How can operational examples be used in training?

by Stanislaw Drozdowski

In ATC situations can develop rapidly: what was perfectly planned just seconds ago can turn into a situation which requires the full range of skills to handle. Controllers are trained to deal with several types of emergencies but sometimes their training is too theoretical...

A proper theoretical background is important but the practical application of the acquired knowledge will ultimately show if the training was successful. Familiarisation with real-life examples can help controllers to deal with non-nominal events. This article uses TCAS (Traffic alert and Collision Avoidance System) training as an example of how operational examples can be used to enrich controller training.

TCAS is an avionics system that works independently of ground-based systems to prevent mid-air or near mid-air collision[1]. If an imminent risk of collision is detected, an RA (Resolution Advisory) will be generated which tells the pilot the range of vertical speeds within which the aircraft should be flown to avoid a collision. Pilots are required to follow RAs and ignore any conflicting ATC instructions. Therefore, TCAS can have significant impact on ATC operations as it may cause pilots to depart from their current ATC clearance and, by doing so, TCAS is "removing" the controller from the loop. TCAS collision avoidance logic, which is subject to international standardisation, is complex and not always intuitive.

TCAS will save the day, won't it?

Some RAs are caused by level bust, pilot non-compliance with ATC or incorrect ATC clearance. TCAS provides a successful mitigation against these causes if pilots follow RAs promptly and correctly and the controller does not interfere with the RA manoeuvre by issuing instructions during the RA.

On the other hand, TCAS does not know the ATC clearance or pilot's intentions and, therefore, an RA will be produced based only on the extrapolation of the aircraft's trajectory. So, it happens that RAs are issued when the separation would have been maintained without the RA. These RAs are sometime seen by the controllers and pilots as nuisance.

Any excessive vertical speed before level off is likely to trigger an unwanted RA. Although the pilots are required to reduce the vertical speed to 1500 ft/min in the last 1000 ft before the cleared level, experience shows that often this is not done.

TCAS provides a successful mitigation if pilots follow RAs promptly and correctly and the controller does not interfere with the RA manoeuvre by issuing instructions during the RA.

The frequency of RA occurrence depends on the airspace type and complexity but RAs are rare. The average number of RAs per day in European airspace has been estimated at about 18, most of them RAs occurring in congested TMAs[2]. During the RA and immediately before it, the controllers are typically presented with a number of alerts on the screen. Most likely a Short Term Conflict Alert (STCA) will be displayed. It may be accompanied by other alerts, depending on the ATM system sophistication. Dealing with a complex but not so common situation is no doubt a stressful experience for which controllers need to be properly prepared.

TCAS Training

Controllers are typically introduced to TCAS during their ab initio training which should follow the requirements of European Common Core Content and Training Objectives as well as cover the topics recommended in the ICAO ACAS Manual (Doc 9863). While the ab initio training gives the trainees a good basis for understanding TCAS operations and related provisions, it usually provides few, if any, practical examples of TCAS events. TCAS topics are also covered during recurrent training for non-nominal situations.

Some training material is loaded with technical details and tests controllers on issues that

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.

1- For more information about TCAS see previous issues of HindSight: № 5: TCAS and STCA – Not Just Anagrams; № 6 Changes to ICAO rules regarding TCAS RAs; № 10: TCAS II and Level Bust).

2- Drozdowski, S., Dehn, D., Louyot, P. Monitoring of TCAS Resolution Advisories in Core European Airspace, Air Traffic Control Quarterly, Vol. 18, 2010.

How can operational examples be used in training? (cont'd)

are really not relevant for them. Sometime these courses are developed as "one-size fits all" and in one session they cover topics which are of interest to pilots and controllers while forgetting that each party has different roles and responsibilities during an RA.

TCAS training for controllers, especially in recurrent training, should focus on topics that matter to them in day-to-day operations. The training session should provide the minimum of technical information and maximum of practical application. We all know that we learn best from previous experience, so previous events should be used to enrich training sessions. There is a lesson to be learned in each event once it has been properly analysed. Real-life examples will tell us how others reacted, what kind of mistakes were made, how correct actions improved or could have improved the situation ("what if" scenarios).

