

The complexity of attaching blame to a pilot, or indeed to any other *single* cause of a disaster, was never better illustrated than in the case of the world's worst aircraft accident. With any luck, the deaths of 583 people at Los Rodeos Airport on Tenerife in the Canary Islands on March 27, 1977 is likely to remain a record for many years to come, because it involved two Boeing 747s. The main undercarriage of a 747 belonging to KLM 4805 hit Pan Am Jumbo Clipper 1736 as it taxied across the runway. Both aircraft immediately burst into flames; all 234 passengers and 14 crew members aboard the KLM plane died, as did 335 of those aboard the Pan Am jet, although, miraculously, 61 Pan Am passengers and crew survived.

Behind these simple statistics lies an extraordinarily – and typically – complicated story. It started earlier that day when a bomb was planted at Gran Canaria's Las Palmas Airport by Canary Island separatists. While the airport was being cleared and searched for further bombs, aircraft were diverted to the smaller airport at Los Rodeos, Tenerife, which was consequently overcrowded with traffic. Moreover, its facilities, particularly its taxiways, were not designed to cope with Jumbos.

The Pan Am plane, captained by a veteran pilot, Victor Grubbs, was *en route* from Los Angeles and New York carrying a group of elderly tourists to join a cruise ship. Captain Grubbs was denied the permission he requested to remain airborne until Las Palmas was reopened, and was forced to land at Los Rodeos.

But the main problems arose from the KLM plane, a charter being flown by Jacob van Zanten, KLM's chief training pilot for 747s. Within the airline he was a star: it was his face that gazed out, serenely handsome and confident, from the KLM advertisements. But despite his seniority – he had been flying with KLM for over a quarter of a century – he had not flown commercially recently, having instead been instructing. (Indeed, and critically, his co-pilot was a former pupil – used to deferring to the older man.) Van Zanten was seemingly obsessed by the exceedingly strict restrictions on flying hours newly-introduced by KLM and the need to unload his passengers at Las Palmas – which had reopened after the American

jet landed – in time to enable him to return to Amsterdam. Presumably to save time, he ordered a refuel at Las Palmas; owing to the lack of space on the airport's aprons, this 35-minute procedure blocked up the airport and delayed the Pan Am flight from taking off again in the meantime.

Eventually, the two airliners were ready to depart. They moved off, the KLM plane to its take-off position, and the Pan Am Jumbo to a taxiway.

Meanwhile, a thick fog had descended over the Tenerife airport, wrecking visibility and – in the absence of a ground radar system at the small, local airfield – leaving the aircraft relying exclusively on radio communications for positional information. The effects of the weather were then magnified by a further fog of misunderstandings and error. The air traffic controller, who had been on duty all day, was under considerable strain because of the rush of aircraft diverted from Las Palmas. Nevertheless, it is clear that he never actually gave Captain van Zanten clearance to take off. Because of the awe van Zanten inspired, neither his co-pilot nor the flight engineer dared to tell him that they had not received this express – and vital – permission.

Amid a confused jumble of radio messages involving both captains and the control tower, the senior pilot – by now highly impatient – decided to take off, blind, along the runway, and pushed the throttles forward.

According to Paul Roitsch, a senior Pan Am pilot who flew in afterwards to investigate the crash, the first officer said, 'No, wait a minute – we don't have our air traffic control clearance!'

Roitsch's report goes on: 'The captain replied, "Yes, I know that." He pulled the throttles back and added, "Now, go ahead and call for it." The first officer called for the air traffic control clearance. The controller then called back and gave him his clearance to Las Palmas, adding an instruction that, after take-off, he should turn right to such-and-such a heading. It's possible that, after the first officer had asked for take-off clearance and air traffic control clearance, he could have inferred that *any* answer in the positive indicated that

