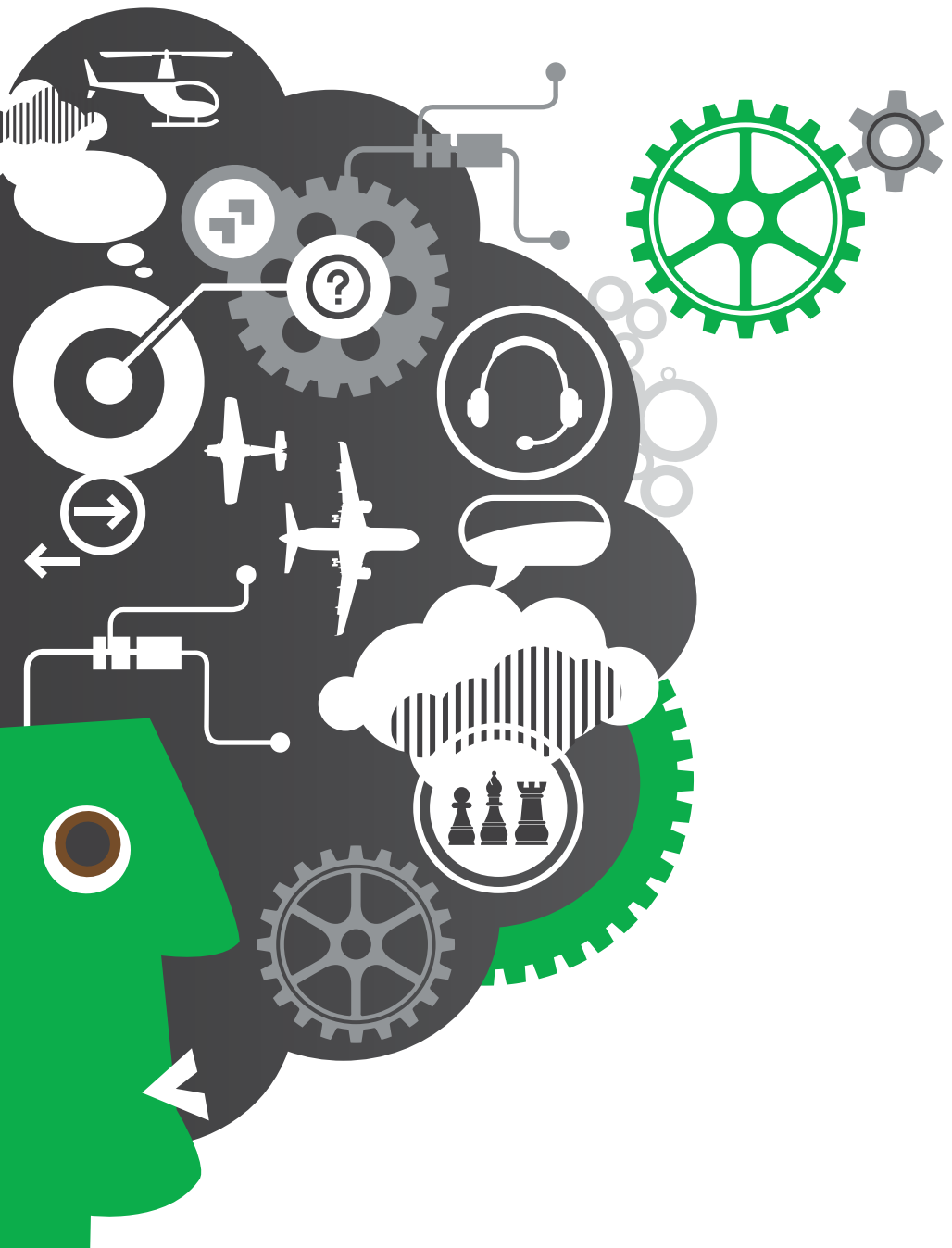
Australian Government
Civil Aviation Safety Authority

Safety behaviours: human factors for pilots 2nd edition

Resource booklet 5 Teamwork



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Effective teamwork is critical in high-risk industries such as aviation. Successful teamwork occurs when every member of a team—on the ground and in the air—performs and contributes in the best way possible to achieve a common goal. Individual performances are not the primary focus—it is the collective performance of the team which matters the most.

