relates to the situation where the pilot does not comply with the RA. If the pilot neither follows the RA nor reports it, the controller is still responsible for the separation of that aircraft. RA downlink may lead the controller to mistakenly believe that the pilot will comply with the RA and hence that responsibility has ceased. Although this is a valid concern, the underlying problem seems to be independent of RA downlink. Can the controller be responsible for separation of an aircraft whose pilot ignores an RA? And what if the pilot of the conflicting aircraft intends to follow the RA?

CONCLUSION

RA downlink is undoubtedly a complex topic. Nevertheless, the complexity arises from the intricacies related to integrating ACAS with the ground (human-machine) system, rather than the downlink itself. In spite of this, there is evidence for benefits of RA downlink: RA information can help the controller identify that he or she is no longer responsible for aircraft separation and, thus, can decrease the likelihood of contradictory clearances.

THE RUNWAY AND YOU

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.

It is an interesting fact that most air traffic controllers think of the runway as their territory - like the area inside the fence around their gardens at home. They protect it from intruders with as much care as they use to keep stray dogs off their roses, or small boys out of their apple trees (well, with a lot more care really).

The runway is the springboard from which all flights depart and to which they later return, and it is the controllers' job to manage aircraft so that the maximum use is made of the runway consistent with safety. They rightly take pride in their skill in keeping conflicting traffic apart. They are acutely aware of the danger of allowing an aircraft or vehicle to enter the active runway when it is in use by another aircraft.
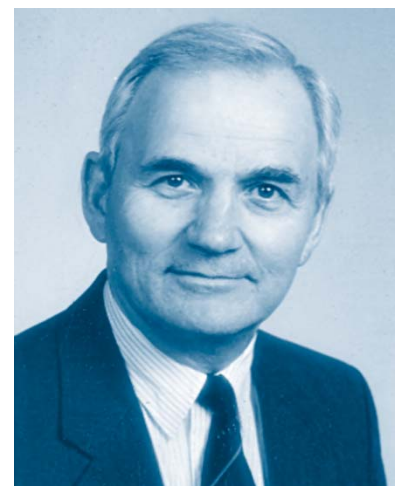
Runway incursions don't happen very often, but when they do, they always leave the controllers involved asking themselves if they could have been at fault. They know that there could have been an accident, so even if their performance was perfect and they should have a clear conscience, they still find themselves worrying in case there was some little extra thing that they could have done. There are many sleepless nights when the whole scenario is relived while they examine their every action with an intensity hardly matched by the investigation board, to see if it could have been improved or augmented in some way.

But if an incursion takes place as a clear result of their (incorrect) actions or omissions, even though an accident was avoided, the feeling of failure is immense. Despite all their training and experience they have somehow committed a fatal (or near-fatal) error; they have let themselves down and undermined that essential trust between pilot and controller.

I want to look briefly at some runway incursion incidents which took place in USA in recent years. There are common features in them all - features for which we should be on the look-out - which we should try to eliminate from our own operations.

SEATTLE/TACOMA INTERNATIONAL AIRPORT, JULY 8, 2001

A controller issued a taxi clearance to a Boeing MD-80 to cross runway 34R at the same time that a Boeing 767 was on short finals to the same runway. The pilots in the landing aircraft reported applying maximum braking to avoid a collision with the crossing aircraft, and the 767 stopped only 810 feet short of the MD-80. On the night of the incident, the controller was working his third shift in 2 days, with an 8-hour rest period between shifts. The day before the incident, he had worked from 1400 to 2200, slept between 4 and 5 hours at home, worked from 0555 to 1355 the day of the incident, slept 3 hours at home and then returned to work the

incident shift, which began at 2245. The controller stated that he tried to avoid midnight shifts whenever possible because of fatigue; at the time of the incident he was feeling tired, in part because he knew he "…had to be up all night long on a double quick turn-around."

DENVER INTERNATIONAL AIRPORT, SEPTEMBER 25, 2001

A Boeing 757 departed from runway 8 in night-time VMC. Runway 8 had been closed because of construction workers and equipment operating near its departure end and, during takeoff, the aircraft passed within 32 feet of lights that had been erected to illuminate the construction area. The controller handling the 757 was aware of the runway closure and had instructed the crew to taxi to a different runway. However, after the crew requested take off on runway 8, the controller agreed and instructed the crew to taxi and take off from the closed runway. The controller had worked a shift at the tower from 0530 until 1330 the day before the incident and then had a 9-hour rest period during which she obtained

between 60 and 90 minutes of sleep. She then returned to work the incident shift, which began at 2230. When asked why the incident occurred, the controller stated that she was "…probably tired, not alert enough."

LOS ANGELES INTERNATIONAL AIRPORT, AUGUST 19, 2004

A controller cleared a Boeing 737 to taxi onto and take off from runway 24L at the same time that a Boeing 747 had been cleared to land on the same runway and was on a short finals. The pilots in the landing aircraft saw the 737 taxi onto the runway and discontinued their approach about 12 seconds before the impending collision would have occurred, passing approximately 200 feet above the 737 during the go-around. The controller had worked a shift the previous evening from 1530 until 2330, then went home and slept between 5 and 6 hours before returning to work the incident shift, which began at 0730. The controller described the portion of his shift before the incident as a "hard day" and attributed his error, in part, to fatigue.

CHICAGO O'HARE INTERNATIONAL AIRPORT, MARCH 23, 2006

A controller cleared an Airbus A320 to cross runway 4L and, less than 15 seconds later, cleared a Boeing 737 to take off on the same runway. The pilots in the departing 737 observed the A320 moving toward the runway, rejected the takeoff, and stopped before reaching the taxiway intersection where the A320 was to cross. The controller had worked an 8-hour shift

the previous day until 2130 and was then off duty for 9 hours. Because of commuting and personal activities, he slept only about 4 hours before returning to work for the incident shift, which began at 0630. He reported that he felt "semi-rested" during his shift but was "not as sharp as he could have been." He stated that the second shift had been a quick turnaround with "no coffee."

The effects of fatigue on controller performance have been under study in USA for many years, and the issue was raised again following the fatal accident involving a Comair CRJ-100 which crashed while attempting to take off from the wrong runway at Lexington Blue Grass airport on August 27, 2006. During its investigation, the NTSB learned that the air traffic controller who cleared the accident aircraft for takeoff had worked a shift from 0630 to 1430 the day before the accident, then returned 9 hours later to work the accident shift from 2330 until the time of the accident at 0607 the next morning. The controller stated that his only sleep in the 24 hours before the accident was a 2-hour nap the previous afternoon between these two shifts. In its final report on this accident[1], the NTSB concluded that the controller did not detect the flight crew's attempt to take off on the wrong runway because, instead of monitoring the airplane's departure, he performed a lower-priority administrative task that could have waited until he transferred responsibility for the airplane to the next ATC facility. The extent to which fatigue was a factor in the controller's decision could not be established.

