Australian Government
Civil Aviation Safety Authority

Safety behaviours: human factors for pilots 2nd edition

Resource booklet 7 Decision making

First edition of *Safety Behaviours: Human Factors for Pilots* (2009), **Second edition kit (2018)** ISBN: 978-1-921475-54-2
Book 1: ISBN 978-1-921475-55-9 (paperback) ISBN 978-1-921475-56-6 (pdf), Book 2: ISBN 978-1-921475-57-3 (paperback) ISBN 978-1-921475-58-0 (pdf),
Book 3: ISBN 978-1-921475-59-7 (paperback) ISBN 978-1-921475-60-3 (pdf), Book 4: ISBN 978-1-921475-61-0 (paperback) ISBN 978-1-921475-62-7 (pdf),
Book 5: ISBN 978-1-921475-63-4 (paperback) ISBN 978-1-921475-64-1 (pdf), Book 6: ISBN 978-1-921475-65-8 (paperback) ISBN 978-1-921475-66-5 (pdf),
Book 7: ISBN 978-1-921475-67-2 (paperback) ISBN 978-1-921475-68-9 (pdf), Book 8: ISBN 978-1-921475-69-6 (paperback) ISBN 978-1-921475-70-2 (pdf),
Book 9: ISBN 978-1-921475-71-9 (paperback) ISBN 978-1-921475-72-6 (pdf), Book 10: ISBN 978-1-921475-73-3 (paperback) ISBN 978-1-921475-74-0 (pdf)
Workbook: ISBN 978-1-921475-75-7 (paperback) ISBN 978-1-921475-76-4 (pdf)

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Flying is a dynamic activity, sometimes requiring quick decisions to ensure a safe and successful flight. Pilots must be vigilant and be prepared to take action to counter hazards and unexpected situations.

Most of the time, pilots will be well practised, and avoid errors in decisions and actions. However, unexpected circumstances such as the sudden onset of bad weather or a passenger falling seriously ill, will require non-routine decisions. Circumstances such as time constraints, tight deadlines and fatigue levels can also affect decision making.

Contents

Superior pilots use their superior judgment to avoid situations that would require the use of their superior skills.

Old aviation saying, author unknown

Introduction

Decisions … we're faced with choices every day. What we wear, which route we travel to work, what we buy, what we eat. The extent to which safety considerations enter our decision making depends on the situation.

In a relatively benign environment such as that of a retail store, people scour products, comparing prices and deciding on style and colour. At a restaurant, customers read through the menu and make a choice from a multitude of options. These choices are unlikely to end badly. But in a safety-critical environment the wrong decision and subsequent action could kill you.

A pilot may need to decide whether to continue a flight with a known deficiency, or into adverse weather, or make a poorly planned approach to an airfield. The following example illustrates how inadequate in-flight decisions or planning can lead to an accident.

The short charter flight in a light, single-engine aircraft had been arranged to transport three passengers to another aerodrome where they were to connect with a scheduled flight. The passengers had less than 15 minutes to make the connection. After a normal take-off, the aircraft was seen to make an abrupt right turn at about 250 feet above the ground. The aircraft was last seen descending towards the ground in a 45° nose-down attitude. All four occupants were killed in the subsequent impact. The behaviour of the aircraft in the moments preceding the impact was consistent with a stall leading to loss of control. The investigators considered the pilot was in a hurry to depart and had not climbed to a safe height before making a turn downwind in turbulent wind conditions. The pilot had not maintained sufficient airspeed for continued flight under the prevailing circumstances.[1,2]

It's too simplistic to think that good decisions are those which produce good outcomes and that bad decisions produce negative outcomes. There's a huge difference between deciding what to do in a non-threatening, low-risk, controlled environment, and making decisions in an operational environment where there is little margin for error and time is limited.

Too often, others assess (with the benefit of hindsight) whether a decision was good or bad based on the consequence—if everything worked out okay then others conclude it was a good decision. Get it wrong, however, and with the benefit of hindsight and knowledge of the circumstances (which the operator probably didn't have at the time), people can be quick to criticise the decisions made and actions taken, as shown in the following case studies.

The Hillsborough Football Ground tragedy

On 15 April 1989, the Hillsborough Football Ground was the scene of the worst tragedy in English sporting history.

Liverpool was playing Nottingham Forest in an FA Cup semi-final. The disaster began as hundreds of Liverpool fans began streaming towards the stadium and the stand allocated to them. With more fans arriving than could be safely filtered through the turnstiles, a bottleneck developed and just before the game kicked off, the police commander-in-charge ordered a gate be opened, thinking that it would alleviate the crowding.[3]

Unfortunately, that decision forced even more people into the already crowded central pens. They were forced up against those in front of them, who in turn were pushed against the perimeter fencing. This resulted in 96 Liverpool fans being crushed to death and 766 people sustaining serious injuries. The inquest later heard that those trapped in the pens were packed so tightly that many died of compressive asphyxia as they stood.

The inquest found several factors had contributed to the incident:

- there was no system on the day to ensure fans were evenly distributed as they entered the pens
- the police match commander was new in his post and had limited experience in policing soccer matches
- the funnel-shaped nature of the area meant that congestion was hard to escape for those at the front, and the turnstiles became difficult to operate, resulting in people starting to become crushed.