While real-life examples from own airspace might be best, in the absence of these trainers may use other publicly available resources like EUROCONTROL ACAS II Bulletins (available from www.eurocontrol.int/acas).

Using real-life TCAS examples has additional training advantages. The circumstances leading to an RA typically involve some intermediate events from which additional lessons can be learnt: STCA generation (Was it timely?), controller avoiding instruction (Correct phraseology used? Effectiveness?), workload management (Were things done in the optimal order?), etc.

The two cases described next will provide an illustration of how real-life examples can provide an additional training resource.

CASE 1: descent clearance picked up by wrong aircraft [3]

Traffic is moderate in this en-route sector. An Embraer 195 is heading south at FL330 while a B777 is at FL320 heading west. When the aircraft are some 60 seconds from crossing, the controller instructs an aircraft in a different part of the sector to descend to FL270. Although there is no callsign similarity, this transmission is wrongly picked up by the Embraer crew who read back the descent instruction (using their callsign). This error is not detected by the controller and the Embraer starts to descend towards the B777 below.

A few seconds later when the Embraer is passing through FL328, the ATM system generates a Short Term Conflict Alert. The predicted horizontal distance is 0.6 NM. Almost simultaneously, RAs are generated in both aircraft: the Embraer gets a "Climb" RA while the B777 gets a "Descend" RA. Although the STCA alert is generated promptly, it is already too late to give the controller the chance to address the separation loss.

Both pilots respond to their RAs promptly and correctly and the vertical spacing between the aircraft rapidly starts to increase. Both aircraft pass each with a spacing of 0.6 NM and 1100 feet.

CASE 2: both aircraft cleared to the same level

Traffic is quiet is this typically busy TMA. An RJ85 is cleared after departure to climb to FL150 on a heading of 330 degrees. An A330 is flying on a heading of 300 degrees descending towards its destination. The predicted trajectories of both aircraft are expected to cross with a horizontal separation of less than 1 NM. The controller planned to clear the A330 to FL160 (1000 ft above the RJ85). However, he clears the A330 to FL150 by mistake.

Some time later, the controller instructs the RJ85 to turn right onto a heading of 345 degrees. When the aircraft are less than 2.5 NM and 2100 ft apart, STCA warns the controller of the impending conflict.

The controller issues avoiding action instructions to both aircraft:

"A330 turn right heading 360 degrees"

"RJ85 turn left heading 270 degrees."

He subsequently gives the A330 a further instruction to turn onto a heading of 035 degrees and provides traffic information to the RJ85 pilot.

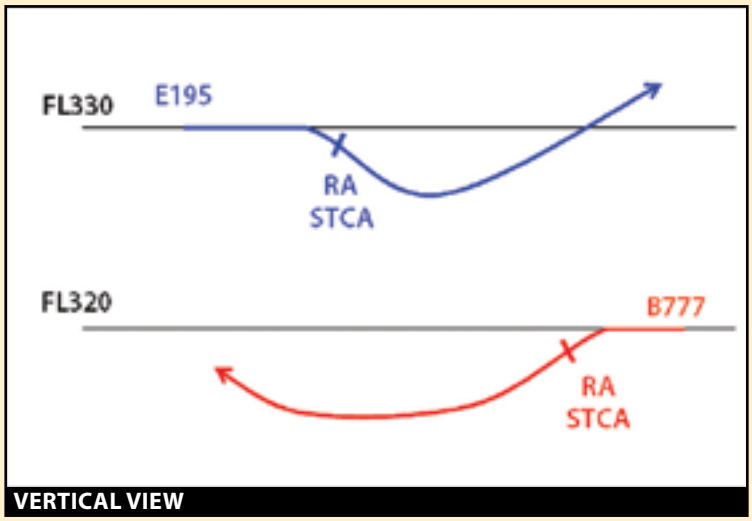
When the aircraft are 1.6 NM and 850 ft apart, a first RA is issued for the A330 – "Maintain vertical speed, crossing maintain". The A330 at this point is descending at almost 2500 ft/min and this RA tells the pilot to continue this vertical speed crossing through the level of the threat aircraft. Two seconds later, the RJ85 which is climbing at 1500 ft/min, also receives a "Maintain vertical speed, crossing maintain" RA. Both pilots follow their RAs and make reports to ATC.