This latter accident prompted the NTSB to write to the FAA and the US controllers' union, and their letter[2] and associated data merit serious study. In this letter, the NTSB noted that all four controllers involved in the incidents described above were working rapidly rotating counterclockwise[3] shift schedules and had received scheduled rest periods of 9 hours or less before coming to work. They stated that "in view of the high percentage of controllers who work such schedules and research carried out by FAA's Civil Aerospace Medical Institute, the probability is very high that controllers are sometimes working when they are significantly fatigued and are committing fundamental errors directly as a result of being fatigued."

According to the NTSB letter, one controller who committed an error that led to a runway incursion event reported that, although he had been diagnosed with a sleep disorder 7 years before the incursion, he had discontinued the treatment prescribed by his doctor within two years because of side effects and had not sought further medical evaluation. When asked about controller awareness of fatigue-related issues, a supervisor on duty during the incident involving this controller said she did not know the extent to which controllers were aware of fatigue-related issues, that controllers did not discuss fatigue among themselves, and that they were "just used to being tired." A controller who was on duty during another runway incursion was also asked about controller awareness of fatigue-related issues. He stated, "Recently they mentioned something to us about fatigue, but it's never been an issue." When queried about whether

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[1] The final report was not posted on the NTSB website at the time of writing, but the statements quoted are contained in http://www.ntsb.gov/recs/letters/2007/a07_44_48.pdf
[2] See http://www.ntsb.gov/recs/letters/2007/a07_30_32.pdf, which also contains references to the full incident reports.
[3] Counterclockwise shift schedules are characterised by progressively earlier start times

he felt fatigued during midnight shifts, the controller stated, "Yes, but not so where I can't do my job." A supervisor on duty during the same incursion incident commented, "controllers here don't think fatigue is a problem."

The letter continues: "When faced with circadian disruption and short rest periods, it is essential that controllers use personal strategies to maximise restorative sleep and minimize fatigue. However, some controllers may have personal habits that exacerbate the fatigue caused by shift work. For example, the controller involved in the March 23, 2006, runway incursion had only 9 hours off duty before reporting for the incident shift. He arrived home from his previous shift about 2200, engaged in routine activities at home, fell asleep while watching television between 0100 and 0130, and slept only 4 hours before getting up to prepare for his next shift, which began at 0630. That he obtained only 4 hours of sleep before his next shift suggests that this controller may not have been using effective personal strategies to obtain adequate sleep. This practice may not be unusual. In fact, few controllers interviewed by the NTSB during the investigation of recent runway incursions have reported using comprehensive personal strategies for maximizing restorative sleep between shifts."

Controller fatigue is just as much of a problem in Europe as it is in the USA; although like the Americans, it is not a subject that we discuss widely. Most controllers accept fatigue as a fact of life, inextricably associated with their job, and perhaps they are right. After all, if civil aviation is to operate on a 24/7 basis, then most controllers will have to work anti-social shifts and some measure of fatigue is bound to result. In its way, fatigue in aviation can be as dangerous as it can behind the wheel of a car: the difference is that we can't pull over to the side of the road when we feel drowsy - we have to do something else about it.

There may be room for improving work schedules to minimise the occurrence of fatigue, and this should be the subject of on-going discussions between employers and unions, based on the reported experiences of controllers. Controllers should be encouraged to report incidents when they feel affected, even though no error results, so that adjustments to work schedules target the real danger areas.

At the same time, efforts should be made to combat the effects of fatigue. A first step should be to increase awareness of the problem and its potential dangers; then controllers should be helped to develop personal strategies to deal with fatigue. EUROCONTROL has done some excellent work in this area; for example, their brochure: Fatigue and Sleep Management contains an in-depth study of the effects of sleep deprivation, written in an easy-to-read style, and associated with practical tips to help the controller. These tips are published separately in an associated leaflet.

Team Resource Management (TRM) is another important tool in this battle, encouraging controllers and supervisors to work together as a team to eliminate error. If TRM is a new concept to you, have a look at the EUROCONTROL TRM leaflet. You can find all these products on the New Human Factors Documents website[4]. More detailed information on running TRM courses can also be found on the Human Factors Publications website[5].

4   http://www.eurocontrol.int/humanfactors/public/standard_page/10_newsletter_other.html
5   http://www.eurocontrol.int/humanfactors/public/site_preferences/display_library_list_public.html

AIRBUS AP/FD TCAS MODE: A NEW STEP TOWARDS SAFETY IMPROVEMENT

by Paule Botargues

Paule Botargues works in the Engineering Automatic Flight System Department of AIR-BUS France. She is in charge of the multi-program development of the AP/FD TCAS Mode and also of research activities for the auto flight system.

TCAS has been introduced in order to reduce the risks associated with mid-air collision threats; today this safety goal has been reached. Yet many incidents ("near misses") do still occur despite the presence of TCAS.

The in-line operational feedback analysis shows that there are some opposite reactions, many late reactions and overreactions from aircrews to TCAS Resolution Advisories (RA) leading to injuries in the cabin, undue aircraft trajectory deviations from the latest ATC clearance and even to altitude busts, as well as lack of proper communication from the crew to the ATC when an RA occurs.

This feedback shows that the root cause of such crew misbehaviour is the surprise and stress created by the RA, which directly affects the performance of the pilot.

The present RAs are indicated to the pilots by an aural message specifying the type of the Advisory (Climb, descent, monitor, adjust…), and by green/red zones on the Vertical Speed Indicator (VSI) specifying the manoeuvre the pilot has to fly; in order to fly this required manoeuvre the pilot has to switch both Auto Pilot (AP) and Flight Director (FD) to off, and adjust the pitch of the aircraft so as to get the proper V/S. This flying technique is quite unfamiliar to pilots, and disrupts the current flying technique they had at the time of the RA occurrence, which adds to their stress level.

AIRBUS has carried out an in-depth analysis of the need expressed by airlines' pilots regarding human factor studies linked to TCAS system and recommendations given by airworthiness authorities. The result of this study is the development of a new concept to support pilots flying TCAS RAs: the AP/FD TCAS mode.

The AP/FD TCAS Mode is a guidance mode built-in the Auto Pilot computer which allows the pilot to automatically fly the RA if the AP is ON or to hand-fly the RA by obeying the Flight Director command bars if the AP is OFF.