he had been cleared for both events, which was not in fact the case. The additional directions in the clearance didn't help, either, because it reinforced the impression that they were cleared for take-off. As the first officer was reading the clearance back to the controllers, the captain again commenced the take-off, pushed up the throttles, said, "We go," and the aircraft started to roll. This happened while the first officer was still repeating back the clearance. He sensed that this was not right – he knew that they hadn't been cleared for take-off – and so, after he finished reading back the clearance, he said either, "We are taking off," or "We are at take off." It wasn't even that clear: the words are difficult to comprehend, and the tone of the voice changes. It's obviously very tense, but the first officer felt that he had done his part in letting people know that they were commencing their take off. The words that he used were also ambiguous. The tower thought he had said, "We're at take-off position," but the controller wasn't sure. He said, "OK" – a long pause – "Stand by for take-off." He felt he had covered the situation in any event.'

But by a further twist of fate, the Pan Am first officer – who had also picked up the confusing message about 'taking off' – had clicked his radio, on the same frequency, and said, 'We're still on the runway, Clipper 1736.'

This statement interfered with the tower's transmission back to the Dutch aeroplane instructing it to *stand by* for take-off.

'In the cockpit of the Dutch aeroplane,' writes Roitsch, 'the words to stand by were changed in timbre, lowered in volume. It sounded like a different transmitting station, but it was capable of being heard. The Dutch aeroplane heard the words "Clipper 1736", and then they heard the tower say to the Pan Am aeroplane, "Roger Clipper, advise when you're clear." The Pan Am first officer replied, "Roger, we'll advise when we're clear."

The KLM flight engineer heard the American response, and it must have rung major alarm bells with him: the cockpit voice recorder picked up his urgent question to his captain and co-pilot: 'Is he *not* clear, then?'

The two men replied: 'What?'

‘Is he not clear then, the Pan American?’

Both crew members then said, ‘Ja, ja, he’s clear.’

That was perhaps the last moment to avert the horrific tragedy from unfolding. By now, the KLM jet – weighing several hundred tonnes, brimming with aviation fuel and packed with 234 passengers and 14 crew – was racing down the tarmac. Just a few hundred yards away, hidden for the moment by the fog, the Pan Am aircraft was trundling *across* the runway.

‘It was only, I believe, just after VI [the speed at which a decision has to be made as whether or not to take off] that they saw the Pan Am aircraft desperately trying to get off the runway,’ says Roitsch. ‘The Americans had spotted the Dutch aeroplane bearing down on them; they could see the landing lights. The captain of the Pan Am aeroplane shoved the throttles up and tried to turn the aircraft, but there was not enough time. The rest is history.’

Pan Am co-pilot Robert Bragg told his story in a film called *Tenerife Crash*. ‘When we first saw the KLM airplane, it didn’t surprise us too much. The first thing that got my attention was his landing lights were on, and that’s one of the last things that a pilot does when you receive the takeoff clearance... Then, due to the low visibility, it was very obvious that the airplane was moving, coming at us, and my initial reaction was, I said very loudly, “I think he’s moving”. And the Captain had seen the same situation as I had, and he had pushed the throttles to full power... As we were turning, I looked back, and KLM had lifted off the ground, and I could see his red rotating beacon on the belly of the airplane. That was the only time in my life I have ever seen something happening that I could not believe was happening. And I basically ducked, closed my eyes, and when the KLM airplane hit us, I really didn’t think the man had hurt us. It was a very slight impact, very slight noise, like *CLUNK*, that was about it, it was so minor it was unbelievable. Until I opened my eyes and looked up. All the windows were gone in the cockpit. Then I looked out to the right, and the right wing was on fire, and then I looked to the left, and on this particular configuration airplane we had an upstairs lounge with 28 passengers in it... The captain had allowed two elderly ladies

[from the lounge] to come up to the cockpit and watch us start the engines [and] when I looked back, the lounge was gone and all the 28 people were no longer there, and there was just a void, just a big hole, and I could see all the way to the tail of the airplane. It was about that time that I figured it was time to get out of the cockpit. I was saying, "Get out, get out, get out," and I just jumped right over the side and it's approximately 38 feet down, but at that time I gave no consideration to the height.'

