Zagreb, Tenerife and Cove Neck: Revisiting the Assumptions Underlying ICAO’s Language Proficiency Program

Simon Cookson

Follow this and additional works at: https://corescholar.libraries.wright.edu/isap_2011

Part of the [Other Psychiatry and Psychology Commons](https://corescholar.libraries.wright.edu/isap_2011)

Repository Citation


This Article is brought to you for free and open access by the International Symposium on Aviation Psychology at CORE Scholar. It has been accepted for inclusion in International Symposium on Aviation Psychology - 2011 by an authorized administrator of CORE Scholar. For more information, please contact corescholar@www.libraries.wright.edu, library-corescholar@wright.edu.
In 1976 a DC-9 and a Trident 3B collided over Zagreb in the former Yugoslavia; in 1977 two Boeing 747s collided on the ground in Tenerife; and in 1990 a Boeing 707 ran out of fuel after a missed approach and crashed at Cove Neck. Because they involved language issues and resulted in 832 deaths, these three accidents have been cited by the International Civil Aviation Organization (ICAO) in justification of a worldwide program to improve the language proficiency of pilots and air traffic controllers. This paper shows that: (1) both linguistic and non-linguistic causal factors contributed to each accident; (2) a range of linguistic causal factors were involved, such as code switching and L1 interference, with each accident featuring different factors; and (3) the linguistic factors were in all three cases exacerbated by the effects of high workload, stress and fatigue.

The International Civil Aviation Organization (ICAO), the UN agency that oversees international air transport, has over the last decade been implementing a program to improve the English language proficiency of pilots and air traffic controllers around the world. This program has seen the development of language proficiency requirements (LPRs) and a six-level proficiency rating scale. ICAO initially intended for all pilots and controllers involved in international flights to demonstrate proficiency at Level 4 or higher on this scale from 2008, but difficulties in implementing the changes resulted in the deadline for compliance being put back to 5 March 2011.

In justifying the new program, ICAO has cited a number of airline accidents that were at least partly caused by language factors. Seven accidents, for example, were listed at the Language Proficiency Implementation Plan Workshop held in 2008 at the ICAO Asia and Pacific Office (Lamy 2008). This paper examines three accidents cited by ICAO: the mid-air collision over Zagreb in 1976; the runway collision at Tenerife in 1977; and the crash of Avianca Flight 052 at Cove Neck in 1990. Table 1 summarises the three accidents.

The following questions are addressed by this paper. What were the language factors that contributed to the three accidents? Was it simply that non-native speakers had inadequate English language proficiency? Or were more complicated factors involved, and if so, can any patterns be identified? The paper examines each accident, with a summary of the main events followed by analysis of the linguistic factors. Sources of data include accident reports, air traffic control (ATC) transcripts, cockpit voice recorder (CVR) transcripts and ICAO documents. The paper concludes with a summary of the lessons that can be drawn from the analysis.

Table 1. Summary of the accidents analysed in this paper.

<table>
<thead>
<tr>
<th>Location of accident</th>
<th>Accident 1</th>
<th>Accident 2</th>
<th>Accident 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of accident</td>
<td>10&lt;sup&gt;th&lt;/sup&gt; September 1976</td>
<td>27&lt;sup&gt;th&lt;/sup&gt; March 1977</td>
<td>25&lt;sup&gt;th&lt;/sup&gt; January 1990</td>
</tr>
<tr>
<td>Number of fatalities</td>
<td>176</td>
<td>583</td>
<td>73</td>
</tr>
<tr>
<td>L1 of flight crew</td>
<td>(1) English</td>
<td>(1) Dutch</td>
<td>Spanish</td>
</tr>
<tr>
<td></td>
<td>(2) Serbocroatian</td>
<td>(2) English</td>
<td>Spanish</td>
</tr>
<tr>
<td>L1 of air traffic controllers</td>
<td>Serbocroatian</td>
<td>Spanish</td>
<td>English</td>
</tr>
</tbody>
</table>
Accident 1: Zagreb 1976

On 10th September 1976, British Airways Flight 476 was flying from London Heathrow to Istanbul when it collided in mid-air with Inex-Adria Airways Flight 550, en route from Split to Cologne. The crash occurred in daylight and in fine weather conditions at an altitude of 33,000 feet over Zagreb in the former Yugoslavia. All 176 passengers and crew on board the two aircraft died in the collision.