The AP/FD TCAS guidance mode controls the vertical speed (V/S) of the aircraft on a vertical speed target adapted to each RA, which is acquired from TCAS. It is designed to respect the TCAS hypothesis regarding the dynamics of the reaction as well as to minimise the deviations from the latest ATC clearance, as recommended by the procedures. The AP/FD "TCAS" mode is automatically triggered in any of the following TCAS RA cases:

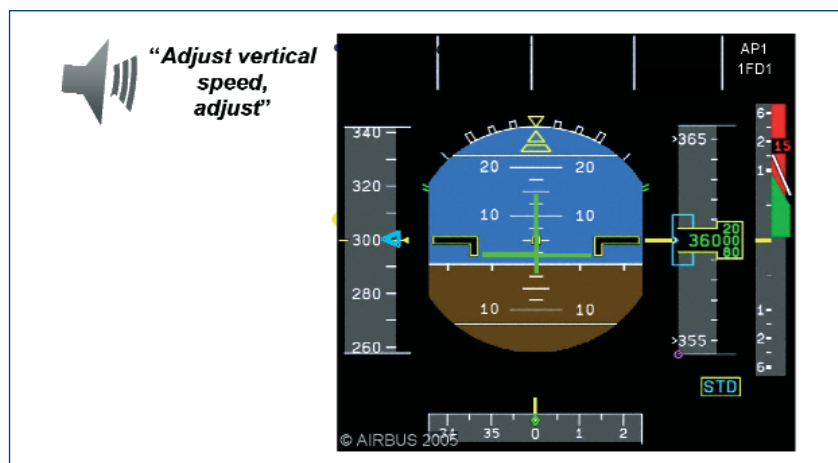● If the AP is ON, the TCAS mode automatically engages on the AP; the AP then guides the airplane to the V/S target associated to the RA, with the adequate authority.

● If the FD is ON and AP is OFF, the TCAS mode automatically engages on the FD; the FD crossbars provide an unambiguous order to the pilot who has to simply fly and centre the crossbars so as to control the V/S of the aircraft to the V/S target of the RA (into the green "fly to" vertical speed zone and out of the red vertical speed zone).

● If the AP and FDs are OFF at the time of the TCAS RA, the FD bars will then automatically reappear with TCAS mode active, assisting the pilot as here above.

The AP/FD TCAS mode behaviour can now be detailed regarding the kind of RA triggered by the TCAS:

● In case of a Corrective RA (e.g. "CLIMB", "DESCEND", "ADJUST", etc. aural alerts), the aircraft vertical speed is initially within the red VSI zone. The requirement is then to fly out of this red zone to reach the

Figure - PFD upon a Corrective TCAS RA "ADJUST V/S, ADJUST"

green one, near the boundary of the red/green V/S zones to minimise the vertical deviation from initial ATC clearance. Consequently in the case of a Corrective RA:

- The TCAS longitudinal mode engages. It ensures a vertical guidance to a vertical speed target equal to red/green boundary value ± 100 ft/mn within the green vertical speed zone, with a pitch authority increased up to 0.3g.
- All previously armed modes are disarmed except the altitude capture mode (ALT) in case of the "ADJUST V/S" RA, which prevents undue altitude busts: the vertical speed 0fpm is never within the Red V/S zone of such RA.
- The current engaged lateral mode remains unchanged.

- In the case of a Preventive RA (e.g. "MONITOR V/S" aural alert), the aircraft vertical speed is initially out of the red VSI zone. The requirement is then to maintain the aircraft

vertical speed as is, out of this red VSI zone. Consequently in case of a Preventive RA:

- The current AP/FD longitudinal mode is kept, if it ensures that current vertical speed is maintained. If not, the current longitudinal mode reverts to the "vertical speed" (V/S) mode with a target synchronised on the current vertical speed.
- The TCAS mode is automatically armed, in order to raise crew awareness on the RA situation, and because a Preventive RA may turn into a Corrective RA if the collision risk situation gets more severe.
- All previously longitudinal armed modes are automatically disarmed, except for ALT mode; indeed a Preventive RA never forbids a level off, which means that the vertical speed 0fpm is never in the Red VSI zone. Keeping ALT armed thus prevents undue altitude busts.

- Once Clear Of Conflict, the expectation is to resume navigation

in accordance with last ATC clearance:

- The AP/FD longitudinal mode reverts to the "vertical speed" (V/S) mode, with a smooth vertical speed target towards the FCU target altitude (eg +/or - 1000 ft/mn).
- The ALT mode is armed to reach the FCU target altitude (last clearance altitude provided by ATC).
- The lateral mode remains unchanged.

This design ensures that the aircraft will be guided back towards the initially cleared altitude by ATC, as expected.

It should be noted that the AP/FD TCAS Mode described above comes in addition to the whole already existing TCAS RA features (traffic on Navigation Display, aural alerts, vertical speed green/red zones materializing the RA on VSI).

The operational benefits of the AP/FD TCAS mode solution are numerous; it addresses most of the concerns raised by the in-line experience feedback:

- It provides an unambiguous flying order to the pilot, and thus eliminates risks of confusion during the RA and once Clear of Conflict.