An effective team manager recognises that individuals have different strengths and limitations, but ensures, through communication, programs and culture, that the individuals work together in a coordinated manner to achieve team goals. Teamwork can have a major impact on successful operational risk and safety management.

Contents

Introduction 4

High-performance teams 4

Teamwork lessons from sport 6

Teamwork in safety-critical industries 9

Team composition and dynamics 15

Teamwork lessons across industries 21

Improving teamwork 23

Key points for professional pilots 25

Key points for charter operators 25

Resources 25

References 26

The way a team plays as a whole determines its success. You may have the greatest bunch of individual stars in the world, but if they don't play together, the club won't be worth a dime.

Babe Ruth, US baseball star

Introduction

Teams are found in almost every organisation or company. From the shop front to the corporate boardroom, teams are often seen as a means to motivate personnel to achieve common goals and increase productivity.[1]

The goal for any type of team is to be successful and each team's success depends on its members interacting well.

Teamwork is necessary in any industry that requires reliable human performance,[2] though the goals of that teamwork will depend on the context. For instance:

- Aviation depends on individuals coming together to ensure flights operate safely.
- Hospitals need allied health teams to work together to save patients' lives.
- The military uses large teams of people to protect the country.
- Finance professionals need to work as a team to keep the nation's economy running smoothly.
- In sport, a champion team will win over a team of champions, as in the Babe Ruth quote on page 3.

What makes a team?

A team is 'a small number of people with complementary skills who are equally committed to a common purpose, goal and working approach for which they hold themselves mutually accountable'.[3]

Simply gathering a group of people together does not make a team. A team has clearly defined goals and performance objectives for which members are individually and collectively accountable.

A team:

- is trained and mentored in group dynamics and communication
- is strongly interdependent not only for expertise and information, but also for mutual support and assistance
- develops individual and group behaviour norms and enforces them
- has strong commitment both to team and individual member success.

High-performance teams

History shows us examples of amazing high-performance teams and teamwork over the years, with some famous examples on the following pages.

image: © Civil Aviation Safety Authority

Apollo 11 Moon landing

Apollo 11, the first manned mission to land on the Moon, was an amazing example of teamwork on a grand scale.

On 25 May 1961, US President John F. Kennedy said, 'I believe this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to Earth.'

A number of political factors affected Kennedy's decision and the timing of it. In general, Kennedy felt great pressure to have the United States 'catch up to and overtake' the Soviet Union in the space race. In 1957, the Soviet Union launched the Earth's first artificial satellite, *Sputnik-1*. Four years later, on 12 April 1961, cosmonaut Yuri Gagarin became the first human in space, greatly embarrassing the United States who had hoped they would achieve this scientific advancement first.[4]

In 1966, after just five years of work by an international team of scientists and engineers, the National Aeronautics and Space Administration (NASA) conducted the first unmanned Apollo mission, testing the structural integrity of the proposed launch vehicle and spacecraft combination.

Three years later, on 20 July 1969, Kennedy's goal was achieved when Apollo 11 commander, Neil Armstrong, stepped off the lunar module's ladder and onto the Moon's surface.[5]

NASA estimated that it had taken more than 400,000 engineers, scientists and technicians to accomplish the Moon landings, reflecting the vast number of systems and subsystems needed to send humans there.[4]

In 1970, a year after his return from the Moon, Neil Armstrong was asked in an interview his thoughts on what impact the Apollo mission had on mankind. Armstrong replied,[6] 'I believe that the message of Apollo 11 was that in the spirit of Apollo, a free and open spirit, you can attack a very difficult goal and achieve it, if you can all agree and work together to achieve that goal. Anything is possible if you work together as a team.'

image: Astronaut Edwin E. Aldrin during the Apollo 11 extravehicular activity (EVA) on the lunar surface | NASA

Characteristics of high-performance teams

What does it take for a high-performing team to achieve its goals? Different characteristics have been used to describe such teams, with common characteristics including:[4,7,8]