This tragedy occurred because of the co-incidence of a number of factors (AAIB 1977). Firstly, in the ATC centre at Zagreb a flight progress strip was not handed over as Flight 550 climbed into the upper sector. The controller of the upper sector was overloaded with other work, and the assistant controller was absent for several minutes prior to the collision, an absence that went unnoticed by the chief of shift. In addition, the first call from Flight 550 to the upper sector controller was delayed by radio traffic. As a result of these factors, the upper sector controller did not follow the vertical movement of Flight 550 and did not provide adequate separation between it and the other plane, British Airways Flight 476. When he finally did give a warning, the controller gave an incorrect flight level for Flight 476 and he also switched from English to Serbocroatian, his L1, which meant that the British Airways flight crew could not understand a critical part of the dialogue. The two aircraft collided moments later.

Two of the causal factors involved language issues: the code switching of the upper sector controller from English to Serbocroatian and the numerical slip that meant he gave an incorrect flight level for the British Airways aircraft. Considering the first issue, it is not clear why the controller switched from English to Serbocroatian, but perhaps he realised a collision was imminent and deliberately switched to his L1 (and that of the crew of Flight 550) to ensure he would be immediately understood. Or perhaps the code switching was not deliberate, but brought about by a combination of time and workload pressure. Ganushchak and Schiller (2009) note that unintentional code switching may occur under conditions of psychological stress. They suggest that when speakers using L2 are subjected to time pressure there may be intrusions from the ‘dominant native language’, on account of the higher cognitive workload required to speak a second language. The controller was under time pressure to resolve the problem, and workload pressure from handling the upper sector alone for most of the previous ten minutes, when two or three controllers should have been assigned to each sector. In addition, he was quite possibly suffering from fatigue as a result of working three twelve-hour shifts in three days (Stokes and Kite 1994).

Whatever the reason, the code switching unfortunately prevented the pilots of British Airways Flight 476 from monitoring this critical part of the dialogue as they could not understand Serbocroatian. With hindsight it has been suggested that had the controller only spoken English, the British Airways flight crew might have realised that the two aircraft were at the same altitude and tried to prevent the collision (Beaty 1995). However, the accident report points out that even if this had happened there may not have been enough time for the pilots to take avoiding action (AAIB 1977). Furthermore, the suggestion that only English should have been used fails to take account of all the causal factors listed above; specifically, it ignores the pressure the controller was under, which may have rendered him incapable of accurately communicating the vital message in English, his L2.

The second language factor was the numerical slip: the controller told Flight 550 to stop climbing because another plane was approaching at flight level 335 (= 33,500 feet). The other plane, Flight 476, was actually at flight level 330 (= 33,000 feet), its assigned altitude. The controller later claimed that his radar indicated flight level 335, but ten minutes before he had spoken with the crew and confirmed they were at flight level 330. It has been speculated that the controller, believing that disaster was inevitable, ‘may have attempted to mask the terrible reality by “adding” that extra 500 feet to the flight level’ (Weston and Hurst 1982). The mistake may be attributable, though, to other factors. As Dismukes et alia (2007) note, high workload can cause recently acquired information to be forgotten or not remembered correctly, and both Cushing (1994) and Monan (1986) list numerous instances of miscommunication involving numbers. In fact, the upper sector controller made two other numerical slips in the two minutes preceding the crash: first he gave an incorrect radio frequency, which he immediately corrected, and then he incorrectly read back a flight number. Those two mistakes were of no consequence, but the third was catastrophic as it directed two aircraft to the same flight level just as their flight paths crossed.

Accident 2: Tenerife 1977

On 27 March 1977, KLM Flight 4805, flying from Amsterdam, and Pan Am Flight 1736, from Los Angeles via New York, were bound for Las Palmas Airport in the Canary Islands when a bomb explosion caused the
airport to be closed. The aircraft, both Boeing 747s, were diverted to Los Rodeos Airport on Tenerife Island. After Las Palmas Airport reopened, the Pan Am crew wanted to leave Tenerife as soon as possible, but had to wait until the KLM aircraft, which was blocking access to the runway, finished refuelling. Weather conditions deteriorated as thick cloud enveloped the airport. Finally both aircraft were instructed to taxi along the active runway, the taxiway being blocked by other aircraft. Flight 4805 reached the end of the runway, turned around, and began its takeoff roll without receiving clearance from the control tower, and with Flight 1736 still on the runway. The KLM aircraft had just started to lift off when it collided with the other plane. A total of 583 people were killed in the collision.