The inquest jury ruled that the victims had been unlawfully killed as a result of failures in decision making by police and ambulance services. It found that the police delayed calling a major incident, which also delayed the appropriate emergency response.

There was a lack of coordination, command and control which delayed or prevented appropriate responses.

Inquest findings—Hillsborough Football Ground[3]

A well-intentioned decision by the police match commander to open a gate to ease the crowding had devastating consequences. Consider, however, the unknowns the police were faced with at the time and their intention to solve the congestion problems by opening a gate. At the inquest, the police match commander explained quite eloquently what the police were faced with when he said:

There's 1000 things happening, you're aware of 100 and you can only do something about 10.

Statement by the Police Match Commander at the Inquest[3]

image: Liverpool fans trying to escape during the Hillsborough disaster at Hillsborough football stadium in Sheffield, David Giles | PA Wire

Lindt Café siege

Closer to home, another incident where police were criticised was in their handling of, and response to, the Lindt Café siege on 15 and 16 December 2014. Lone gunman, Man Haron Monis, held 10 customers and eight employees hostage at the Lindt Café in Martin Place, Sydney.

The siege led to a 16-hour standoff, at which point a gunshot was heard from inside the cafe and police from the tactical operations unit stormed the cafe. Tori Johnson (a Lindt Café employee) was killed by Monis, and Katrina Dawson (a customer) was killed when a police bullet ricocheted. Three other hostages and a police officer were injured by police gunfire during the raid.[4]

The response of the NSW Police Force came under heavy scrutiny following the siege. Many were critical of the lack of negotiation and claimed that action should have been taken earlier. NSW Police Commissioner, Mick Fuller, conceded in hindsight, things should have been done differently, but he said the siege was an 'unprecedented event'.

At the inquest following the siege, it was revealed that agencies such as the Australian Federal Police (AFP) and the Australian Security and Intelligence Organisation (ASIO) had a large amount of information to suggest Monis was violent, but only a very small amount of that information made its way to the police commanders.

Had the commanders known that Monis had become radicalised, had criminal charges and had engaged in violent acts in the past, their decision to employ a 'contain and negotiate' tactic rather than a 'deliberate action plan'—storming the café—may have changed earlier.

In the same way that a pilot will make a 'go/no-go' decision, the police had to decide if, and when, to storm the café. However, without the necessary information and wanting to secure a peaceful resolution, commanders decided to take a passive approach and wait.

The inquest identified many deficiencies in the handling of the event, and the lack of preparedness. The NSW State Coroner, Michael Barnes, discussed, amongst other issues, the lack of coordination, communication and information flow and stated, 'a real crisis isn't the time to learn about crisis decision making'.[4]

image: NSW Public Order and Riot Squad Police are seen on Phillip Street in the central business district of Sydney
AAP Image | Dan Himbrechts

Lessons for pilots

These incidents demonstrate how decision making in high-pressure, time-critical situations can very easily result in undesirable outcomes. The key lessons for pilots are:

- when time is critical, breaking things down into chunks (smaller and more manageable pieces) and prioritising what to do next, is a useful coping strategy
- having access to all available information avoids incorrect assumptions
- being fully prepared for each flight means you are less likely to have to make decisions on the run and will be better at anticipating what's coming.

Defining decision making

Put simply, decision making is the act of choosing between alternatives under conditions of uncertainty.[5] We consider the circumstances and reach a judgment, or choose an option or action depending on the situation. It sounds easy, but in an operational environment, we're not just talking about one decision where we can consider the pros and cons at our leisure.

The very nature of flying and the aeronautical environment means that we're subject to a continuous cycle of monitoring and re-evaluating. Decisions may have to be made within a tight timeframe; just when we think we've settled on a course of action, circumstances may require us to review and change it.

There is sometimes no one correct decision, but many decisions with different outcomes. It's our job to use good resource management to make the best decision in the circumstances.[6]

In aviation, decision making is involved in every action a pilot makes before and during a flight, including pre-flight activities, and go/no-go decisions. Every decision will, hopefully, ensure an uneventful, safe flight, but the safety consequences of some poor decisions can be irreversible.