- **Participative leadership**—using a democratic leadership style that involves and engages team members.
- **Effective decision making**—using a blend of rational and intuitive decision-making methods, depending on the nature of the task being undertaken.
- **Open and clear communication**—ensuring that the team mutually constructs shared meaning, using effective communication methods and channels.
- **Valued diversity**—valuing a diversity of experience and background within the team, including a diversity of viewpoints, leading to better decision making and solutions.
- **Mutual trust**—trusting in other team members and trusting in the team as an entity.
- **Managing conflict**—dealing with conflict openly and transparently and not allowing grudges to build up and destroy team morale.
- **Clear goals**—goals that are developed using SMART (specific, measurable, accountable, reasonable and timely) criteria. Each goal must have personal meaning and resonance for each team member, building commitment and engagement.
- **Defined roles and responsibilities**—each team member understands what they must do (and what they must not do) to demonstrate their commitment to the team and support team success.
- **Coordinative relationship**—the bonds between the team members allow them to seamlessly coordinate their work to achieve both efficiency and effectiveness.
- **Positive atmosphere**—an overall team culture must exist that is open, transparent, positive, future-focused and able to deliver success.

Teamwork lessons from sport

What makes a sports team? Is it just a matter of a group of athletes being in the same place at the same time, wearing the same uniform, or being listed in a program as a team member?

Legendary Boston Celtics basketball coach Red Auerbach put it this way. 'Some people believe you win with the five best basketball players, but I found out that you win with the five who fit together best. While talent is definitely important to be successful, the most talented team on paper does not always win the tournament or championship.'

'Talent without teamwork is trouble. I have seen too many teams who had great talent yet were unable to play to their potential because of selfishness, jealousies, conflict and players who were unable to accept their roles. Likewise, I have seen teams with solid but not superior talent, rise to a championship level because of teamwork. Thus, teamwork becomes a sort of "wild card" factor whether you have great or average talent.'[1]

So, for sporting excellence, every team member must consciously be committed to placing the goals of the team first. If team members are more focused on their own aspirations, egos, money and selfishness, the entire team suffers.

Take the following examples of teamwork where the goals of the team were put above individual needs:[1]

2008 Summer Olympic Games

After winning her first Olympic gold medal at the 2004 Olympic Games, Dee Dee Trotter returned in the 2008 Olympic Games hungry for another gold medal in the 4 × 400 metre relay.

However, she was nursing a knee injury, and just as the team was moving from the warm-up area to the track, she decided to withdraw from the event. After asking herself if it would hurt her team's chances of advancing by trying to run when she wasn't at her physical best, she decided that, yes, it would.

'I had to let one of my other teammates run in my place, and she was prepared to do so. It wasn't the easiest decision, but it was the decision I had to make for the team,' she said.

This selfless action allowed Trotter's teammates to record a season-best time and win the gold medal.

New Zealand All Blacks

The All Blacks rugby team is statistically the most successful professional sports team ever. It has won multiple championships in a sport in which teamwork is everything. But back in 2004 things weren't so great. The team was losing games, senior members of the team were threatening to leave, and discipline and putting the team first were at an all-time low.

The team needed a change, and new coach Graham Henry began the rebuilding process. The team's mantra became, 'Better people make better All Blacks.'

It was believed that humility and other core principles would be critical to the team's success. One of the team's foundations and a core value of future success became 'Sweep the shed.'

This principle promoted teamwork, humility and displayed humbleness, with a belief in leaving every locker room better than they found it, whether they were playing a home or away game. This meant that even senior leaders of the team would be required to pick up rubbish or sweep with a broom. It also required that they leave egos at the door and instead live, by example, the team value of humility.[9]

Seven Cs of championship team building

Champion teams often focus on the following seven Cs. But they are as relevant to aviation organisations committed to delivering consistently safe and efficient operations as they are to sports teams.

1. **Common goal.** Championship teams have a single, common focus. The primary, specified, overt goal is to win the championship, and all other goals revolve around it. The goal is firmly embraced by all members of the team, coaching and support staff, and the players understand that their individual goals must fit within the team's goal.

   A common goal for an aviation charter operator is to provide a quality service to its customers without compromising essential safety objectives.