The whole of the top of his aircraft had been ripped away, and it was ablaze. On the grass around the runway, he was confronted by the sight of injured and dying passengers.

'First thing I saw was one of the passengers, probably from the upstairs lounge, and this lady was on her knees and all her clothes were burnt off of her, her hair and everything. I walked over to the lady and said everything would be OK... and she basically just collapsed. And then the impact of looking at this airplane burning up... I just could not believe this airplane in that short [time] had turned into that raging fire. The entire left wing of the airplane had filled up with passengers... the engines were going at full speed and were extremely loud, but the wing was full of passengers just standing there so I went back up as close as I could and started yelling and motioning for them to jump and they did. They jumped right off the wing, that's like 25 feet, with the exception of one lady, and she slid down the side of one of the engines and she burned herself very badly. I expected the wings and the entire airplane to blow up and I saw one man pulling a lady by the ankle running as fast as he could and it was strange, and I asked myself, "Why is he doing that that way?" Turned out that this was his wife and when she jumped... everybody hit on top of her and it broke both arms, both legs and her back, and as soon as her husband discovered that she couldn't walk, he grabbed her by the ankle and just started running as fast as he could. About that time, the centre fuel tank went off.'

Bragg was unhurt, but was taken to hospital 'at 100mph' by a Spanish taxi driver; he had to ask the man to slow down, lest he suffer the horrible fate of surviving the world's worst plane crash, only to

die in a mundane car accident. There, he was besieged by reporters, and suffered the further agony of talking to burned victims who were unaware of how desperately injured they were, only to find them dead an hour later. He shared a bottle of champagne – there was no beer available – with the man who had dragged his wife clear. ‘One thing was very appreciated,’ he said. ‘None of the passengers ever even hinted that we had been at fault.’

But were they right not to blame the Pan Am crew? The investigation was a joint one, involving the Spanish, the NTSB, Pan Am, Boeing, the engine manufacturer, KLM and the Dutch government. It started amicably enough, but it soon became apparent that the Dutch could not bear the destruction of their icon, van Zanten. As Roitsch described it, ‘The Dutch had decided to circle the wagons.’ They suggested that the air traffic controllers had been listening to a football game in the tower at the time of the accident, a slur based on the flimsy foundation that ‘someone thought they heard the Spanish word for football in the tower.’ They even tried to blame the Pan Am crew, a suggestion hotly refuted by Roitsch.

The disaster was eventually attributed, rather vaguely, to ‘human factors’. But in fact it was the result of a series of appalling coincidences. As Macarthur Job says in his *Air Disaster* series, ‘if the bomb had not gone off; if the Pan Am Boeing had been permitted to hold; if the KLM crew had not decided to refuel; if the Pan Am aircraft could have squeezed past its KLM sister ship without having to wait for it to move; if the weather had not deteriorated; if the Pan Am crew had not bypassed [a possible] taxiway; if they had not transmitted at the moment they did, when they feared the KLM aircraft was about to take-off; if the KLM captain had taken more notice of his flight engineer’s doubt... Any of these factors could have altered the whole course of events.’

Tenerife was not merely the worst accident on record; as Stephen Barlay put it in his book *Cleared for Take-off*, ‘Tenerife changed the way airlines thought of behaviour on the flight deck.’

Of course, there are dozens of crashes where the blame can legitimately be shared between the pilot and other factors, be it

the airline itself for not training the pilot or not maintaining the aircraft, or the airport involved. Typical of the latter was the case of a Singapore Airlines flight taking off from Taipei to fly to Los Angeles on October 31, 2000. In heavy rain, at night, and with a typhoon looming, and with the plane's paravision display – which provides the pilot with a view of his surroundings – inoperative, the crew failed to take account of repairs which had shut part of a runway. On takeoff, the aircraft hit concrete barriers, excavators and other equipment, crashed back to earth, broke up and burst into flames. Eighty-three of the 179 people aboard died. One of the first officers told the subsequent investigators that he had been preparing to tell the pilot 'not to take off if the runway picture was not right.' Probably because the airline had a hierarchical structure, however, he didn't warn his superior in time.