- The flying order is adjusted to the severity of the RA; thus it reduces the risks of overreaction by the crew, minimises the deviations from trajectories initially cleared by ATC, it adapts the load factor of the manoeuvre and reduces perturbations in the cabin.
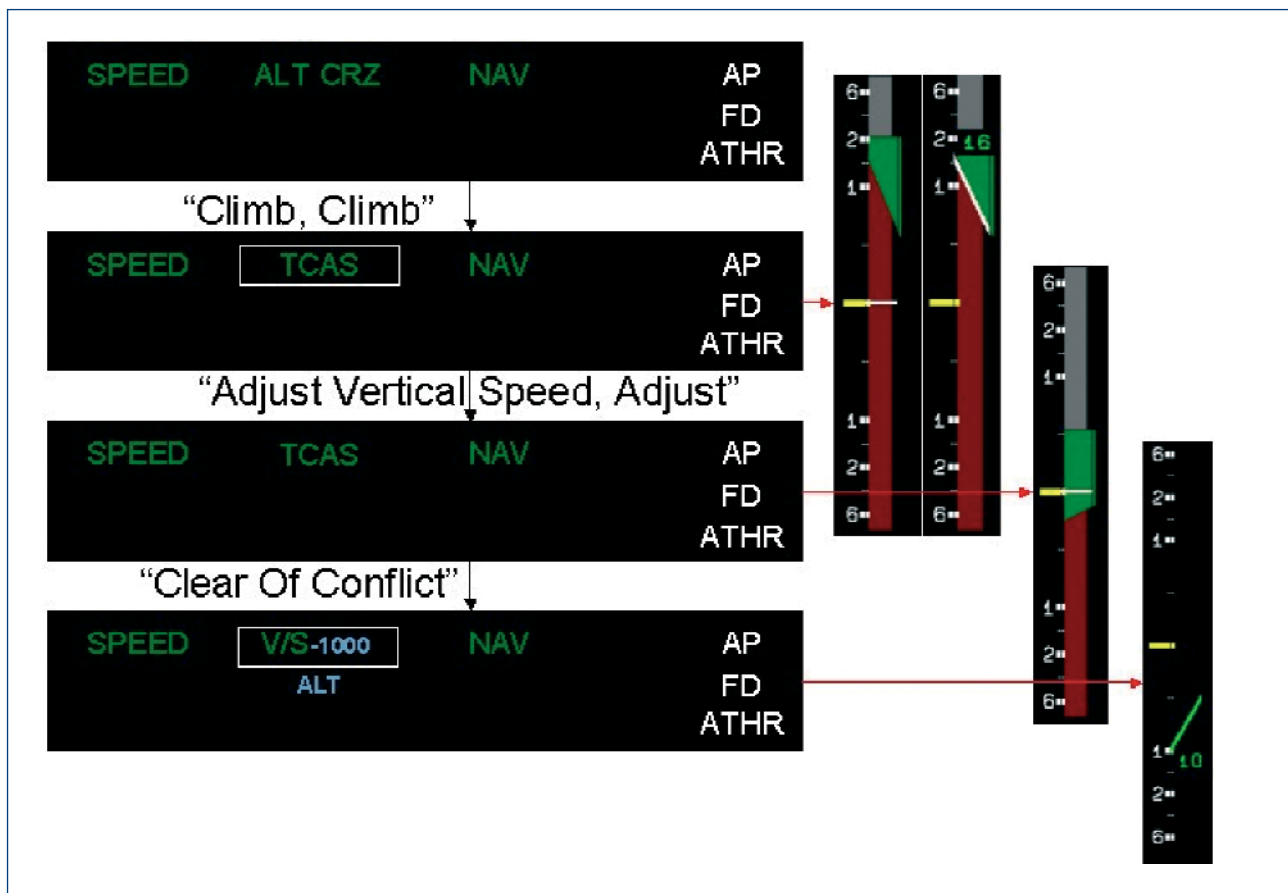
Figure - FMA upon a TCAS RA sequence

- The availability of such an AP/FD TCAS mode makes it possible to define simple procedures for the aircrews, eliminating any disruption in their flying technique: the procedure is simply to monitor the AP or to hand-fly the FD bars when TCAS mode engages while monitoring the VSI scale.

- Such simple and straightforward procedures reduce pilot stress and possible associated confusion (as for example with the "Adjust V/S Adjust" RA). Therefore the APFD TCAS mode should reduce significantly:

- late reactions to TCAS RAs
- overreactions to TCAS RAs
- opposite reactions to TCAS RAs
- misbehaviour when CLEAR of CONFLICT
- lack of adequate communications with ATC.

Finally it is important to underline that the introduction of the AP/FD TCAS mode is transparent from the controller point of view as far as this mode is guiding on (or performing) a manoeuvre, which is the same as the one expected today without such a system.

AP/FD TCAS Mode was demonstrated to a large panel of airlines (Air France, North West Airlines, Lufthansa, British Airways, KLM, SAS, United Airlines) and was perceived by them as a simple and intuitive solution really consistent with current Airbus auto flight system and cockpit philosophy. All of them agreed that AP/FD TCAS Mode represents a fundamental safety improvement in reacting to TCAS-RAs.

MID-AIR COLLISIONS, ELEPHANTS, AND SYSTEMS APPROACHES

By Barry Kirwan

Barry Kirwan is the Coordinator for Safety & Human Factors Research at the EUROCONTROL Experimental Centre, Bretigny, France. barry.kirwan@eurocontrol.int

- Could a civil mid-air collision happen tomorrow in Europe?
- Have we done everything we can to prevent such an accident?

These are two questions which sit uncomfortably with me, because in my personal opinion (I have to state this) the answers 'Yes' and 'No' don't fit where I would like them to, even more than five years after Überlingen, and even after strenuous efforts by many people (myself included). Several of the discussions in this issue of Hindsight already point out why it is difficult to improve the situation: more traffic, more conflict complexity; no more obvious 'low-hanging fruit', etc. Okay, but we still need to improve. So what do we do? When you have a really complex problem, people may say to you - 'take a systems approach'. This sounds boring and unlikely to deliver, however - so first, a little on elephants, a story you may already know…

Three blind men encounter an elephant. The first touches its trunk and says that an elephant is like a palm tree, another touches its side and says that an elephant is like a rough wall. Another feels its tail and says that an elephant is like a piece of rope. Each comes into contact with a different part of the elephant and is convinced that their own explanation is correct and that the others are wrong. None of them realises that they are all

experiencing just one part of the same elephant and that none of their explanations are complete.

I won't labour the metaphor. Suffice it to say, systems approaches entail looking at the whole problem in all its richness and complexity, to determine a solution. If there is no single 'magic bullet' solution, then inter-related solutions must be developed: a 'system' of safety defences. 'Compartmentalised' safety won't work on complex problems. It will fail.

The Überlingen accident involved a tragically unfortunate interaction between the controller and TCAS (amongst other factors), and highlighted a fatal vulnerability in the mid-air collision defence system, which principally involves controllers, pilots, STCA and TCAS. The central 'morphology' concerned the pilot following a controller's resolution rather than his TCAS RA. Since 2002 and persisting until today, there have been a number of incidents, including some very close near-misses, which continue to follow this 'failure path', despite major efforts by ICAO to reinforce the rule of 'Follow the RA'. The threat of another mid-air collision involving a controller and TCAS may have reduced, but has certainly not gone away. So, what are the options? A number exist: some we're looking at, some not. Here are some to put on the table (to which

Bert Ruitenberg's 'off-set' solution [this issue] can be added, along with his caveat that the same off-set rule must be applied internationally).

IMPROVED ACAS REVERSAL LOGIC

The first, TCAS reversal, could have prevented the Überlingen accident if it had worked comprehensively (i.e. for all scenario geometries) at the time. Work since the accident has striven to close the gaps in the reversal logic so that a situation with geometry and development like Überlingen would indeed be prevented if the same conditions arose. It is however not yet clear when the new logic will be implemented.