2. **Commitment.** Some seasons may start with the entire team focused on a common goal, but rarely do they end that way. Commitment is probably the single most important factor that differentiates championship teams, coaches, athletes, businesses and even marriages, from the mediocre. It's easy to say you want to win the championship but it's a different matter to put in the blood, sweat and tears needed to pursue it—especially when obstacles and adversity strike.

   Continual commitment to the team's common goal is one of the toughest areas of team building. Champion teams buy into the mission at every level and make it their own. The players and coaches work hard and pay their dues because they want to, not because they have to. The team members also feel a sense of personal and group accountability.

   The players have a clear understanding of how their individual choices and decisions influence the collective psyche and success of the team. There is a sense that if a player is slacking off, they are not just hurting themselves but their entire team. The players feel a sense of responsibility and obligation to give it their best.

   For pilots working in an aviation charter environment, being truly committed to the goal of safety first takes continual effort, as the best intentions can be eroded subtly by self-imposed, customer or external pressures to reach the intended destination on time.

3. **Complementary roles.** Each player is assigned specific positions and responsibilities that help determine the team's success. Individual members are not solely responsible for the team's success or failure, but collectively the roles form a synergistic whole which is greater than the sum of its parts.

   A major difficulty can be that some roles get more attention and praise, making them seem more important. Champion teams realise, however, that everyone is critical to the team's success. Each member willingly accepts their role.

   A successful aviation charter operator will encourage all staff, regardless of their role, to be not only accountable for their own actions but to call out at-risk behaviour when they see it in others. The operator will encourage individuals to praise their co-workers and thus help foster morale and team spirit.

4. **Clear communication.** A fourth characteristic of championship teams is clear communication on and off the field. On-field communication helps the team perform more efficiently and effectively. Off the field, players need to continually monitor the team's effectiveness, modify things when necessary and celebrate successes.

   Communication within an aviation environment does not just involve clear phraseology between pilots and with ATC, but effective communication with others, including refuellers, maintenance personnel, aerodrome operators and customers, to ensure shared goals are understood.

5. **Constructive conflict.** Along with effective communication, champion teams can keep conflict under control. Coaches and players are able to use conflict constructively to further develop and strengthen the team. They make sure that their common goal always takes precedence over any conflict.

   It is important that a clear process for dealing with potential conflict exists within aviation, whether it be from customers or external parties, so that above all else, safety goals are not compromised.

6. **Cohesion.** Members of champion teams genuinely like and respect each other. They like to spend time with each other outside scheduled practice and game times, and often find reasons to socialise. Cohesion is a factor that will often help your team perform at a higher level.

   As any aviation auditor will attest, it doesn't take too long to work out if individuals get along with and respect each other. Often this stems from the example set by the leadership team and the amount of effort that goes into maintaining morale outside business hours.

   Does this have a direct impact on safety? Not necessarily, but it does tend to encourage better communication and willingness to share information more openly. In an emergency, this might mean the difference between an individual knowing what to do and struggling with how best to respond.

7. **Credible coaching.** Finally, it takes a credible coach (or leader) to develop, orchestrate and monitor all the other 'Cs' of championship team building. A coach plays a critical role in helping the team arrive at a common goal, monitoring and maintaining players' commitment, assigning and appreciating roles, communicating with the team, keeping conflict under control, and promoting the team's chemistry and cohesion. The team must have a leader it believes in and who has the skills to get the most from the team. A credible coach creates an effective environment that allows the team to perform to its full potential.

   Any organisation that provides a quality service, produces a product, or achieves desired production goals, will find this difficult without good leadership from the top.

Teamwork in safety-critical industries

In safety-critical industries such as marine, rail and aviation, we're not playing to win grand final trophies and bragging rights—we're 'playing' to produce safe and efficient outcomes. Teamwork, and its relationship to communication, situational awareness, decision making and safety culture, is vital.

Good teamwork is particularly important in reducing error and maintaining safety. There are numerous cases where teamwork failures have contributed to accidents, such as the collision between a fast-attack US Navy nuclear submarine USS *Greeneville* and the Japanese training fishing vessel *Ehime Maru*, where nine people were killed.