The Taiwanese authorities blamed the crew, but Singapore Airlines objected; the airport, built in 1979, had not been updated, and its 'systems, procedures and facilities... were seriously inadequate'. Officials had not marked the closed runway properly with runway guard lighting for times of poor visibility. It did not help the Taiwanese case that the pilots had been placed under house arrest after the accident while the authorities decided whether or not to prosecute. It took an almighty row to get them released.

The pilots' role has changed enormously over the past few decades. Above all, they are finding it difficult to abandon their previously unchallenged power in the cockpit. Traditionally, the pilot has been a figure of unquestioned authority, and it is only in the last 30 years that this has been tested. Early on, this led to considerable problems, but these have resulted in largely successful procedures to transform attitudes and relationships within the flight crew. When David Beaty joined British Overseas Airways after the Second World War, 'many of the captains lived up to their nickname – "The Barons".' As a consequence: 'Communication on the flight deck could be very strained. First officers did not correct the captain or his mistakes. I had my hand smartly smacked when I leaned over the throttle box to put a captain's VHF on the correct switch after he had complained

of not being able to hear anything. He would give the order, he said, when he wanted me to do anything. Otherwise I was to shut up and do nothing.’

Norman Tebbit, later Lord Tebbit, was employed as a co-pilot with BOAC. In his autobiography, *Upwardly Mobile*, he described how he ‘rated captains not least according to how often they were willing to play the co-pilot’s role to their first officer’.

This fear – of a co-pilot of interfering with the captain – is known in the trade as the ‘Captain God complex’, and it can leave the junior party psychologically helpless in emergencies. The basic question, which remains difficult to answer, is at what point, and in what extreme circumstances, can a junior member of the flight crew justify even questioning the captain’s judgment, let alone trying to override his actions – even when the captain in question is overbearing and incompetent? It is a relationship which concerned writers about seafarers for centuries before the first aeroplane ever flew: the downright dangerous Captain Queeg in *The Caine Mutiny* is the model for the situation in which many crews have found themselves over the years. Too often pilots have behaved like the one in an incident recounted by David Beatty in *The Naked Pilot*, where a co-pilot told his captain that approach control had ordered them to slow down to 180 knots.

‘His reply,’ said the co-pilot, ‘was something to the effect, “I’ll do what I want!” I told him at least twice more and received the same answer. Approach control asked us why we had not yet slowed. I told them we were doing the best job we could and their reply was, “You almost hit another aircraft.”’

When the co-pilot reminded the pilot that he had disobeyed an instruction to descend only to 3,000ft the pilot replied, ‘You just look out the damn window.’

Sometimes a co-pilot has no choice in overruling his senior. In 1966, the pilot of a KLM DC8 died of a massive heart attack a mere 30 seconds before touchdown, when the plane was at only 150ft. The first officer, Cornelius de Jager, managed to put on full power and go round again, dragging his dead colleague from his seat while the automatic pilot flew the plane, thus eliminating any danger that the

pilot's body might interfere with the controls.

But the key event which led to a transformation in the relationship between pilots and their crew, and indeed between pilots and their employers, was the crash of a BEA Trident, flight BE 548 from London to Brussels, at Staines on a summer Sunday, 18 June, 1972. The story of this crash reads like one of Nevil Shute's techno-psychological thrillers, beginning, as it does, with, the personality of the pilot and his relationship with his fellows. In charge that day was 51-year-old Captain Stanley Key, a highly experienced and much-decorated World War II veteran who was disliked by junior crew members. Around the time of the crash, BALPA was in dispute with British European Airways. First officers, particularly, were exercised about pay and conditions – some were already out on strike – while senior pilots, including Key, were strongly against this militant stance. Further strike action was being threatened, with a crucial meeting due to be held on 19 June, the day after what turned out to be the fatal flight.