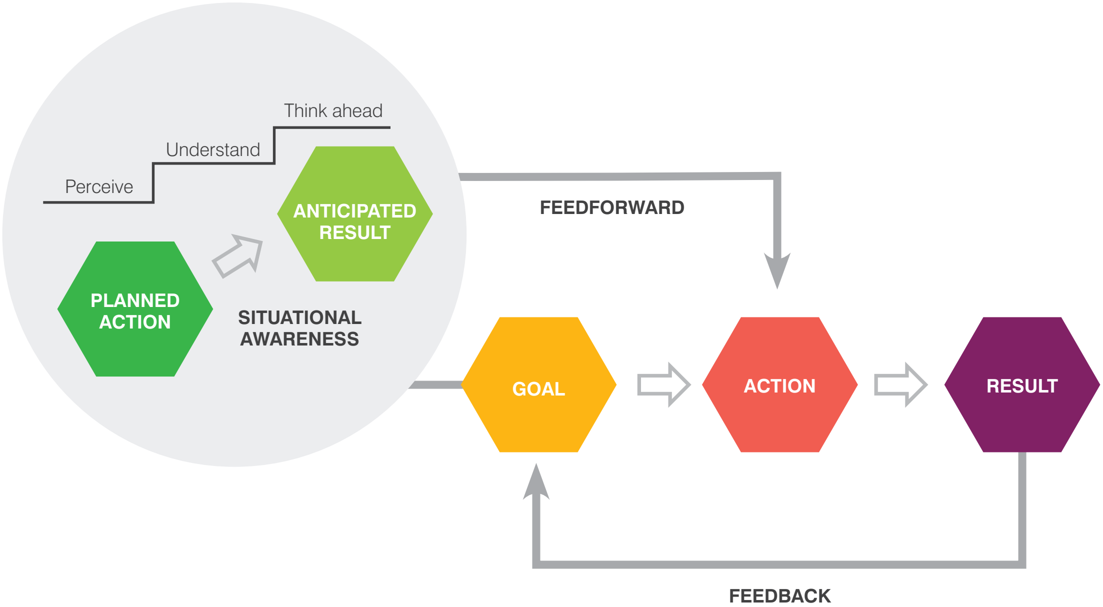
For example, a pilot who loses control while landing in a crosswind, makes a decision to attempt the landing. A non-instrument rated pilot who proceeds with a flight in marginal weather and ends up in instrument meteorological conditions (IMC) decides to firstly, proceed with the flight and secondly, not turn back when the weather indicated visual flight rules were not able to be maintained.

The key for any pilot is to monitor constantly and think ahead, maintaining a high level of situational awareness. To make successful decisions, we need to be aware of all the conditions, consider appropriate options and be able to make a sound evaluation—often under time constraints and stressful situations.[5]

Awareness of all relevant conditions is important for good decision making. If we miss cues or don't understand their relevance and importance, we may end up making an inappropriate decision.

… a successful decision is not necessarily the optimum or most rational decision. It is the decision the operator understands and knows how to apply effectively in the context of the situation.[5]

The following figure illustrates how decision making is directly linked with situational awareness of events. Poor understanding or comprehension of the environmental cues or threats can easily lead to an inappropriate decision.



Naturalistic decision making

There is a wealth of research and data in the finance world which explains the decision-making process and focuses on reaching optimal or perfect solutions. They involve formulas and mathematical equations to choose between options and weigh them against desired goals.

While many of these techniques are sound, they can be quite complex and time consuming, and their application in high-risk, dynamic operational environments such as aviation is problematic.

It was only in the late 1980s, after a series of major accidents in which poor decision making was implicated, that psychologists began to develop decision-making techniques that would be ideally suited to environments such as aviation.

The goal was to understand the way in which aircrew made decisions in the normal operational environment of cockpits and air traffic control towers.[3]

This new approach, called naturalistic decision making, ensured that the context and challenges of the dynamic operational environment such as high risks, uncertainty, shifting goals, inherent time pressures and ambiguous or missing information, were understood and taken into account.[3]

The decision-making process

Decision-making skills are crucial for pilots to enable them to make correct (and indeed, correctable) decisions in a timely manner. The timeframe for making decisions may vary, but the basic information process will be the same. The key components include:

- receiving information
- converting information into reality
- generating options
- analysing options
- deciding
- reviewing decisions/actions.[8]

While pilots make decisions every time they fly, there is limited focus or study on why and how things went *well* in an adverse event. Learning from when things went well is invaluable in helping others understand what happened and gaining insight into problem solving and decision making.

Such lessons have been shared by Richard de Crespigny AM and the flight crew of QF32 following the Qantas A380 engine explosion in flight—the ensuing multiple system failures could have easily resulted in tragedy.

Most of us can only imagine the decision-making process de Crespigny and the flight crew went through on Airbus A380 VH-OQA on flight QF32 from Singapore to Sydney on 4 November 2010.

Just four minutes after take-off, climbing through 7000 feet not long after retracting the slats and flaps, one of the engines suddenly exploded, causing multiple systems to fail. De Crespigny and the other flight crew members were forced to make quick decisions to save the lives of the 469 people on board.[9]

In the language of the official report, the aircraft sustained an uncontained engine rotor failure (UERF) of the number 2 engine, a Rolls-Royce Trent 900. Debris from the UERF hit the aircraft, resulting in significant structural and systems damage.

The flight crew managed the situation and, after completing the required actions for the multitude of system failures, returned to Changi and landed safely.[10]

The Australian Transport Safety Bureau (ATSB) investigation found that several oil feed stub pipes within the high pressure/intermediate pressure (HP/IP) hub assembly were manufactured with thin wall sections that did not conform to the design specifications. These non-conforming pipes were fitted to Trent 900 engines, including the number 2 engine on VH-OQA. The thin wall section significantly reduced the life of the oil feed stub pipe on the engine, leading to the development of a fatigue crack, and ultimately releasing oil during the flight that resulted in an internal oil fire.