RAs requiring the pilot to cross through the altitude of an intruder aircraft are rare and account for approximately 2% of all RAs[4]. TCAS is designed to select non-altitude crossing RAs if these provide the desired vertical separation. Only when

3- **The events described in this article are based on real-life incidents. They have been de-identified here to support training. Descriptions of the events have been simplified and/or abbreviated for clarity and to facilitate the training process.**

Even though the callsigns were not similar, one of the main contributory factors in this incident was callsign confusion. The controller did not notice that the wrong aircraft acknowledged the descent instruction – controllers should not underestimate risks associated with read-back (hear-back) errors. This event also highlights that STCA will not always provide a timely warning of an impending loss of separation.

In this case, both RAs were followed correctly and TCAS prevented a major incident (the predicted spacing without TCAS RA was estimated at 0.6 NM and 300 ft).



VERTICAL VIEW

that cannot be achieved will an RA with altitude crossing be posted.

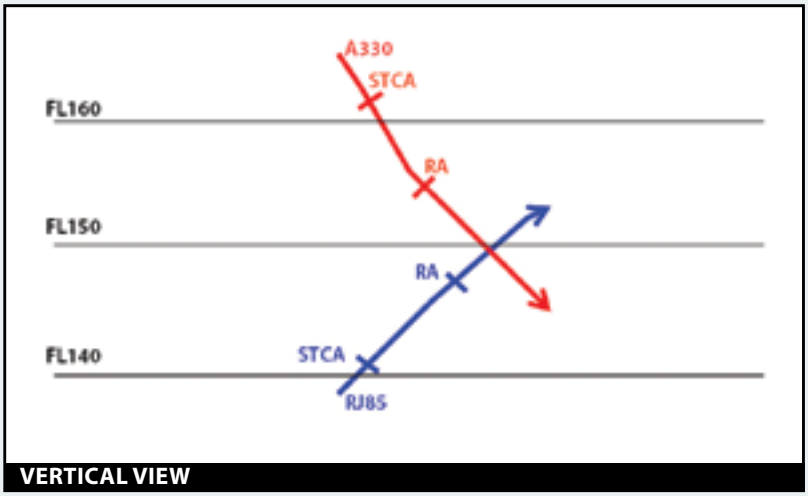
When the aircraft pass each other the A330 is over 600 ft below the RJ85 and both aircraft subsequently receive a "Clear of conflict" announcement.

In this event STCA did provide the controller with sufficient warning of impending separation loss. The controller reacted promptly to STCA by giving horizontal avoiding instructions. That helped to increase the horizontal spacing between the aircraft. Horizontal avoiding instructions will not contradict collision avoidance manoeuvres given by TCAS – this point should be emphasised during controller training. In this case TCAS issued crossing RAs – although they are rare, the controllers should be aware of them as these RAs are less intuitive than other RAs and may give the impression that the aircraft are being wrongly directed towards each other.

As in the case described above, both RAs were followed correctly and TCAS prevented a major incident caused by ATC error.

Conclusion

Real-life examples will complement theoretical TCAS training and will also provide more general learning points. Trainers should use them in the classroom – learning points should be discussed, actions analysed and discussed. Questions such as "what would you do differently?" or "was that an optimal solution?" would help to stimulate discussion and make the learning process interactive.



VERTICAL VIEW

4- **EUROCONTROL EVAIR Safety Bulletin No 6, page 27.**