On the day of the flight itself, Stanley Key and other members of staff happened to meet in BEA's crew room and a row broke out between them after a first officer made plain his disagreement with Key. The older man erupted in anger, and one eyewitness described what followed as 'the most violent argument I have ever heard.' Key's state of mind cannot have been helped by the fact that seat-backs in several Trident cockpits had recently been scrawled with graffiti which referred to him in hostile and uncomplimentary terms.

An hour after the argument, the Tannoy ordered Key to the flight deck of one of the defaced aircraft – the graffiti on which implied that Key regarded himself as 'God's representative in BEA' – for the afternoon flight to Belgium. His co-pilot on BE 548 Papa India was a 22-year-old novice, Jeremy Keighley, who had only 40 hours under his belt, and had been on the job for just six weeks. To make matters worse, Keighley had just witnessed the full force of Key's domineering personality in the crew room. The third pilot – a second first officer on BEA Tridents, analogous in some ways to a flight engineer – was

also a relatively callow operator. As Jonathan Scott, a senior BA pilot, observed, ‘The relative inexperience of his two junior crew members meant an increase in the workload which, in any case, was relatively high for a captain due to the way the procedures were written in those days with the new jet aircraft.’

The take-off was normal, despite the blustery weather, low cloud and rain. At around 90 seconds into the flight, the pilot throttled back as part of an agreed noise abatement procedure; at around two minutes, the control tower received the message, ‘Climbing as cleared – passing 1,500ft.’

That was the last anyone heard from the crew; within seconds, they were locked in a desperate fight for their lives. They failed: very shortly afterwards, the aircraft hit the ground and broke apart, killing the crew and all 112 passengers (though two people were still alive when rescuers arrived, they quickly died). Astonishingly, despite its near-full fuel tanks, the Trident did not catch fire, so investigators were faced with an easier task than they might have been. They were hindered by the fact that the jet did not carry a cockpit voice recorder, but the flight data recorder revealed precisely what had caused the crash: a deep stall. This had been precipitated by the premature retraction of the ‘droops’, a device hinged at the bottom of the leading edge of the wing which provided additional lift while the plane was taking off and climbing to its cruising altitude. If the droops were extended, the speed at which the Trident stalled was greatly reduced; if they were retracted, it increased by about 30 knots.

In any case, the plane had failed to reach the speeds appropriate to the successive stages of take-off and climb. Moreover, even when the droops *had* been retracted, the pilots had plenty of visual and other warnings – alarms, stick-shakers – to prompt them to take remedial action. They could have applied more power to increase speed; they could have extended the droops again; or they could have tried to reverse the stall by pushing the control column forward. This left several unanswered questions, posed by Macarthur Job in *Air Disaster*. Among these were: who had prematurely retracted the leading edge,

and why the crew had not tried – or been able – to recover the aircraft once the stall warnings had sounded?

Because of the lack of a CVR, these questions remain unanswered to this day. But some other important information was forthcoming. Inside a week, a team of six pathologists had conducted autopsies on all of the bodies, and that on Captain Stanley Key provided one clue. The post mortem revealed a severe case of atherosclerosis, and a tear in the lining of the wall of one artery caused by a rupture in the small blood vessels in the artery wall – a tear which had occurred not more than two hours before the crash. It seems likely that Key would have been suffering from chest pains before he climbed into the cockpit, that he dismissed them as indigestion resulting from his outburst in the crew room, that the ‘indigestion’ caused him increasing problems as he underwent the naturally high strains engendered by even the most routine take-off, and that this had led this normally most punctilious of pilots to fly at too low a speed for safety.