The report produced by Spain’s Civil Aviation Accidents and Incidents Investigation Commission cited four actions by the KLM captain that caused the accident, plus nine contributory factors (CIAIAC 1978). This accident, like Zagreb, was the result of multiple factors and featured communication problems between pilots and controllers. However, unlike Zagreb, it was preceded by a bomb attack that caused diversions and delays. Los Rodeos was, moreover, a small regional airport at an elevation of 2,000 feet, subject to rapidly changing visibility caused by wind-blown clouds, and not used to handling international traffic or aircraft as large as the Boeing 747.

The communication problems occurred in the final five minutes before the collision. The first problem was that the Pan Am crew had difficulty understanding instructions from the control tower ‘because of the heavy Spanish accent of the controller as he spoke English’ (Roitsch et alia 1978). As they taxied down the runway the Pan Am crew struggled to find the correct exit because they were not familiar with the airport, visibility was poor, and there were no signs marking exits. At 17:02 GMT the controller said, ‘Affirmative, taxi into the runway and – ah – leave the runway third, third to your left.’ The Pan Am captain thought the controller had said ‘first’, so the first officer asked for confirmation and another controller replied, ‘The third one Sir, one, two, three, third third one.’ This solved one problem but created another because the third exit required the aircraft to make two 148-degree turns. In fact it was ‘a practical impossibility’ for a Boeing 747 to negotiate these turns (ibid 1978). In the event, either by mistake or because they thought it easier, the Pan Am crew continued towards the fourth exit, which they were approaching at the time of impact.

The second language problem occurred as the KLM crew prepared for takeoff. At 17:05 the aircraft rolled forward slightly until the first officer warned the captain that they had not yet received ATC clearance. The tower then issued ATC clearance, giving permission to fly the first part of the route. Confusingly, this clearance included the word ‘take-off’, but it was not the takeoff clearance. The first officer repeated the ATC clearance to the tower: ‘Ah– Roger sir, we are cleared to the Papa beacon flight level nine zero, right turn out zero four zero until intercepting the three two five. We are now at take off.’ Just after the first officer had started this read-back, the KLM captain released the brakes and began the takeoff roll.

There has been much debate since the accident about the last sentence in the first officer’s read-back, underlined above. Some commentators have posited linguistic interference from the first officer’s L1: in Dutch a preposition may be used with the infinitive form of a verb to indicate an action currently being performed (ICAO 2004). Hence, the first officer may have meant the phrase ‘at take off’ to mean ‘in the process of taking off’. His words, though, were ‘hurried and the voice tremulous’, indicating that he was under stress and making transcription of the voice recorder tapes so difficult that a report by the Airline Pilots Association (ALPA) suggested that he might actually have said, ‘We are, uh, taking off.’ (Roitsch et alia 1978).

According to the Spanish accident report, the controller interpreted the first officer’s last sentence as meaning ‘We are now at take-off position’ (CIAIAC 1978). In other words, the controller assumed an elliptical construction and, from the available context, inferred the missing element was ‘position’. He believed, after all, that the KLM aircraft was waiting for takeoff clearance. The controller replied at 17:06, ‘O.K.’, and continued, ‘Stand by for take-off ... I will call you.’ The Pan Am first officer made a radio transmission at almost the same time saying, ‘and we are still taxiing down the runway, the Clipper one seven three six.’ Either message could have alerted the KLM crew to the imminent disaster, but unfortunately the near-simultaneous transmission caused interference – another communication problem – so that neither could be heard clearly by the KLM crew.

The controller then requested the Pan Am aircraft to report when they were clear of the runway. This message could be heard in the KLM cockpit, but instead of referring to the Pan Am plane as ‘Clipper’ the controller used the phrase ‘Papa Alpha’, which was less likely to catch the attention of the pilots. The KLM flight engineer
presumably heard this message, for he twice asked his colleagues whether the other plane had cleared the runway. The KLM captain replied emphatically (but mistakenly), ‘Oh, yes.’ Seconds later the collision occurred.

The Tenerife accident involved the tragic co-incidence of many factors, and the ALPA accident report, which focused on human factor issues, highlighted the effects of stress and fatigue on those involved. In the tower, the two controllers had been on duty since 10:00 and had to handle three frequencies, with an unusually large amount of traffic on account of diversions from Las Palmas, compounded by the fear of a further bomb attack at Tenerife (Roitsch et alia 1978). Workload pressure and fatigue may explain why one controller used the wrong flight number three times, saying KLM 8705 instead of KLM 4805, and it may also have prevented the controllers from realising that a Boeing 747 could not negotiate the third taxiway.