AUTOMATED DOWNLINK OF ACAS RA

The second, downlinking of the TCAS Resolution Advisory or RA, is a more complex area, and also discussed in this Issue (see Doris Dehn's article). At first sight it seems logical that if the controller had been aware of the TCAS RA, he would not have given contrary instructions. But in the details of EUROCONTROL's RA downlink study

and in the complex and tight timing of real incidents and accidents, it is not always so clear cut. Hence for the RA downlink concept, the jury is still out, awaiting further and more precise evidence. This further evidence is likely to be in two main forms. The first is a better understanding of what incidents and near-incidents actually occur, so that RA downlink (or other approaches) can be formulated on a more evidence-based understanding of the problem. This is not easy since the events of interest are rare and do not occur to order, but a study to do this is being launched by EUROCONTROL. The second form of evidence relates to a risk-based model and results confirming that the benefits of RA downlink outweigh any potential side-effects. There are still some open issues as to what represents the right risk framework and model with which to judge any intervention, but work is in progress.

IMPROVED STANDARDISATION OF STCA LOGIC

The third, namely enhancement and harmonisation of STCA, can help reduce the exposure to TCAS by warning controllers more efficiently in advance of TCAS activation (i.e. STCA and the controller resolve the situation before TCAS triggers). This area has great safety merit in its own right, but is unlikely to reduce exposure sufficiently to remove completely the specific threat of negative interactions between controllers (and STCA) and TCAS (also because, as my colleague Ben Bakker commented to me, there are inevitably some conflict geometries where STCA may not occur before TCAS).

CONTROLLER PRACTICES TO MANAGE SPECIFIC HIGH-RISK SITUATIONS

The fourth is an interesting area in that although it was discussed in the original post-Überlingen High-Level Action Group on ATM Safety (AGAS) forum, it has received comparatively little attention. The approach would entail controllers giving lateral resolutions when aircraft are getting close enough for TCAS to occur (since TCAS only gives vertical dimension instructions). This would necessitate either that controllers have prior criteria for deciding when to give lateral instructions only, or else STCA predicts time to TCAS RA and informs the controller. The controller would also benefit from (down-linked) information about aircraft TCAS serviceability.

There are some potential disadvantages, e.g. lateral resolutions may not be as effective (fast) as vertical ones depending on altitude and speed as well as conflict geometry (see UK CAA SRG CAP 717 - Radar Control Collision Avoidance Concepts, 2006); a pilot who initiates a lateral manoeuvre then gets a TCAS vertical instruction may have significant difficulties complying with the latter; potential impacts on third-party aircraft in busy airways, etc. Yet there is a certain logic that suggests that lateral instructions could avoid the Überlingen-type accident. Such a lateral dimension would also constitute a more clearly coordinated air-ground concept of conflict and collision avoidance. Even if the lateral solution does turn out not to be a good idea, it should be examined seriously with other potential solutions, because it might lead on to better remedies.

AUTOMATE TCAS RESOLUTION EXECUTION

The fifth option, that of automated TCAS, is contentious but an obvious solution for many who have considered that if the human was taken out of the equation in this narrow, time-stressed and unclear situation, then the world might, on balance, be a safer place. Application of such full automation (probably with pilot veto [i.e. return to manual] available) is not without precedent (e.g. automated aircraft landings), but requires a significant safety advantage (e.g. an order of magnitude, or a 'factor of ten' safer than non-automation) to be demonstrated to overcome concerns relating to trust in automation and automation failures. Even if we in ATM are not considering this option, we can be sure at least some of our wider aviation partners are (e.g. Airbus), and we should therefore investigate the likely impacts on ATM.

IMPROVED UNDERSTANDING OF SEPARATION ASSURANCE

The sixth approach attempts to move the problem upstream, and focuses on enhancing controller separation assurance procedures based on a better understanding of how assurance is currently achieved, and the nature of vulnerabilities in such assurance processes, based on the analysis of data from actual ACCs. This work complements studies of actual incidents. Incidents deal with events 'after the fact' - often investigations find it hard to uncover what was happening before, and therefore ignore what constitutes 'normal' separation assurance practices. From a systems perspective, if you want to put something right, it is not enough

to look always at what is going wrong - 'normal' behaviour must also be analysed, otherwise assumptions about how controllers control traffic may be incorrect. It is also important to understand the variability in ACC working practices and separation assurance in Europe (including use of safety nets), in case there is not a 'one size fits all' solution. A good example of beginning to understand what is actually happening in separation assurance, albeit from the safety event perspective, is the NATS article in this issue.

IMPROVED CONFLICT DETECTION AND RESOLUTION TOOLS

The seventh approach also attempts to tackle problems 'upstream' and so reduce the number of times STCA and TCAS are called into action. Tools such as Medium-Term Conflict Detection (MTCD) and Tactical Controller Tool (TCT - under development) may offer significant promise for safety more generally. A key question for such tools however, as found in real-time simulations in 2006 at the EUROCONTROL Experimental Centre (EEC), is what is the best timeframe for such tools? Again, it is here that a better understanding of actual tactical control and separation assurance is needed. Often, new tools are aimed at 8-20 minutes' advance prediction, yet the EEC study in 2006 suggested 4-7 minutes was what the controllers actually needed and wanted (TCT can work in this shorter timeframe). Probably both are needed, when considering Planner and Executive (Tactical) controllers. Even if such tools do work most of the time, there will inevitably be encounters and conflicts (e.g. so-called

'pop-ups') that arise in the STCA/TCAS timeframe (MAC-3mins), so again these tools can only be part of a larger integrated solution set, but could add significantly to safety.

SELF SEPARATION LOGIC

The eighth approach is free flight (possibly also including advanced ASAS - Airborne Separation Assurance) wherein the pilots are in control of their own separation. This could prevent controller-TCAS interactions (though there might be ASAS-TCAS ones), but is probably many years away, and so does not help with the immediate threat.

WHERE FROM HERE?

I am clearly proposing that a more integrated approach be adopted - that the different people and groups holding different parts of the elephant work together somehow, with a single aim of developing a Coordinated Safety Defences System, which includes safety nets, their interactions, and barriers further 'upstream' (separation assurance tools and practices). Within EUROCONTROL things are already moving firmly in this direction, but

could probably go further. Clearly in this respect we also need constructive engagement with the ANSPs we aim to serve, as is already happening for example through the SPIN (Safety-nets Performance Improvement Network) initiative.

There is also a clear need for a better understanding of separation assurance, as well as loss of separation, so that we can make the right decisions based on the best evidence available.
EUROCONTROL is currently seeking to look deeper into these two sides of the same coin, with ANSP partners. Once such an understanding exists, different 'solutions' and 'solution partnerships' can be evaluated, improved, modified, shelved, or even discarded - to design an optimal system of safety defences.