Further, it’s possible that the P3 monitoring pilot was occupied at the time with the flight log, or that he and the co-pilot were too busy coping while Key was suffering with his ‘indigestion’ to take sufficient notice of the stall-recovery warning systems. But these should have been unmissable, as Jonathan Scott explained: ‘First an amber light would have gone on in front of each pilot, as well as a “droops out of position” warning light in the front of the central pedestal, followed by a stick-shaker which warns the pilots, by shaking the control column, that they are about to stall the aircraft. The noise and the suddenness of the shock would have been difficult for even the most experienced crew to handle. The Trident was the first British aircraft to be fitted with droops, and it had two separate levers: one for the wing flaps, the other for the droops.’

Other aircraft had a single lever; possibly, either Key or Keighley pulled the wrong one. In the absence of a CVR, Scott surmises that the captain might have thought that the co-pilot had made the mistake and barked an order to Keighley which the poor co-pilot misunderstood. Another element in the mix was that the warning system had previously given several false alarms.

The accident report was a model of its kind. As aviation pathologist Air Commodore Tony Cullen said, ‘Accident investigation is putting pieces in the jigsaw. We put in one piece saying that Key had severe coronary heart disease with an acute change that we believe would have incapacitated him. The psychologists entered other pieces; the operations inspectors put in others, as did the engineers and flight data recorder people, and the net result is that the report comes out saying that the reason the aircraft crashed was because the droops had been retracted. Where the medical and psychological side comes in is answering the question of *why* the droops might have been retracted.’

The traumatic consequences of the crash led to a number of technical improvements; to the immediate acceptance by BEA’s pilots of CVRs (which were already mandatory equipment in other countries, including the USA, France and Australia); and to a totally new emphasis, which by now has become the norm, on the training of pilots to act as part of a team.

The focus on pilots’ psychological problems brought other insights. Psychologist and former airline pilot Bob Besco explained, ‘Pilots would like to feel that accidents are caused by a dumb pilot. *I’m not dumb like that dead pilot is, so I don’t make those kind of mistakes, or, I’m not deviant in my personality characteristics like that dead pilot is, so I’m not subject to the same kind of errors.* This gives them a false sense of comfort. For generations, pilots have been willing to accept these partial definitions of accident causation in terms of pilot error because it absolves them of having to face the same kind of risk when they go to work.’

The two most significant innovations have been expressed in two acronyms: CHIRPs and CRM, which stand respectively for Confidential Human Factors Incident Reports and Cockpit Resource Management. CRM started in the late 1970s and is now, says one expert, ‘so much part of the culture that it’s taken for granted, especially in western Europe.’ In the late 1970s and early 1980s, the aviation authorities belatedly woke up to the need to improve communication between the pilots and themselves. In the past, the repeated failure of pilots to report a particular fault had often led to disaster. It took the

crash of a twin turbo-prop Beechcraft at Spokane in 1981 – when the pilot flew into a hill three miles short of the runway after an error in using his distance-measuring equipment – to bring out into the open five pilots who admitted that they, too, had almost come to grief in a similar way, but had been too embarrassed to report it, assuming – wrongly, in their cases – that it was they, and not the equipment, that had been at fault.

This sort of revelation, and the fact that pilots often dared not report incidents, dared not complain of stress, of fatigue, of bad maintenance, of unreasonable demands imposed by their employers, brought change. In 1977, a prototype safety reporting system had been introduced in the United States, requiring pilots to report every incident of any significance to NASA. However, it was badly publicised and many pilots were unaware of it (or of its British equivalent, the CAA's Mandatory Occurrence Reporting). This was reinforced by a system of confidential reporting, a sort of confessional for pilots, surrounded by all the secrecy which that implies. This was introduced in the early 1980s by NASA in the United States, where it was known as ASRS – Aviation Safety Reporting System – and was copied a few years later in Britain in the guise of CHIRPS. Run by the Royal Air Force's Institute of Aviation Medicine, it proved a great success; soon, information on thousands of potentially or actually dangerous incidents was being passed on every year. One pilot told Patrick Forman, 'It's one of the few aviation circulars read from cover to cover by most pilots.' *There*, pilots tend to feel, *but for the grace of God go I*. According to CHIRPS, most companies are compelled by commercial pressures to operate to the legal limits, 'and they can't be held responsible if the limits are too liberal.'