That fire led to the separation of the intermediate pressure turbine disc from the drive shaft. The disc accelerated and burst with sufficient force that the engine structure could not contain it, releasing high-energy debris.[10]

The extent of the damage and systems failure was unprecedented, and the incident could easily have led to a catastrophe. As CASA reported in a feature article in *Flight Safety Australia* (QF32 and the Black Swan):

image: Significant structural damage to the number 2 engine | EPA/STR

… shrapnel from the disintegrating engine cut more than 600 wires and left more than 100 impacts in the wing, about 200 impacts on the fuselage and 14 holes in the fuel tanks. The no. 1 and no. 2 AC bus systems failed, the flight controls reverted to alternate law and two other engines, in addition to the destroyed one, went into what the ATSB preliminary investigation called 'degraded mode'. Fuel was streaming from the wing. One of the projectiles that passed straight through the wing was later found to have missed the top of the fuselage by 2 cm.

Interviews with the QF32 flight crew highlighted several lessons for all pilots about decision making under stressful conditions. Two of the most notable were in relation to crew resource management (CRM) and checklists.

Crew resource management

In a fortuitous twist of fate, QF32 had five flight crew on board during the incident, as the captain was undergoing a line check. This meant that there were two other captains on the flight deck: a check captain, Harry Wubben, and a senior check captain, David Evans, who was supervising Wubben. Also on the flight deck were first officer Matt Hicks, and second officer Mark Johnson.[10]

De Crespigny has talked about the virtues of crew resource management (CRM) and the benefit of being able to use all available resources, including consultation with the four other flight crew members and air traffic control. This resulted in a team effort to problem solve, consider options and make executive decisions during the one hour and 44 minutes from the time of the uncontained engine rotor failure to the time they were able to land successfully back at Changi.[12]

image: QF32 crew | Roslan Rahman/AFP/Getty Images

Captain de Crespigny and the crew were faced with an unimaginable situation, as he explained during a Flight Safety Foundation speech:[12]

We had lost 750 wires … We lost 70 systems, spoilers, brakes, flight controls. … Every system in the aircraft was affected … and flight controls were also severely damaged … We were getting pretty close to a [cockpit work] overload situation, working through the checklists, cancelling the alarms … It was hard to work out a list of what had failed. It was getting to be too much to follow. So we inverted our logic. Like Apollo 13, instead of worrying about what failed, we focused on the controls we did have and how we could use those to somehow mitigate the threats and land safely …

Checklists

The crew was faced with an unprecedented number of checklists from the A380's electronic centralised aircraft monitor (ECAM) during the event. Captain de Crespigny estimated that more than 120 appeared while they were attempting to address the issues, and described what it was like in the cockpit.

There was a sea of red lights above us on the overhead panel, and pages of red synoptic displays spewed up failed systems from all over the plane … the ECAM system was becoming overwhelming … We were all in a state of disbelief that this could actually be happening.[12]

So many spurious ECAM alerts were popping up de Crespigny stated he thought the crew was 'chasing a computer problem around when perhaps we should have been flying the aircraft and just landing … ECAM messages kept popping up for 50 min ... The constant racket of ECAM audio alerts was like being in a military stress experiment.'[9]

We were just getting checklist after checklist telling us what was going wrong. It took us an hour to know what all the threats were—then we had to mitigate them.

The flight crew of QF32 have repeated many times that despite the pressure, stress and cockpit warnings, the crew kept at the forefront of their thinking the pilot's number one mantra: 'aviate, navigate, communicate'.[11]

Errors in decision making

While the five flight crew, 24 cabin crew and 440 passengers on QF32 escaped harm, unfortunately others have not been so lucky.

Too often, we read investigation reports where poor decisions have led to poor outcomes. So how does it go wrong? Consider the time constraints, stress and pressure on pilots if a landing has been mishandled. In an instant, the pilot must decide to continue with the landing, or execute a go-around to prevent damage to the aircraft.

Some decisions also have a deadline. For example, there is limited time to make and implement a decision to divert because of adverse weather or fuel shortage.[1]

While we might use a sound process for considering all options, decision making in time-pressured, complex, dynamic work environments such as aviation is subject to pressures and influences that can easily interrupt and impede the decision-making processes such as:

- high stakes with high levels of risk
- inherent organisational pressure, client/passenger expectations, or self-imposed pressure to keep to schedules
- ambiguous problems
- too much or too little information
- uncertainty of situations
- shifting, ill-defined or competing goals
- multiple events happening
- deadlines and time constraints.[6,14]

NASA–Ames Study

A NASA–Ames Research Centre study of errors in aviation decision making found a common pattern in pilots' tactical decision errors was their decision to continue with a flight when conditions suggested it was not appropriate.[8] Examples are, where a pilot, VFR-only endorsed, proceeds despite forecast weather changing and IMC threatening; or where a charter pilot continues with a landing because of pressure from clients, when it would have been more appropriate, and safer, to go around or divert.

Pilots frequently face classic 'go/no-go' decision making because of ambiguous or dynamically changing conditions.

Commercial pilots receive intensive training in how to make such decisions, with regular refresher training in these skills in a simulator.

