QANTAS FLIGHT QF32: LESSONS FROM AN INFLIGHT EMERGENCY

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ABSTRACT

This paper summarizes the address by Captain David Evans to the 2011 Air Transport Research Society annual conference in Sydney, Australia. The paper draws on the responses of the crew of Qantas flight QF32 to an inflight emergency to identify areas of weakness in simulator training. Two significant issues that emerge are the lack of simulated training for actions to be taken after the aircraft is successfully landed by the crew and the impact of a high workload on the crew's ability to hear audible signals.

Keywords: inflight emergency, crew's ability in emergency, weakness in simulator training, crew's decision-making process

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1. INTRODUCTION

In November 2010, an uncontained engine failure on a Qantas Airways A380 aircraft as it climbed out of Singapore airport presented the crew with a highly degraded aircraft. The experience of the crew in dealing with that emergency offers insights into the design of simulator training, the increased reliance on automated systems for decision making on modern aircraft, the impacts of high work load situations on the awareness of audible warnings and the importance of airmanship as a primary skill when dealing with emergency conditions on an aircraft. This paper summarizes the keynote address delivered by Qantas Check Captain David Evans to the Air Transport Research Society Annual Conference in June 2011.

2. CHRONOLOGY OF EVENTS BY CAPTAIN DAVID EVANS

On the morning of 4th November 2010 Qantas 32, an Airbus A380 VH-OQA was to operate Singapore to Sydney. This was the continuation of the London to Sydney service that makes a transit stop through Singapore for fuel and a crew change.

I was tasked to conduct a 'route check' on the Captain of the flight, Richard de Crespigny who had positioned to Singapore the day before. I was also tasked to train and mentor a new Check Captain, Harry Wubben. Harry was to conduct the route check under my supervision.

A route check is simply a check of a pilot's normal procedures on a normal flight. The check pilot takes no part in the operation. In fact if a check pilot becomes involved in the operation the check is either a failure or incomplete. In the case of QF32 the check was incomplete as both Harry and I became involved!

To complete the picture the crew is also made up of First Officer, Matt Hicks and a Second Officer, Mark Johnson. This was an unusual crew complement as it was made up of 3 Captains, 1 First Officer and 1 Second officer, a total of 5 pilots on the flight deck.

The weather on the morning of 4th November was fine with a light South Westerly breeze with temperature of around 27C: a perfect day to go flying. After a normal take-off the aircraft was setting course passing through around 7000 feet when a pair of muffled explosions were heard on the flight deck. The aircraft was leveled at 7400 feet when the crew was faced with a multitude of ECAM procedures.

ECAM is an Airbus acronym for Electronic Centralized Aircraft Monitor. The system attempts to prioritize the various messages as best it can. On the 4th November it had its hands full with upwards of 50 ECAM messages to deal with.

The explosions were a result of a faulty oil stub pipe dating back to the original manufacture of the engine. The details of this failure have been well documented elsewhere and I won't go into too much detail here.

To summarize, the pipe failed allowing oil to ignite around the ITP shaft of the engine. The shaft failed causing the turbine to over-speed and subsequently burst. Aircraft manufacturers consider a burst turbine to have "infinite energy" and it is not containable.

Airbus, like all aircraft manufacturers, consider a turbine burst in its design and mitigate against this by routing critical services through a variety of paths so that the chances that all services are cut are extremely remote.

However, only one impact is considered in this design requirement. QF32 had all three major turbine pieces, weighing approximately 80kg each, impact the aircraft. Over 100 other impacts from smaller engine components struck along the left wing, fuselage and tail.

These impacts severed electrical wiring, fuel tanks and transfer pipes, hydraulic lines, pneumatic ducts, and flight control surfaces.

The result on the flight deck was an overwhelming display of almost 60 ECAM messages and procedures for the crew to follow. Airbus procedures demand that these procedures are auctioned in the order in which they are displayed to the crew. Richard and Matt without much delay began the process; however it eventually became evident that auctioning the messages was going to take some time.

One limitation of the ECAM is that it only displays one or perhaps two messages at a time and does not indicate how many are to follow. It was almost one hour into ECAM actions that Matt reached the end of this very lengthy list.

During the ECAM process it also became evident that some messages were spurious and more importantly not appropriate to proceed with. For example there were many FUEL messages indicating that the aircraft was going outside its lateral imbalance limits. This was already obvious as we were leaking fuel heavily from various points on the left wing. Some of the ECAM procedures were asking us to open cross-feed valves and to start transferring fuel from the undamaged heavier wing into the damaged lighter wing.

This didn't seem like a good idea and, as a crew, we elected not to implement some of these fuel procedures. This was a revelation to me as at no time during any of my Airbus training was I taught even to consider NOT doing a check-list!