Originally more contentious were the many and various training schemes devised by airlines over the past couple of decades to train crews, and pilots in particular, to work better together; schemes generally grouped under the generic name of CRM. Few have gone as far as Qantas, which for a couple of decades now has run a course designed to highlight the horrible potential consequences of a crew's failure to act as a team.

As so often, it was the worst sinners who repented the earliest, and the most thoroughly – in this case, United Airlines, which then employed 8,000 pilots. Bob Besco said, ‘In the 1950s, United Airlines had the misguided philosophy that they didn’t want to hire overqualified military pilots. They felt they’d be malcontent and discontented employees. This philosophy was interpreted in a lot of hangar talk as United only wanting to hire people they could control... good employees rather than good pilots. Consequently, when we started looking at the types of pilot-error accidents that became defined as CRM accidents, we found that United Airlines was committing a lot of them, primarily because the captains had been taught by the airline itself that they couldn’t trust their co-pilots; that they had very marginally qualified co-pilots, hired right out of college.’

This led to a revolution. ‘To their credit,’ said Besco, ‘United implemented one of the first programmes in crew resource-management.’ By the late 1990s, United’s safety department was a sort of mini-NTSB with its own crisis centre and technical experts on tap, 365 days a year.

Another major American airline, Delta, started its own CRM programme in 1988. Ray Justinic, a systems manager at Delta, had been an accident-investigator himself, so he could see the need for reform of pilots’ attitudes. ‘What we thought was the right stuff turned out in an airline operation to be the wrong stuff,’ he said. ‘We needed team players. We’re not going to change anybody’s personality in two hours a year, or a three-day programme: what we do try to do is make people aware that there are different personalities. It’s not so much, *You’re a nice guy, I’m a nice guy*, as, *You’re different from me, but we can work together as long as we realise that our primary mission is a safe flight. You may have different ideas – we may disagree on politics, religion or whatever – but the object is still a safe flight.* Now, how do we get that done? We give them some skills they can use to make that happen, and to make it happen better. When it was first introduced it was not warmly received, either by the airlines or by the FAA. We started a complete programme to educate a little over 5,000 pilots in a 12 month period. We brought them all through a three-day programme. We introduced them to

decision-making concepts, to workload management concepts, to communication skills; we did classroom work on it, and then we took them into simulators. The way a cockpit or an aircraft is run, compared to how it was five years ago is much safer. When we first started at Delta, we did an attitude survey to see how open captains were to input from other people. We found that most captains still bought in to the “right stuff”, solo type of mind-set. At the completion of the initial CRM, we did another survey and found that the percentage saying, *Yes, I want some input, this is a good resource and it's OK for me to use it*, had increased dramatically. Now when we do audits or surveys again, which are just attitudinal checks, we're finding that this attitude is growing. They're more open, they're more receptive.'

Nevertheless, there's an understandable feeling that there's nothing new under the sun. To Dave Miller, CRM was simply 'a new name for an old trick'. He told an interviewer, 'It used to be called airmanship. Somebody has put this name to what's been going on already, but has now formulated what was previously an unsystematic approach to the problem of crew relationships.'

But there are deeper, cultural problems which cannot be solved even by solutions like CRM. These are most obvious in the exaggerated respect for the pilot in a hierarchical society, or (as happened in the Air Florida Potomac River crash recounted in Chapter 15) when the junior member of the crew has been schooled in automatic obedience to his superiors in the course of military training. I believe that Qantas's success in remaining virtually accident-free through the years owes a lot to a peculiarly Australian factor: the willingness of Australians to stand up to their bosses. In their non-hierarchical society, subordinates are culturally encouraged to feel free to challenge their superiors. In airline management terms, this leads to a healthy tension between air crew and management, who cannot impose their ideas as easily as they can among more obedient races. If an Aussie crew member thinks a plane is potentially unsafe he will not hesitate to say so, loudly and frequently. This could do more than anything else to save lives.