Returning to my two uncomfortable questions at the start of this article, the answer to the first is likely to remain a 'Yes' for some time, since removing the possibility completely is very difficult to achieve. However, it would be good to have the same affirmative response to the second question.

ALERT CONTROLLER PREVENTS CFIT ACCIDENT

The incident described below involved an Airbus A310 passenger flight to Birmingham Airport in November 2006. The account of the incident is reprinted from UK AAIB Bulletin 4/2007, omitting only the introductory information.

SYNOPSIS

The aircraft was being radar vectored for an ILS approach to Runway 15 at Birmingham Airport. The radar controller had cleared the crew to descend to an altitude of 2,500 ft, but noticed that the aircraft continued to descend below the cleared altitude. He instructed the crew to climb and repeated the QNH, which the crew had not set. With the correct QNH set the aircraft climbed and levelled at 2,000 ft, as instructed by the controller. Having intercepted the localiser they were cleared to descend with the ILS and a normal landing was completed.

HISTORY OF THE FLIGHT

The aircraft was on a scheduled flight from Tehran to Birmingham Airport. The commander was the Pilot Flying (PF) and the co-pilot was the Pilot Not Flying (PNF). The crew contacted the Radar controller at 2037 hrs as they were approaching FL80. They confirmed that they had received the ATIS and repeated the QNH of 982 hPa. They were instructed to maintain FL80 and their present heading.

The controller intended to provide radar vectors for the aircraft to intercept the localiser for Runway 15 at a distance of 9 nm. At 2038 hrs he cleared the aircraft to descend to an altitude of 4,000 ft on the QNH of 982 hPa, which the PNF acknowledged correctly. During this descent, the aircraft was cleared to descend further to an altitude of 2,500 ft and this was again acknowledged correctly by the PNF.

At 2043 hrs the crew were instructed to turn right onto a heading of 060° and to reduce speed to 180 kt; the aircraft turned onto the base leg and continued its descent. The controller, who was also controlling several other aircraft, saw F-OJHH descend through 2,500 ft. He transmitted "5020 CLEARED ALTITUDE TWO THOUSAND FIVE HUNDRED FEET SAY AGAIN TWO THOUSAND FIVE HUNDRED FEET". The PNF responded, "TWO FIVE HUNDRED 5020 TWO THOUSAND FIVE HUNDRED". Seeing the aircraft still descending the controller transmitted "YES IF YOU COULD CLIMB BACK UP TO TWO THOUSAND FIVE HUNDRED PLEASE AND TURN RIGHT NOW ONTO ONE TWO ZERO DEGREES". The PNF responded to the instruction after a short pause. Seeing the aircraft still descending, the controller repeated, "5020 YOU ARE STILL DESCENDING CLIMB TWO THOUSAND FIVE HUNDRED FEET ACKNOWLEDGE". This was acknowledged again by the PNF but the aircraft still continued to descend. The controller instructed the crew that there was a mast 4 nm due east of their position which was 1,358 ft amsl, and that they should climb immediately. The PNF acknowledged this instruction.
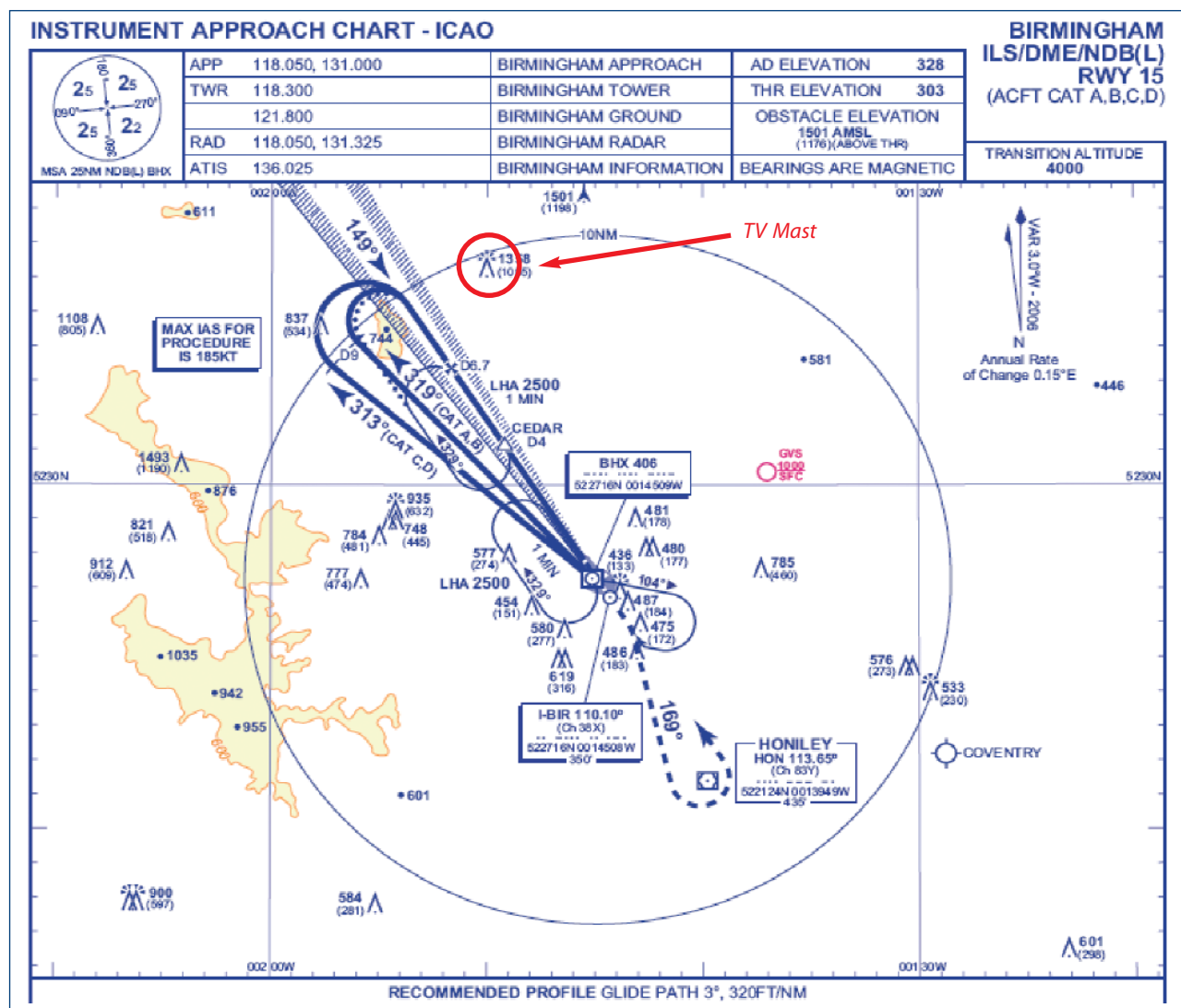
Suspecting that the crew had not set the QNH, the controller transmitted "5020 QNH 982 CONFIRM YOU ARE INDICATING ONE THOUSAND FIVE HUNDRED FEET". At this point the crew realised that the altimeters were still set to the standard pressure setting of 1013 hPa and not the Birmingham QNH of 982 hPa. The PF initiated a climb and he and the PNF set the Birmingham QNH and crosschecked the altimeters. The PNF informed the controller "JUST GOT IT NOW AND CLIMBING READING 2,000 FEET". The controller responded "YOU CAN LEVEL OFF AT TWO THOUSAND FEET PLEASE TO INTERCEPT THE GLIDEPATH AT NINE MILES YOU ARE NOW CLEAR OF THE TV MAST". The PNF acknowledged the instruction and they were then cleared to descend on the ILS. The crew continued with the approach and landed without further incident.