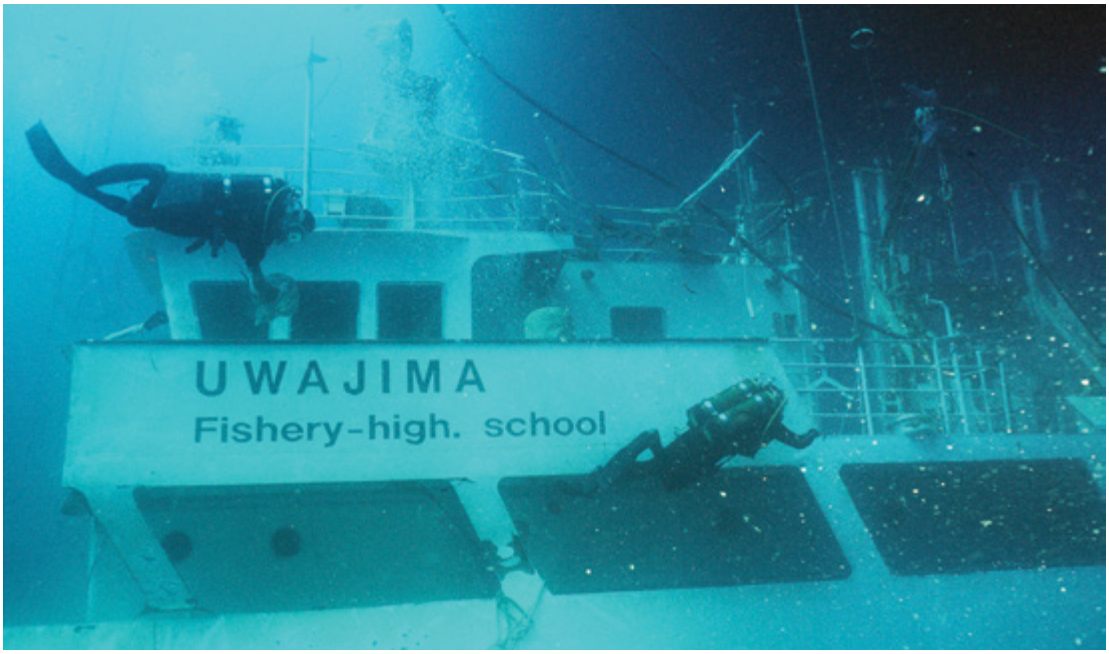


image: Divers examine the wreckage of the *Ehime Maru* | United States Navy photo ID 011105-N-3093M-041

In the course of conducting an emergency main ballast tank blow and ascent, the nuclear submarine came up underneath the *Ehime Maru* in a catastrophic collision that smashed the hapless fishing boat and led to it sinking within 10 minutes. Of the 35 Japanese crew, instructors and students on board the fishing trawler, 26 were rescued and nine (including four high school students) died.[10]

The investigation found that the probable cause of the collision was the commanding officer's overly directive style and a failure in teamwork and communication of key procedural steps.[11]

There were several teamwork failures:

- Because the submarine was behind schedule, the commanding officer rushed his crew. This resulted in the steps recommended for the operation at the time being truncated.
- The commanding officer took over the conn (directing the steering of the submarine) without acknowledging that he was doing so.
- The commanding officer had flawed situational awareness of vessels on the surface and his leadership style and comments discouraged backup from his crew.[12]

Teamwork and coordination in aviation

In aviation, many tasks and operations are team affairs; no single person or organisation can be responsible for the safe outcome of all tasks. However, if someone is not contributing to the team effort, there can be unsafe outcomes.

Examples where crew coordination failed at critical moments and led to serious aviation accidents include:[12]

- A co-pilot, concerned that take-off thrust was not properly set during a departure in a snow storm, failed to get the attention of the captain. The aircraft stalled and crashed into a river.
- A crew, distracted by non-operational communications, failed to complete checklists and crashed on take-off because the flaps were not extended.
- A breakdown in communication between a captain, a co-pilot and air traffic control regarding fuel state led to a crash from fuel exhaustion.