But in a couple of cases, retraining required a complete cultural overhaul of the pilots' attitudes. By no coincidence they both concern societies in the Far East, traditionally seen as the home of hierarchical customs.

In 1996, a China Airlines A300 crashed at Taipei, killing all 196 occupants. The official report blamed 'inadequate coordination between the captain and the first officer'; the Taiwan-based airline was so shaken by the incident, and the findings, that it turned to Lufthansa for help in radically changing the relationship between captains and crews, specifically addressing the unhelpful hierarchical attitudes which persisted on the flight deck, by retraining all of its 670 pilots. Particular focus was given to turning older pilots, many of them ex-military men, into better team players.

But the most thorough piece of cultural retraining involved Korean Air. Towards the end of the 20th century, the airline suffered a series of crashes which left its accident rate at 17 times that of the larger American airlines. As a result, its international partners stopped collaborating, the US Army forbade its soldiers from using the airline and the FAA downgraded its safety rating. An outside audit revealed a mass of problems, ranging from crews smoking cigarettes on the tarmac during refuelling, to reading newspapers during the flight in such a way that warning lights were obscured. Most seriously, there was real concern as to whether first officers could fly the aircraft if the captain was incapacitated. This disastrous performance led the airline to hire David Greenberg from Delta to run its flight operations. He realised that the problem lay in the devilishly complicated network of social relationships within Korean society, which included six different types of conversational address depending on the nature of the relationship between the two parties. As Malcolm Gladwell put it in *Outliers*, 'Greenberg wanted to give his pilots an alternative identity. Their problem was that they were trapped in roles directed by the heavy weight of their country's cultural identity. They needed an opportunity to step outside those roles when they sat in the cockpit, and language was the key to that transformation.'

So all training was to be in English, and a subsidiary of Boeing was brought in to take over the company's training and evaluation programmes. The results were little short of miraculous. There were no crashes in the first 11 years of the new millennium, and in 2006 the airline received the 'Phoenix Award' from the prestigious trade magazine, *Air Transport World*, in recognition of its efforts.

Nevertheless, some pilots retain the old attitudes. On July 28, 2010 an Airbus A321 belonging to the Pakistani airline Airblue crashed on its approach to Islamabad airport, killing all 152 people on board. The weather at Islamabad was poor with deteriorating visibility; a PIA flight had only managed to get down on its third attempt, and a flight from China had turned back. But Captain Pervez Chaudhry, with 35 years and more than 25,000 hours in the cockpit, was cleared for landing. He ended up flying straight into a hill – having ignored 21 ground proximity 'pull up' warnings related to the rising terrain he was approaching. The official report painted a damning picture of the captain. The CVR showed that he had belittled his co-pilot – a former Pakistani air force F16 pilot and squadron leader, but a man with only a year's civilian flying behind him – by lecturing him and firing questions at him during the initial climb, and using 'harsh words and a snobbish tone towards him' during the rest of the flight. As a result, by the time disaster approached, the first officer had gone into his shell, and 'remained a passive bystander in the cockpit, failing to supplement and compliment or to correct the errors of his captain assertively due to the captain's behaviour in the flight.' The result of Chaudhry's arrogance and hubris was horrific.

The last word goes to Rudi Kapustin – a veteran NTSB investigator, with 40 years of tin-kicking behind him: 'Senator Goldwater used to say that you can't legislate morality, and I think if you've got a blockhead, no matter how much CRM and CLR you expose him to, he's probably still going to be a blockhead. A lot of people disagree with that. But if you've got a lousy personality, one who doesn't like to interact with people, who doesn't take advice, I don't know if you can fix that. As far as arrogance and ego are concerned, I think pilots are essentially people, and we find arrogance and egos in the non-pilot population.'