WEATHER

The synoptic situation at 2100 hrs on the day of the incident showed a low pressure system (969 hPa) centred near Eire. A broad warm sector was covering the southern half of the British Isles with a light to moderate south-south-westerly flow over the Midlands and Southern England. Weather conditions over the Midlands were cloudy with outbreaks of rain, mainly in the West Midlands. The surface visibility was generally 25 km but locally 10 to 15 km in rain. The mean sea level pressure in the Birmingham area was 982 hPa with the Barnsley Regional Pressure Setting, valid from 2000 hrs to 2100 hrs, of 974 hPa.

The 2020 hrs weather report at Birmingham Airport recorded a surface wind from 160° at 10 kt, with the visibility greater than 10 km in light rain, few clouds at 1,600 ft with scattered cloud at 2,200 ft, the temperature was 12ºC, the dew point was 11 ºC and the QNH was 982 hPa.

Extract from the UK AIP, published with the permission of UK CAA, showing the ILS approach procedure to RWY 15 at Birmingham Airport. The television mast is circled in red.

ALTIMETER SETTING

The Standard Operating Procedure (SOP) for altimeter setting in the descent was set out by the operator in the descent checklist of the normal procedures. This requires both the PF and PNF to set the QNH when cleared by ATC to descend from a flight level to an altitude.

ANALYSIS

The crew had not changed the altimeter setting from the standard setting of 1013 hPa to the Birmingham QNH of 982 hPa when first cleared to descend from a flight level to an altitude. Based on an average height of 30 ft per hPa, a height difference of 930 ft existed between the aircraft actual altitude and that indicated on the altimeters. Consequently, thus when the altimeters were indicating 2,500 ft the aircraft had actually descended to 1,570 ft. As the aircraft continued its descent below its cleared level of 2,500 ft the radar controller notified the crew and warned them of the mast ahead. Having realised that the altimeter sub scale setting was incorrect the crew

initiated an immediate climb, re-set the altimeters to the correct QNH and followed the controller's instructions.

The crew could not recall any distractions or unusual flight deck activity at the point at which they would normally have adjusted the altimeter sub-scales.

LESSONS LEARNED

The following extracts from EUROCONTROL Level Bust Briefing Note ATM2 are relevant:

"3.1. The controller has no way of knowing if, after a correct readback, a pilot has misunderstood his clearance or is likely to deviate from it (e.g. because he has mis-set aircraft equipment).

"3.2. The controller can reduce the incidence of level busts by monitoring the flight path of aircraft under his control to the extent that his work-load permits.

"3.3. A busy controller cannot be expected to monitor continuously the progress of all flights under his control. Some form of prioritisation is usually necessary, and experienced controllers often do this subconsciously.

"3.5. Priority in monitoring will be given to aircraft whose clearance has recently been changed from a stable situation (e.g. level flight on flight plan route) to a changing situation (e.g. climbing, descending, or changing routing)."

AVOIDING THE CONFLICT

By Anne Isaac and Victoria Brooks

Anne's early experience in ATM and air-line operation was followed by six years with the Human Factors team at EURO-CONTROL 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.

Victoria is a safety analyst at NATS; based in the Safety Analysis section, working in the area of understanding safety performance.

It would seem strange to an outsider that ANSPs spend an enormous amount of time and resources on selecting and training professionals to separate aircraft, only to have increasing numbers of incidents which involve STCA and TCAS intervention. This is not unique to Europe and it is almost impossible to calculate how many conflicts are not resolved in a timely manner, but the estimate is somewhere in the region of 10 for every 100,000 movements. This is exactly why the air traffic control system finds it so difficult to implement further safety strategies and often struggles to find the balance between safety and service. If controllers got it wrong more often we would be in a better position to implement more robust safety nets.

But why do controllers get it wrong at all? The answer in some part lies in the often difficult balance between conflict resolution and conflict avoidance.

- Conflict resolution, which is the most obvious skill of controllers, is demonstrated when measures are taken in order to prevent the further development of a conflict situation.

- Conflict avoidance, is used to prevent the situation in the first place by using proactive control actions such as heading or level assignments.

When analysing these two strategies it is easy to recognise how complex avoiding the conflict can be.

Conflict resolution can be described simply as a three-stage activity, although at each stage there are several things that may go wrong.

Conflict resolution firstly relies on detection, which means the controller must know what to look at and for, when to look and actively 'see' what is being searched. Here we have the first problem, since incident statistics demonstrate that one of the reasons for the highest number of errors in ATC incidents is to 'not see' the information at all. There are many reasons for this:

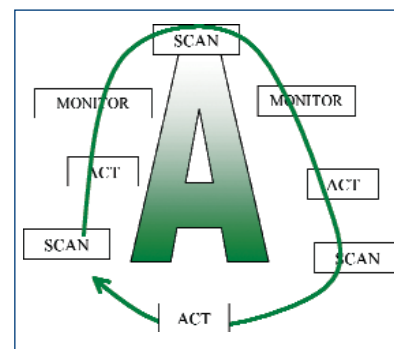- Firstly if the technology does not display the relevant information in an intuitive way, controllers may fail to scan the most relevant data.

- Secondly, controllers may fail to recognise the important information.

- If the relevant information is detected the controller then needs to recognise it as a problem or risk.