On reflection it has occurred to me that as technologies advance, and some of the more mundane procedures are done by computers, we human beings start to rely more and more on them. This manifests itself into a belief that the system is right, however this reliance starts to kill off one's ability to think and even reason.

Common sense would suggest that it is not a good idea to pump JET A-1 fuel into a broken wing full of unknown ruptures and electrical faults, but ECAM was asking us to do just that. In aviation, "Common Sense" is equivalent to "Airmanship" and this "Airmanship" can be equally summarized as making "Sensible Decisions". The sensible decision on this occasion was to not follow these fuel balance procedures.

The fuel problem was just one of many issues that were affected by the turbine burst. In fact all aircraft systems were affected in one way or another.
They included:

- ✓ Engines: Engine 2 failed, while Engines 1 and 4 were left in a 'Degraded' mode and Engine 3 in 'Alternate' mode.

- ✓ Electrical: Engines 1 and 2 generators failed (suggesting that Engine 1 had taken some impact damage)

- ✓ Pneumatics: Left pneumatic duct ruptures.
- ✓ Brakes: The wing landing gear anti-skid system was inoperative.
- ✓ Flight Controls: The slats were inoperative, with only partial spoilers and ailerons available.
- ✓ Hydraulics: The 'Green' system was inoperative requiring gravity extension of the landing gear.

All of these procedures took time and during all this the crew and passengers in the cabin had to be kept informed. This was accomplished by several announcements from the flight deck. The cabin was well managed by the Customer Service Manager Michael Von Reith.

Interestingly, the A380 has a tail-mounted camera that is used on the flight deck for ground maneuvering. These images are also fed into the passenger entertainment system so that passengers can have a bird's eye view of the aircraft. This feature is very popular during take-off and landing, and was also popular as well as the dramas unfolded on the QF32. The request came through from the cabin to switch off the tail camera as all the passengers were watching!

We reasoned that at least it gave the passengers something to do, and wondered what alarm would be sent through the cabin if all of a sudden the picture everyone was fixated on suddenly went blank. Using the "Airmanship" principle, making sensible decisions, the camera stayed on.

It was now time to consider landing the aircraft and to that end a number of calculations and preparations had to be completed. The landing performance of the A380 is calculated with the aid of a computer program. After all the various factors affecting our landing performance were entered (overweight, antiskid inoperative, no slats, partial spoilers, loss of hydraulics etc.) the computer couldn't calculate an answer. After selectively eliminating minor (or what we considered minor) elements, an answer was arrived at but with the slimmest of margins. The computer suggested that we had a little over 100m surplus on a 4000m runway.

While +100m is certainly better than -100m, we had taken some items out of the calculation, so there is a very real possibility that we could overrun the runway. To that end Mark the second officer went back and briefed the cabin crew. He emphasized that we would be flying faster than normal due to our overweight condition and the lack of leading edge slats on the wing. The crew was to wait for our commands from the flight deck unless the situation in their zone became untenable.

As history will attest, the aircraft landed and didn't overrun the runway. However, when we came to a halt at the end of runway 20C in Singapore the next phase of the drama began. It is interesting to note that most airlines train their pilots to deal with various emergencies in the air, and that they end the training session after a successful landing. Only scant regard is given to the after effects of an emergency landing. Certainly our emergency procedures training considers this situation, but it not a big emphasis. On this day after the aircraft came to a halt we proceeded to shut down the engines as dictated by the procedure. The aircraft promptly lost all electrical power and air conditioning.

By this time the aircraft was surrounded by the Singapore Airport Fire services and they were trying to make radio contact with us. In this initial confusion of electrical power loss the First Officer's radio console had died, so it was some seconds before contact was established with the fire commander. Once contact was established, the Fire Chief asked us to shut down all engines, Matt told him we had. He replied that engine 1 was still running! Because the aircraft had reverted to 'essential' battery power, the normal flight instruments had gone blank. To be told an engine was still running came as quite a surprise.

Concurrently the 'body gear' brake temperatures were climbing through 1000C (the temperature gauge that only reads to 990C was already at this value) with fuel leaking from the aircraft under considerable pressure all around these hot brakes.

It doesn't take too much imagination to know that all that was missing in this volatile mix was an ignition source for things to get very bad very quickly. The Fire Chief was encouraged by Matt to start deploying fire retardant around the aircraft immediately.

Throughout all this, all five pilots were focused on Engine1, and the question of how to shut it down. Meanwhile in the cabin, the Customer Service Manager was frantically trying to make contact with us. Interestingly, no one on the flight deck heard the emergency cabin call chime, but after reviewing the Cockpit Voice Recorder in Canberra with the Australian Transport Safety Bureau, there it was blaring out!