The Pan Am crew had been on duty for 11 hours, having to deal with the frustration of diverting to Tenerife when they wanted to hold at altitude, and being delayed on the ground until the KLM aircraft finished refuelling. Meanwhile, after 9 hours on duty the KLM crew knew they had to depart soon on account of strict regulations on duty time limits introduced by the Dutch Government the previous year. Within the KLM cockpit there was an additional problem caused by a steep ‘trans-cockpit authority gradient’. Wiegmann and Shappell (2003) note that ‘when very senior, dictatorial captains are paired with very junior, weak co-pilots, communication and coordination problems are likely to occur.’ The KLM captain was the Head of the Flight Training Department, while the first officer was a junior pilot who had recently received his type qualification check from the captain. This made it difficult for the first officer to question or challenge the captain’s decisions. Furthermore, the KLM captain had not flown as a line pilot in the previous 12 weeks due to his work as a simulator instructor, in which role he would have issued clearances to training crews. As Roitsch et alia (1978) point out, ‘There is never a need for the crew to hold the simulator in position awaiting takeoff clearance.’

**Accident 3: Cove Neck 1990**

On 25 January 1990, Avianca Flight 052 was scheduled to fly from Columbia to John F. Kennedy International Airport (JFK) in New York. Poor weather in the north-eastern part of the United States meant the aircraft had to enter three separate holding patterns for a total of 77 minutes. During the third holding period, the flight crew notified ATC that they could only hold for about five more minutes and could no longer reach their alternate airport in Boston because they were running out of fuel. As the aircraft finally descended towards JFK it encountered wind shear and the crew executed a missed approach. While trying to return for a second approach, all four engines suffered a loss of power and the aircraft crashed at approximately 21:34 EST at Cove Neck, Long Island. Of 158 passengers and crew on board the plane, 73 died as a result of the crash.

The National Transportation and Safety Board report stated one probable cause of the accident and a number of contributory factors (NTSB 1991). The probable cause ‘was the failure of the flightcrew to adequately manage the airplane’s fuel load, and their failure to communicate an emergency fuel situation to air traffic control before fuel exhaustion occurred’. This accident was caused by multiple factors, like Zagreb and Tenerife, and might have been averted if any of the factors had been absent. The report notes, for example, that the accident would not have occurred if the crew had not been prevented from successfully completing the first approach by a combination of wind shear, stress and fatigue.

Two language factors were identified in the NTSB report: the crew’s failure to communicate an emergency fuel situation to ATC, and the lack of standardized, understandable terminology for minimum and emergency fuel states. At 20:44, during the third holding period, the New York Air Route Traffic Control Center (ARTCC) told Flight 052 to expect further clearance information at 21:05. The first officer, who was handling communications with ATC while the captain flew the plane, read back the time and said, ‘I think we need priority we’re passing [unintelligible]’. He then reported they could only hold for five minutes more and, when asked to repeat the alternate airport, he said, ‘It was Boston but we can’t do it now we, we, don’t, we run out of fuel now.’ The first officer thus informed ARTCC about the fuel problem more than 45 minutes before the crash. Crucially, though, he did not declare a fuel emergency. Moreover, ARTCC did not notify approach control about the fuel problem, and the aircraft subsequently received routine vectors including a 360° turn for spacing.

Between 21:03 and 21:06 the flight engineer briefed his colleagues on the go around procedure for a low fuel situation. It is not clear from the CVR data whether this briefing was a continuation of an earlier conversation
because the recording only covered the final 40 minutes of the flight. The crew did not contact ATC again about the fuel problem until they had executed the missed approach at 21:23. From then, during the final 10 minutes of the flight, the captain five times declared in Spanish ‘we don’t have fuel’ or ‘we are in emergency’, and repeatedly instructed the first officer to notify ATC. Instead, the first officer three times said in English ‘we’re running out of fuel’. He finally requested ‘priority’ handling at 21:32 after two engines had flamed out, but even at this point did not declare an emergency. Why not? Was this simply a language proficiency problem?