For a charter pilot, however, without the intensive, practical training in a simulator, it can be very different. They can be faced with a challenging scenario they have not encountered before, or feel pressured to continue a flight despite changing conditions.

Common challenges in decision making

Some of the common challenges which affect pilot decision making include:[3,6,14]

- **Stress:** can promote feelings of inadequacy in handling a given situation and lead to uncertainty as to how to respond appropriately.
- **Time pressure:** can lead to failing to take the facts into account in a given situation and means that one poor decision can lead to another.
- **Fatigue:** particularly at the end of a day, shift or flight, can lead operators to persevere with a chosen course of action or ignore information which could contradict that decision.
- **Changing operational tempo:** flight crews must maintain high vigilance during extended periods of low workload, and yet must be able to make an abrupt transition to demanding, or occasionally overload, conditions.
- **'Get-there-itis'**: if there is company or self-imposed pressure to continue a flight despite changing circumstances such as worsening weather. This is particularly relevant during charter operations when clients are paying for a specific service and expect their requirements to be met.
- **Macho attitude:** an 'it'll be right, I can handle this' attitude, and reluctance to stop, for fear that to do so might reflect badly on the pilot's ability to handle a situation.
- **Licence costs:** the additional cost of an IFR rating on top of a VFR rating, can deter some pilots from advancing to potentially life-saving instrument training. A VFR rating allows pilots to fly only when the weather is good and visibility is clear; it is not sufficient when the weather turns and visibility decreases. Instrument flying does take a lot of skill and it's not the sort of thing you can just pick up and do from time to time.

Pilots need to understand the basic concepts of decision making including, for instance, the influence of employer or client pressure, the desire to get the task done, workload management, work overload and currency.

CASA recognises the importance of good decision-making skills, and pilots need to demonstrate them in flight reviews and proficiency checks, as outlined in CASA Advisory Circular AC 61-08.[16]

Operations versus safety

Most safety-critical organisations face an 'operations versus safety' argument. Unfortunately, too often, operations are prioritised over safety. This can be particularly challenging for charter pilots, who must balance commercial considerations against safety and compliance.

Charter pilots can experience regular pressure from their own organisation, as well as from clients and passengers focused on non-safety issues such as arriving at their required destination by set times or delivering cargo to tight deadlines. These conflicting demands can be very challenging, especially when delayed delivery of cargo can have economic consequences for clients, such as fines, costs for delays, or spoiling of product as in the following example.

A tragic trifecta

Consider this scenario

Put yourself in this pilot's shoes as you read through this true-life scenario. Consider the decisions, conditions and stress that he would have experienced with lack of recency, client demands, delays, an injured passenger and changing weather conditions. Ask yourself at what stage you may have decided that perhaps a 'no-go' or diversion would be better. Unfortunately, this case study, based on a real accident,[15] resulted in multiple fatalities.

- You're a charter pilot, and in the past 12 months you have recorded 515 hours, of which 35 hours were charter flying, most of it short, local, scenic and aerial work flights.
- You are, as far as you know, fit and well with no circumstances that will affect your ability to perform flying duties. However, your family will later report that you appeared unusually anxious about undertaking this flight and had expressed concern about its time frame.
- The charter flight allocated to you is flying live seafood freight from Margaret Bay to Cairns in Queensland in a Cessna 206. You haven't flown to Margaret Bay for some time, but you are familiar with the York Peninsula area.
- You are aware that the client's seafood cargo is valued at approximately $18,000 per flight. You are also aware that the viability of the live seafood is extremely time dependent—it must be delivered before it spoils.
- Apart from flying the seafood, the client from the fishing boat has also asked you to transport an injured deckhand who had severed the tip of his finger on the boat the day before. Although the deckhand does not require urgent medical attention, arrangements have been made to have the severed part of his finger sewn back on—if he gets to hospital within a set time.
- Your charter flight is VFR, as you are a non-instrument-rated pilot. Flights into Margaret Bay where your cargo is waiting are carefully planned to arrive and depart during the two periods each day when tide levels below 1.8 metres permit the use of the beach as a landing area.
- While there are two opportunities that day to use the beach for a landing, the client has said they would prefer the second opportunity. This gives you a very tight margin for a normal turnaround and return flight to Cairns in daylight.
- You and your employer are aware that transporting perishable cargo from a remote beach landing site creates additional hazards to those encountered in normal charter operations. The company addressed the hazards associated with landing and taking off from beaches by firstly, determining tide heights that permit adequate runway width and secondly, by training pilots in additional beach take-off and landing procedures. However, VFR operations increased the possibility of weather or daylight affecting an assured arrival.
- On the morning of the flight you obtain the forecast weather for Cairns which indicates that visual meteorological conditions (VMC) can be expected along the planned route, but with visibility reduced to 2000 metres in isolated areas of drizzle, showers and smoke. You are probably reassured to note that the Cairns terminal area forecast (TAF) issued at 0825 hours forecasts VMC with showers of rain, but no further deterioration until 2000 hours, well after your planned arrival at Cairns during daylight hours.
- You have planned everything carefully and determine that 1500 hours EST is the latest time you can safely depart Margaret Bay for an arrival at Cairns before last light. You are aware of the AIP which states that day VFR flights must not depart from an aerodrome unless the estimated time of arrival (ETA) for the destination or alternate is at least 10 minutes before last light, after allowing for any required holding.
- Later calculations, based on your aircraft performance and forecast winds, gave a planned time interval for your flight from Margaret Bay to Cairns of three hours and 15 minutes.