Reviews of high profile accidents in safety-critical industries have found three main teamwork problems:

1. roles not being defined clearly
2. lack of explicit coordination between people
3. miscommunication/communication problems.[12]

Environmental stressors that can also affect team performance in an operational environment include:

- multiple information sources
- incomplete, conflicting information
- rapidly changing, evolving scenarios
- adverse physical conditions
- performance pressure
- time pressure
- high work or information load
- auditory overload or interference.

Crew resource management

The aviation industry realised decades ago that many errors and airline disasters were caused by a lack of open communication in the cockpit rather than technical problems. The US Air Force Inspector General released a paper in 1951, entitled *Poor Teamwork as a Cause of Aircraft Accidents*. The report was based on 7518 accidents and suggested teamwork training programs were required to tackle the problem.

While it took time and unfortunately many more accidents, the aviation industry did indeed introduce teamwork training as part of crew resource management (CRM) programs from the mid-1980s. This is now mandatory for commercial aircrew.[12,13]

CRM applies human factors knowledge and skills to flight operations. Its objective is to use all available resources (equipment, systems and people) efficiently. CRM combines individual skills and human factors knowledge such as communication, situational awareness, problem solving, decision making and teamwork, with effective crew coordination.[14]

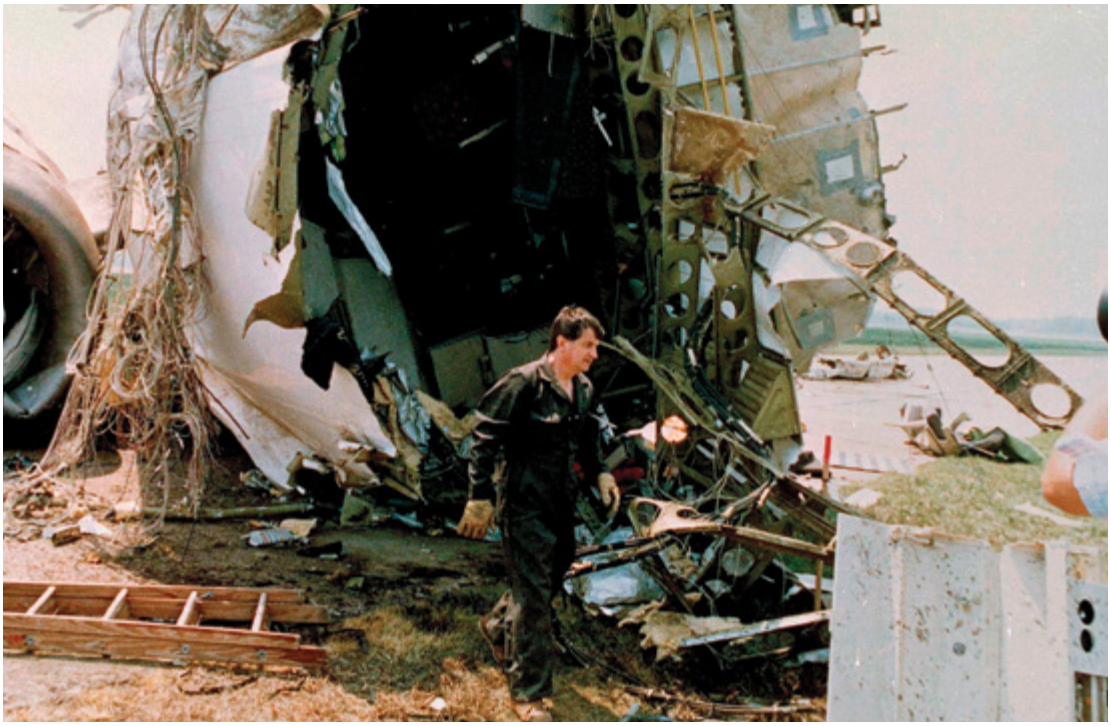


image: Wreckage of United Airlines Flight 232 | AP Photo/Ed Porter

Team members

CRM and teamwork are relevant for both multi-crew and single-pilot operations. There are many sources of assistance for a single pilot; the team can include pilots of other aircraft, air traffic control and even passengers.

This advice is reiterated time and time again by flight crew following high profile accidents. One of the most vocal to this day is Captain Al Haynes, the pilot-in-command of United Airlines Flight 232—a DC-10 which suffered a catastrophic engine failure that cut all hydraulics and crash-landed in Sioux City, Iowa.