Describing the first officer’s English as ‘excellent’ and ‘unaccented’, Helmreich (1994) hypothesises that the crew’s actions can be attributed at least partly to cultural factors, and discusses the role played by collectivism, power distance and uncertainty avoidance. Coming from a strongly collectivist culture, the Columbian crew may have been reluctant to declare an emergency and push ahead of other crews they perceived to be in difficulty. Their reluctance may have been reinforced by a transmission from an American Airlines crew at 21:02 giving a minimum fuel advisory and warning they would soon declare a fuel emergency. Gladwell (2008) develops the hypothesis, noting that authority is highly respected in Columbia and explaining that the first officer – 28 years old and lacking flight experience – would have seen himself as subordinate to the captain and the ‘domineering Kennedy Airport air traffic controllers’. Gladwell (2008) suggests that the first officer instinctively used mitigated speech ‘to downplay or sugarcoat the meaning’ of his messages in deference to the authority of the captain and controllers. Hence the softening of the captain’s statement ‘we don’t have fuel’ to ‘we’re running out of fuel’, and of ‘we are in emergency’ to ‘we need priority’.

Concerning the words ‘priority’ and ‘emergency’, Krause (2003) points out that the first officer may have thought them interchangeable. According to the testimony of an Avianca captain cited in the NTSB report, training provided by Boeing gave the impression that ‘the words priority and emergency conveyed the same meaning to air traffic control’. The report also states that a Boeing manual used to train Avianca crews advised that ‘priority handling from ATC should be requested’ during operations with very low fuel quantities. This is at odds with the advice of controllers questioned during the investigation, who stated that flight crews should only use the terms ‘Mayday’ or ‘Pan-pan-pan’ or ‘Emergency’ when declaring a fuel emergency (NTSB 1991).

Another reason for the communication problems was that the crew, especially the captain, were suffering the effects of high workload, stress and fatigue. The flight time of 6 hours 26 minutes was much longer than the scheduled 4 hours 40 minutes. Furthermore, maintenance problems with the autopilot and flight director led investigators to conclude ‘that the aircraft might have been flown manually from Medellin to JFK’ and that the captain flew the first approach ‘without the aid of a flight director’ (NTSB 1991). In a Boeing 707 – built in the 1960s and designed in the 1950s – this would have been exhausting. Dismukes et alia (2007) state that both stress and fatigue narrow an individual’s focus of attention and impair cognitive processing. As a result, decision-making ability and communication may be adversely affected. Communication degradation may manifest itself not only in impaired speech production but also in a ‘decreased ability to receive and interpret messages’ (Stokes and Kite 1994). This was clearly the case with the captain: analysis of the CVR data reveals a discourse pattern whereby the captain would inquire about ATC communications or the configuration of the aircraft and then ask several times for the same piece of information – usually a number – to be repeated. At 21:17 he even said, ‘tell me things louder because - - I’m not - - hearing it’ (NTSB 1991).

The communication issues in this accident were complex, and they brought about a critical difference in situation awareness between the flight crew, who believed they had informed ATC about their fuel problem, and the controllers, who did not realise that an emergency situation existed. Noting that the first officer twice asked for ‘priority’ and four times advised ATC that the plane was low on fuel, Krause (2003) states that ‘it would seem reasonable and logical’ for the controllers to have asked for clarification. None of them did so, however, and the aircraft crashed before the second approach could be completed.

Conclusion

The aims of the ICAO language proficiency program are laudable, and it goes without saying that clear communication between pilots and air traffic controllers is essential for the smooth and safe operation of the international air transport system. However, the claim by ICAO (2004) that ‘inadequate language proficiency has played a role in accidents’ is a somewhat misleading simplification when it comes to the accidents analysed in this paper: Zagreb, Tenerife and Cove Neck. The analysis underscores the complexity of each of these disasters, and
shows that a range of language issues were involved, including numerical slips, code switching, poor pronunciation, L1 interference, and ambiguity caused by ellipsis. The only factors present in more than one accident were the numerical slips, which featured in all three (but were critical only in the collision over Zagreb). Each accident was tragically unique, but nevertheless the following common features have been highlighted by the analysis:

- All three accidents were complex and occurred as the result of multiple causal factors.
- Each accident involved a combination of linguistic factors and non-linguistic factors. (In other words, none of the accidents were caused solely by language problems.)
- The pilots and air traffic controllers involved were in each case a mixture of native English speakers and non-native speakers. (None of the accidents involved only non-native speakers.)
- While all three accidents featured oral communication problems, there is a suggestion that one of them – Cove Neck – also involved a problem relating to written language.
- In all three accidents the linguistic factors were exacerbated by the effects of high workload, stress and fatigue, and in one case – Cove Neck – cultural factors were also significant.
- Finally, in each accident the language factors contributed to the setting up of a critical difference in situation awareness between the flight crews and the air traffic controllers.

References