It underlines that at times of heavy concentration the first sense you lose is hearing. Although the situation was still very serious the immediate threat of fire was rapidly fading, so now what to do?

Part of our standard operating procedure is to make a coded public address (PA) to the cabin which alerts the cabin crew to go to an 'alert phase' and 'stand by your door for a possible evacuation'. This was done almost immediately, leaving the crew faced with a choice: evacuate the aircraft or not.

An evacuation of a modern airliner is considered possible to be accomplished in less than 90 seconds using only half of the available exists. In fact, during the A380 certification the test aircraft was evacuated in about 75 seconds. But that evacuation was with able bodied people who were ready to react to the evacuation command. Even then there were reported injuries with the test evacuees.

Qantas flight QF 32 had 433 passengers on a double storied aircraft, some of whom were elderly and wheel chair bound. Certainly not what you would consider able bodied. An evacuation, although essential in a dire situation with fire, was going to injure people with some of those injuries potentially being fatal. It's a very serious decision to order an evacuation.

An alternative to an evacuation at Qantas is a "Precautionary Disembarkation". As the name suggests the urgency is removed. There are two versions of this, one using the aircraft slides and one using stairs.

We were located at the end of a 4000m runway, 4 km from the terminal, and there was no sign of any stairs. Opening some doors and inflating some slides was considered but this raised the question of what do you do with the passengers once they made it onto the ground. There was fuel and foam everywhere, and an engine was still running.

The decision was made to order stairs to the aircraft, but the next question was how to arrange that with one serviceable radio? That one radio is our lifeline to the fire commander who will be the first to tell us if there is a fire, so we don't want to lose that contact even for a second. Mobile phones were the only alternative, but who do you call?

I had a Qantas number on my phone so I dialed it. A switchboard operator answered the call. Trying to identify myself to this operator and explain my predicament wasn't making any progress, so I broke off the call and established contact with the Qantas Integrated Operations Centre in Sydney who connected me to the chief pilot. Peter Wilson was advised that we were on the ground safely but that the drama was still unfolding and that we needed stairs and buses to deplane the passengers. This was relayed back to Singapore and the process was begun.

It was after midday in Singapore by now and the outside temperature was over 30C. As we had lost electrical power and air-conditioning, the inside air temperature of the A380 which had 469 passengers and crew onboard was well in excess of that.

It was almost one hour after we landed before the first set of stairs arrived at the aircraft. As busses started to turn up the crew carefully counted passengers as they disembarked to ensure that we didn't lose anyone. If it was a 30-seat bus, then the cabin crew very carefully counted 30 passengers to disembark. All cabin baggage was left on board and only passports and essential medicines were taken. It took a further hour to get all the passengers and cabin crew back to the terminal.

Throughout, it wasn't one individual who made all the decisions but rather a "collective brain" or think tank to overcome the series of obstacles presented to the crew; in any case, the final decision rested with the "pilot in command".

This was by no means a normal flight and because both Harry and myself became involved in the operation, the flight ceased to be a check flight. The successful injury free outcome was a result of sound crew resource management, (CRM). The crew was more than just the pilots and cabin crew. It also consisted of Singapore Air Traffic Control and Fire Services. Even the passengers played their part in the successful recovery of Qantas QF3[1].

3. CONCLUSION

This highly practical address identifies important areas to be addressed in both aviation practice and aviation research. Several of the key issues emerged after the aircraft had come to a stop on the runway. For researchers of human factors, the crew resource management issues include cockpit work (over)load, even after the aircraft had landed, that lead this five man experienced crew to miss an audible emergency call from the cabin, and the need for airmanship to override system generated messages that, if followed, may have had a negative impact on the survival of the aircraft. For airframe builders the capacity of the monitoring systems to process a high volume of messages and to present the crew with essential data around which to base airmanship decisions should be addressed.

Gaps in the simulator training of pilots were identified. Current simulations are regularly designed to end as the aircraft achieves a safe landing. The experience of the QF32 crew highlights several post landing issues, including communication with fire and emergency crews when aircraft systems are degraded, managing the orderly (non-emergency) evacuation of the aircraft to minimize the risk of injury to passengers and crew, and dealing with the consequences of failed engine control systems.

An unusually large and experienced crew brought the aircraft back safely and without injury. This success can be built on by learning from the crew's decision-making process and focus on airmanship as a primary skill.

[1] VH-OQA remained in Singapore for almost 18months while a complex repair took place. The aircraft then returned to service in the Qantas fleet and is currently flying the line with the only legacy of the incident being a slight increase in fuel burn.