Without training or procedures to guide it, the flight crew worked out a way to attempt a landing without conventional flight controls. With 296 crew and passengers on board, the aircraft broke apart and caught fire on landing. While tragically 112 people died, 184 people survived what was considered an unsurvivable event.[15]

In spite of the loss of life, the accident was recognised as validating CRM, because of the many survivors and the way in which the flight crew handled the emergency and landed the DC-10 without conventional controls.

Captain Haynes was determined that the lessons from his experience be shared and has given nearly 2000 speeches since the accident. His main theme and message is the value of CRM and teamwork. Cooperation is one of five key messages in every speech Haynes has given since the accident:

'The five things that I talk about are luck, communication, preparation, execution and teamwork/cooperation. This is not my doing. It was a team effort, so I can't take credit for anything except what the team did.'

Teamwork in single-pilot operations

In relation to CRM and single pilot aircraft, Haynes said:

'I am firmly convinced that CRM played a very important part in our being able to land at Sioux City with any chance of survival. I also believe that its principles apply no matter how many crew members are in the cockpit.

Those who fly single-pilot aircraft sometimes ask, "How does CRM affect me if I fly by myself?" Well, CRM does not imply just to the use of other resources available in the cockpit—it is an "everybody resource". To these pilots I say that there are all sorts of resources available to them (other pilots, air traffic control, flight attendants etc.).

All pilots have a lot of help available to them; all you have to do is ask for it and use it when you get it. The bottom line for pilots is that you have resources available to you. Use them as team members—you are not alone up there.'

The words of Captain Haynes could well have been written for the pilot in the following accident case study.

Wheels-up landing involving Beech 58, VH-UZO

On 8 August 2016, at about 0700 Central Standard Time (CST), a Beech 58 aircraft, registered VH-UZO, departed Gove Airport, Northern Territory, for a charter flight to Elcho Island Airport. On board were a pilot and four passengers.[17]

During the initial climb, the pilot selected the landing gear up and noted the landing gear motor stopped after a shorter time interval than expected. The pilot also observed that the landing gear unsafe light remained illuminated.

The pilot returned the aircraft to hold overhead Gove Airport, while he attempted to ascertain the reason for the landing gear malfunction.

The pilot noted that the circuit breaker for the landing gear had tripped, so he reset it and selected the landing gear down. The landing gear unsafe light remained illuminated and the circuit breaker tripped again.

The pilot conducted the emergency landing gear extension procedure; however, the landing gear remained retracted. Over the next two hours, the pilot tried various methods, along with multiple attempts of the emergency landing gear extension procedure.

At about 0945, the pilot conducted a wheels-up landing. No-one was injured; however, the aircraft was substantially damaged in the accident.

Engineering report A post-accident examination of the landing gear system found that the gear box shaft bearing had fractured. This bearing secures and aligns the shaft worm drive, which attaches both the emergency handle mechanism and the electric motor to the gear box.

Failure of the bearing allowed the shaft worm drive to disconnect from the gearing. The drive became jammed, causing further damage to the gear box. Damage to the gear box prevented normal operation and caused the electric motor to overload and trip the circuit breaker. The bearing failure also prevented the emergency handle from connecting to the gear box.

CRM application and lessons There were many positive findings about the application of CRM in this investigation, including decision making, communication, workload management, problem solving, planning, reviewing procedures and multiple instances of teamwork. For example:

- During the initial climb, when the pilot selected the landing gear up, he obtained additional information from the passengers, who told him they had heard a ‘crunching sound’.
- Rather than continue the flight to Elcho Island, the pilot made a sound decision to return the aircraft to hold overhead Gove Airport while he attempted to ascertain the reason for the landing gear malfunction.
- The pilot then sought assistance from personnel on the ground and contacted the aerodrome reporting officer (ARO), requesting a visual confirmation of the position of the landing gear. The ARO reported that all landing gear appeared to be fully retracted.
- The pilot held the aircraft to the north of Gove Airport and engaged the autopilot so he could reduce his workload and focus on problem solving.
- Given that normal landing gear extension had been unsuccessful, the pilot followed procedures and elected to do an emergency landing gear extension.