- Loading of the live seafood into tubs and transfer from the fishing boat to your aircraft takes longer than normal on this day. Witnesses said later that you appeared extremely agitated and visibly distressed about the delay, but you expressed the belief that more favourable winds at a higher altitude might enable you to make up the lost time.
- The pilot of another VFR aircraft on the beach at the same time as you estimates there is inadequate daylight for his return to Cairns with the existing wind conditions and elects to remain overnight. That pilot speaks with you and suggests that you might want to delay your flight and stay overnight as well, but you have made up your mind and elect to return to Cairns.
- Despite your careful plan, with your latest departure time being stated as 1500 hours to arrive at Cairns in daylight, you depart Margaret Beach at 1520 hours due to the delay in the cargo loading. This results in an ETA for Cairns of 1835, which is actually seven minutes after last light.
- At 1719 hours the Cairns controller broadcasts an amended terminal area forecast. This means that to meet the requirements for VFR flight, you will have to arrive and land at Cairns by 1748 hours.
- When you hear the amended terminal area forecast, you probably have a thought that as per your training as a VFR pilot, possibly the better option at this point is to divert to another destination while weather and daylight permit. Weather conditions at Cooktown that afternoon for instance, were reported to be VMC.
- The Cairns terminal area forecast changes—it is no longer for VMC. You request weather conditions and cloud cover reports at nearby locations, perhaps with the intention of diverting.
- You are aware that if you divert along your way, for instance to Cooktown, alternate surface transport arrangements will need to be made for the perishable cargo and that a journey by road will take more than eight hours.
- You are also very aware that the consequences of making a decision to divert will delay treatment to your injured passenger and possibly see expiry of the time frame in which his amputated finger can be reattached. You also know that a diversion may risk the loss of the perishable cargo worth more than $18,000 to the client.
- Shortly after the Cairns terminal area forecast change, you revise your estimate for arrival at Cairns to 1838 hours, which is 10 minutes after last light. Another pilot about 38 nautical miles from Cairns sights the lights of your aircraft at an altitude of 100 feet and in visibility reduced to less than one nautical mile in heavy rain and rapidly approaching darkness.
- At 1824 hours, just four minutes before last light, you contact Cairns approach and report you are 33 nautical miles north of Cairns. You are so close to your destination. After a stressful flight you are undoubtedly already looking ahead to the relief of landing and being back on the ground.
- The Cairns controller asks if you are able to remain in sight of the coast and if you are capable of flight in IMC. You reply that you have the coast in sight, but no, you are not capable of flight in IMC.
- The controller issues you with a clearance to follow the coast not above 1000 feet and remain in VMC. Although you have not declared an emergency, the controller recognises the potential danger and declares an uncertainty phase.
- The radar data shows that from the time your aircraft was identified north of Cairns, you tracked east of the coast at altitudes varying between 200 and 600 feet. Recognising that the situation is becoming perilous, with last light ensuing and rapidly deteriorating weather, the approach controller provides you with cloud and visibility information.
- The controller provides you with distance and ground speed information, offers you radar headings to establish your aircraft clear of terrain, positions your aircraft for an approach and selects lighting to maximum illumination.

- At this point visibility is only 2500 metres in rain showers with scattered stratus cloud at 300 feet and broken cumulus at 1800 feet. Another pilot who lands ahead of you reports that the approach lights were visible at four nautical miles and the runway lights at one nautical mile. Visibility at the time of your approach is estimated to be 1500 metres in heavy rain.
- Finally, relief sets in, no doubt because you're overhead Cairns Airport. But you can't see anything and report you cannot see the runway lights. The controller helps and instructs you to make a left orbit for a second landing attempt.
- The aerodrome controller sees your aircraft descend from 400 feet to 100 feet during the turn and activates the crash alarm because he thinks an accident is imminent.
- Omni-directional runway lighting is selected to aid detection. Your second approach unfortunately is also unsuccessful and again your aircraft is seen to lose altitude while turning left.
- The approach controller then decides not to risk a third landing attempt and directs you to take up a northerly heading, away from obstacles and terrain. In trying to position you to use the approach lighting for guidance to the runway, your flight path takes you over the water off Machans Beach.
- At 1851 hours, on your third attempt to approach and land and while being radar vectored onto a left base leg to runway 15, your aircraft disappears from radar two nautical miles NNE of Cairns.
- Despite the inclement conditions, the Cairns-based search and rescue helicopter and rescue craft from the airport rescue and firefighting service make an air and sea search of the area.
- At 2050 hours, searchers find the body of your passenger and debris in the water near the reported accident site. The following day some personal items and debris from your aircraft are found. Damage to the recovered aircraft parts suggests that the aircraft had hit the water heavily and the accident was not survivable.
- Air, sea and coastal searches continue over the next few days, including the use of airborne electronic detection equipment, but neither you nor the main aircraft wreckage are found.
- On 9th November, three months after the accident, wreckage is sighted approximately four kilometres offshore. Divers recovered parts from the underwater wreckage that were later identified as belonging to your aircraft. However, your body is never recovered.