The main problem with these activities for experienced controllers is the issue of time, often requiring tasks to be prioritised. High workload also increases the risk of reacting to situations instead of anticipating them.

The existence of monitoring aids and conflict-detection tools such as medium-term conflict detection (MTCD) also invite controllers to not actively scan for conflicts but depend on the tools to warn them. Even safety nets such as short-term conflict alert (STCA) may have this effect, which should be prevented.

Conflict avoidance, on the other hand, is potentially a more robust technique; however it does require the controller to control defensively and proactively, that is to set up the traffic in such a way that should a plan fail, separation would be maintained. This technique is illustrated in the following figure.

With all the whistles and bells of those new systems, you can no longer be taken by surprise... so you can enjoy your coffee...

Comparing this with the conflict resolution model, it can be seen that controllers would be expected to invest more time in monitoring the situation, which of course means a trade-off with other activities or in some cases deferring other activities until the original task is complete. However if a clear set of roles and responsibilities is given and practiced by the controlling team, the investment would ultimately mean less risky and more proactive controlling.

One challenging factor is the year-on-year increase of traffic. It is not surprising that this increase in demand decreases the possibilities of using conflict avoidance techniques. Another area that hampers the use of conflict avoidance is the complexity of air-space, one of the leading contextual factors in ATM incidents. This is a highly challenging area to tackle and demands highly collaborative decision-making, learned over a lengthy period of time.

So what do we know about conflict resolution at the moment? Recent work with regard to STCA has revealed some interesting trends, although how robust these are and how they can be generalised is too early yet to assess. The analysis described here is taken from a small sample of STCA alerts in one area of our airspace, and focuses on the geometry of encounters.
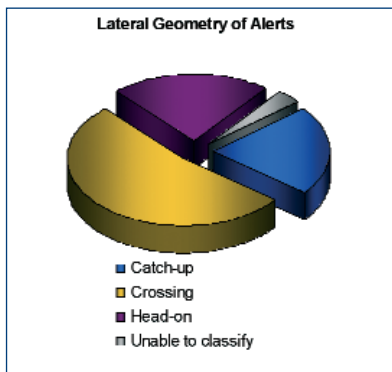
The analysis of STCA alerts requires the lateral and vertical geometries to be defined. The lateral geometry in this work is based on the relative heading of two aircraft; the alert is then classified as head-on, crossing or catch-up as the following diagram indicates.
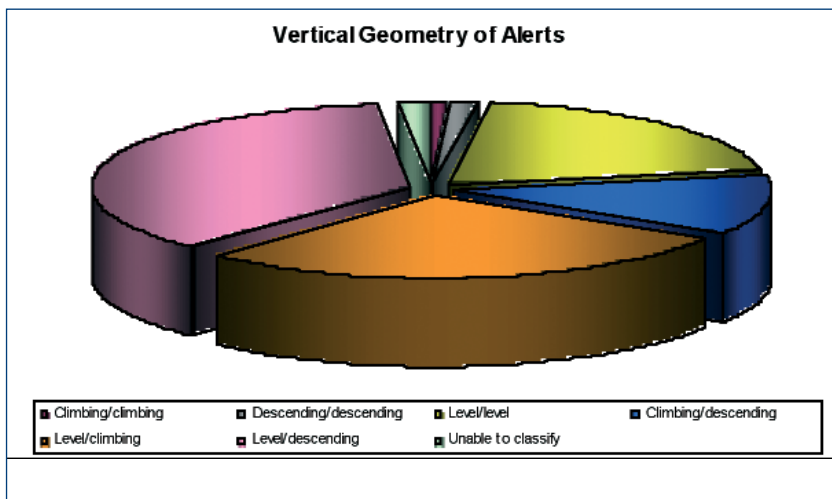

The vertical geometry is based on the altitude change over the last five radar cycles before an alert. The geometry of each aircraft is then classified as climbing, descending or level.
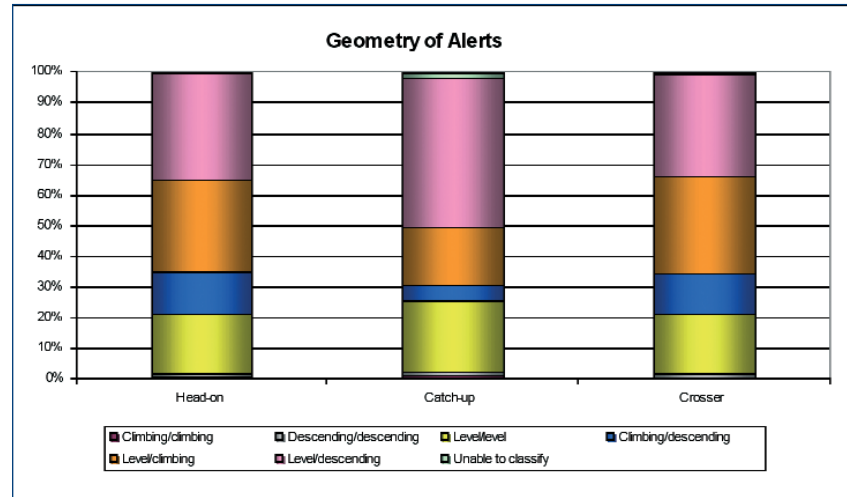
In terms of the lateral geometries of the alerts studied, 55% were crossing, 22% were catch-up and 23% were head-on.

In terms of the vertical geometries of the alerts; 65% of encounters were where one aircraft was level and the other was either climbing or descending.

Combining the lateral and vertical geometries of the alerts shows that approximately 80% of crossing encounters involved one or both aircraft that were climbing or descending.

The above figure illustrates the findings of these geometries.

The version of STCA used in this study uses a two-stage alert, changing from white to red. It is assumed that in the first stage of the alert, white, controllers will acknowledge the alert and act to resolve the potential conflict as required; indeed 97% of alerts that were white remained white until they were resolved. A small percentage of alerts went straight to red, which meant there was little pre-warning; possibly the result of a 'pop-up', for example, either a fast moving military encounter, an encounter with a sudden change in lateral or vertical geometry, or an airspace infringement. And the remainder of the alerts began white before becoming red.

It is difficult to make any substantial claims from one set of data, but further analysis will add to the understanding of what controllers do, particularly when the alert goes white and what, if anything, changes their strategy when the alert becomes red.

If we return to the original discussion of conflict resolution versus conflict avoidance, it would seem that developing techniques to allow controllers to exploit conflict avoidance strategies within their time constraints would be a more proactive approach to ATM safety. How we do this, of course, is another story - watch this space!

N°5 HindSight

WORKLOAD

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