ATSB INVESTIGATION FINDINGS

The circumstances of this accident revealed an ever-cascading level of challenges for the pilot. Anxiety produced by the delayed departure, deteriorating weather conditions and darkness would have combined to increase the pilot's level of stress. Then there is the added likelihood of fatigue affecting the pilot's cognitive and motor skills due to the mental and physical demands of flying the aircraft, especially in the latter stages of the flight.[15]

In putting yourself in the pilot's shoes and considering issues such as tight time frames, pressure to get the passenger and time-critical cargo to Cairns, delayed take-off time, changed weather forecasts and degraded visual meteorological conditions for instance, let's go back to the question asked at the beginning of the case study—what would you have done?

- Was there a specific stage of this sequence or a certain precipitating event that you could say (hand on heart) you would have thought about and implemented a go/no-go or a diversion?

This pilot undoubtedly had the best of intentions and his motivation would have been geared towards client wants and needs. Nobody turns up for work, whether it be at a mine site, hospital, rail yard or aerodrome with the mindset *today's the day I'm going to screw up!* Most people are trying to do their job diligently, achieve their goal and return home safely to their family at the end of their shift. But changing circumstances in our work environment and the job at hand can lead the best of us down a hazardous path.

The ATSB found that the circumstances of this accident, including high stress levels, fatigue and lack of external visual reference most likely contributed to the pilot experiencing spatial disorientation and subsequent loss of control while manoeuvring the aircraft in darkness and poor weather without adequate visual cues.[15]

It is possible that lack of recent exposure to that type of charter flying and concerns for the injured passenger, as well as the perishable cargo, may have influenced judgment and in-flight decision-making skills displayed by the pilot.

The ATSB investigation concluded the significant factors of the accident were:

1. The pilot departed Margaret Bay later than planned without the certainty that the flight could be completed in the required daylight conditions.
2. The pilot continued flight in weather conditions for which he was not currently qualified.
3. The pilot continued flight in weather conditions for which the aircraft was not adequately equipped.
4. The pilot, after receiving radar navigation assistance, was unable to see the runway lights.
5. The pilot possibly experienced spatial disorientation and loss of control while manoeuvring the aircraft in darkness and poor weather without adequate visual cues.

Decision-making tools/ acronyms

Research to develop tools to help pilots with this important skill recognises that so many decisions in the high-risk aviation operational environment are time critical.

Commercial operators with large, modern aircraft have a distinct advantage when faced with a flight operations decision-making dilemma. These modern aircraft provide a variety of information presentation and alerting systems, and electronic checklists, which not only alert crew to a problem, but also provide guidance in resolving the issue. Such features can often break a complex issue down into something that the flight crew can easily see, understand and resolve.[9,12]

Conversely, many charter operation pilots do not have the luxury of the levels of sophisticated technology available in modern, advanced aircraft—technology which could provide an easy fix and solution.

Many commercial operators use mnemonics (acronyms to help remember a system or process) to aid in their flight crews' decision-making processes. Here are some samples, relevant to single and multi-crew operations across all categories of flight operations.[14]

Table 1 Decision-making mnemonics/ acronyms

DODAR (British Airways)	NMATE (Boeing)
D – Diagnose	**N** – Navigate
O – Options	**M** – Manage
D – Decide	**A** – Alternatives
A – Assign	**T** – Take action
R – Review	**E** – Evaluate
DECIDE (US FAA)	**SAFE**
D – Detect	**S** – State the problem
E – Estimate	**A** – Analyse the problem
C – Choose	**F** – Fix the problem
I – Identify	**E** – Evaluate the result
D – Do	
E – Evaluate	
RAISE	**A – GRADE**
R – Review the problem	**A** – Aviate
A – Analyse	**G** – Gather information
I – Identify solutions	**R** – Review the information
S – Select an option	**A** – Analyse your options
E – Evaluate	**D** – Decide
	E – Evaluate the course of action

These types of tools are useful for pilots because they provide a sequence or process-driven approach to help in decision making. The following example uses the acronym 'A-GRADE'.[13]

Imagine you are a single pilot operating a light twin on an IFR flight and discover that the actual weather at your destination is different to that forecast. Should you divert? Taking the following steps using A-GRADE will help you decide:

- **Aviate.** Your first and most important priority is to fly the aircraft. Don't become so consumed with the problem that you allow your speed to deteriorate, deviate accidentally from course, forget to extend or retract the gear, or neglect your checklists. Above all: Fly the aircraft.
- **Gather all information.** You might study the cloud formations, obtain the TAF/METAR, consider your diversion options, ascertain how much fuel you have remaining, evaluate the height of the terrain in the area, and, if you work for an air operator, consider what the company alternates are. At this stage it is important to use more than one source of information to ensure you gather as much information as possible about your situation.
- **Review the information.** Next, break down all the information you have into two to three manageable chunks, and then ask yourself, 'What else do I need?' For example, you may need to contact ATC to obtain a weather update.
- **Analyse your options.** After reviewing all the relevant information, you can now weigh everything up and consider your options based on fuel, weather, and company requirements.
- **Decide.** The next step is to avoid procrastinating and make your decision. You decide to divert. At this point you must also think about how you are going to implement your decision. What heading do you need? What airspace considerations do you need to take into account? Do you need to switch fuel tanks?
- **Evaluate.** The final, and most frequently forgotten step is to evaluate the wisdom of your decision. Have you forgotten something? What about the NOTAMs If you are operating a twin and at your chosen destination a NOTAMs specifies that the main runway is closed, leaving only a wet grass strip available, this may not be optimal.

Improving decision making

Common traps

If you're aware of the common decision-making traps pilots can fall into, it can help to mitigate errors. Some of these more common traps are:[3,5]

- jumping to assumptions or solutions
- not considering all available options
- not communicating with others
- being reluctant to challenge others
- complacency
- assuming you don't have time
- failing to consult
- failing to evaluate and review.

Tips to improve decision making

The following tips are designed to improve the quality of decision making, mitigate the possibility of errors and ensure a considered approach in resolving issues or problems.[3,5,7,8]

- You cannot improvise a good decision, you must prepare for it. You will make a better and timelier final decision if you have considered all options in advance. This is why good briefings are important.
- Use decision-making aids—operational checklists—to ensure you have not forgotten anything important.
- Always have reserve capacity for reacting to unexpected events.
- Delegate your load to other team members (if multi-crew) when time is critical.
- Keep the big picture in mind rather than focusing on one aspect of a problem.

- Where possible, advise others of your plans before you act. This increases the chances of successful follow through on your decision and ensures people are not caught unaware.
- When time is not so critical, involve others in the decision making. That way everybody is more invested in the decision and therefore are likely to be more motivated to support it.

Key points for professional pilots

Decision making is an important skill in most workplaces, but is often safety-critical in aviation. The difference between a good decision and a poor one can be the difference between a pilot going home safely after a flight and being the subject of an air safety investigation report.

Effective decision making means pilots should follow some basic principles. These are:

- gather all available information
- consider options
- take action, and then to close the loop
- evaluate how effective the decision and actions taken were, as aviation is a dynamic environment—things can change requiring a change of decision.

Key points for charter operators

Charter pilots face many stressors when making decisions. The nature of charter flying means these stressors can arise from many sources: pressure from clients to fly in sometimes marginal conditions, inherent and ongoing pressure to maintain schedules, as well as a range of challenging environmental situations and conditions with which to contend.

If you find yourself in an undesired situation, remember the golden rule: aviate, navigate, communicate. Make considered decisions and remember: as part of normal planning and operations, charter operators should continually reinforce the philosophy that safety is a critical and key priority.

Resources

KEY TERMS

charter operation Carriage of passengers or cargo on non-scheduled operations by the aircraft operator or their employees for hire or reward, but excluding publicly available scheduled services.

crew resource management (CRM) The effective use of all available resources for flight crew personnel to assure a safe and efficient operation, reducing error, avoiding stress and increasing efficiency.

decision making The act of choosing between alternatives under conditions of uncertainty.

go/no-go The decision in relation to the margins a pilot will accept in relation to embarking on a flight and/or continuing with the flight if weather or other conditions deteriorate.

IFR Instrument flight rules. Required for flight in 'non-visual meteorological conditions'. IFR rules and regulations were established to govern flight under conditions in which flight by outside visual reference is not safe (e.g. the weather being so bad, the pilot can't see out the window). IFR flight depends upon flying by reference to instruments in the flight deck, and navigation is accomplished by reference to electronic signals.

IMC Instrument meteorological conditions. An aviation flight category describing weather conditions that require pilots to fly primarily by reference to instruments, and therefore under instrument flight rules (IFR) rather than by outside visual references under visual flight rules (VFR). Typically, this means flying in cloudy or bad weather.

naturalistic decision making (NDM)
A framework which emerged as a means of studying how people make decisions and perform cognitively complex functions in demanding, real-world situations. NDM is particularly relevant to those situations marked by limited time, uncertainty, high stakes, team and organisational constraints, unstable conditions, and varying amounts of experience.

safety-critical industry Those industries which need to possess the highest levels of safety integrity because if errors or breakdowns occur they could lead to catastrophic consequences.

situational awareness The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future. Alternatively, knowing what has happened, what is happening, and what is likely to happen next.

spatial disorientation The inability of a pilot to correctly interpret aircraft attitude, altitude or airspeed in relation to the Earth or other points of reference.

VFR Visual flight rules. These are a set of regulations under which a pilot operates an aircraft in weather conditions generally clear enough to allow the pilot to see where the aircraft is going via visual reference to the ground and by visually avoiding obstructions, terrain and other aircraft.

VMC Visual meteorological conditions. An aviation flight category in which visual flight rules (VFR) flight is permitted as the conditions are such that the pilot has sufficient visibility to fly the aircraft maintaining visual separation from terrain, obstacles and other aircraft.

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