Wheels-up landing involving Beech 58, VH-UZO cont.

- The Beech 58's emergency landing gear extension requires the pilot to engage a handle into the landing gear gearbox positioned behind the front seats. The handle is then turned counterclockwise to lower the landing gear manually. Fully extending the landing gear takes about 50 turns of the handle.
- As the emergency landing gear extension was attempted several times and required considerable effort, the pilot asked passengers to help wind the emergency landing gear handle.
- The pilot calculated that he had sufficient fuel to continue to hold for 2 hours 15 minutes. While holding, the pilot contacted the company chief pilot and engineer to assist with further troubleshooting.
- To assist in troubleshooting the malfunction and to ensure clarity, the pilot had the presence of mind to send the engineer multiple videos of his actions and the indications the aircraft systems presented.
- The engineer examined the aircraft wiring diagram and another Beech 58 parked at the airport. The engineer then described several methods to isolate various parts of the electrical system to identify any problem which prevented the landing gear from extending.
- Over the next two hours, the pilot tried these methods along with multiple attempts of the emergency landing gear extension procedure.
- At about 0930, the pilot prepared for a wheels-up landing. He briefed the passengers on the use of seatbelts, brace position, emergency exit locations and actions to be taken after the landing.
- The aerodrome reporting officer (ARO) arranged for emergency services to be in attendance.
- The pilot discussed with the chief pilot whether to land on the runway or adjacent dirt. As the runway provided a hard, smooth surface of known condition, the pilot elected to land on the runway. The chief pilot then briefed the emergency services on the intended actions of the pilot.
- The passenger in the seat next to the pilot held the pilot operating handbook (POH) for the pilot, who reviewed the wheels-up landing procedure in the handbook and elected to conduct a flaps-up landing to minimise damage.
- The pilot prepared the passengers for the wheels-up landing and directed them on what to do as soon as the aircraft was on the ground.

Safety lessons

The ATSB stated:

Even though the operation was conducted single-pilot, this accident provides a good example of effective crew resource management techniques. The pilot quickly established that the available fuel endurance allowed ample time to consider the circumstances carefully and attempt to resolve the issue.

The pilot engaged company personnel, using multiple means, to provide as much information as possible and attempt to identify a solution to the malfunction. The pilot also sought the assistance of the ARO to inspect the aircraft and to alert emergency services.

Holding over an easily identifiable position, and using the passengers where appropriate to assist with management of the emergency, also reduced pilot workload. The pilot also prepared the passengers for the wheels-up landing—this minimised the risk of injury and ensured the evacuation was controlled and orderly.

Team composition and dynamics

A team involves people with different expertise who cooperate on a task, but there must be a hierarchy or command structure. If nobody is ultimately in charge, then decisions may be delayed or operational priorities mismanaged.

In aviation, the pilot in command (PIC) or captain on the flight deck is responsible for major strategic and tactical decisions and has ultimate responsibility for decision making and the overall safety of the flight regardless of whether they are the pilot flying (PF). The first officer and other crew members must have the ability and confidence to question and challenge the captain when appropriate.

Leadership

As with any other team, members of a flight crew need to understand each other's roles, practise communication protocols and be well-trained in teamwork competencies.

The PIC is leader of the team, and their ideas and actions can influence the thoughts and the behaviours of others, resulting in followership, a process in which followers (people in subordinate positions) engage in constructively critical thinking, and interact with, and support, the leader to help achieve a task.

The International Civil Aviation Organization (ICAO) defines leadership in the context of influence, and explains how the leader should recognise the desires of the crew, set an example and use persuasion to create an understanding of goals that need to be met.

ICAO stresses that leadership and followership skills can be learned and says that leadership training is essential for all crew members, since even junior employees may be called to perform leadership duties at different times.[7,13]

While leadership and followership skills can be learnt, and the skills are similar, the follower should not attempt to undermine the leader. One upmanship would be a classic case of inappropriate behaviour for both leader and follower.[19]

Leadership and followership complement the skills and attributes of airmanship, which Tony Kern proposed was an unofficial hierarchy and separate professional identity[20]:

'Airmanship is the consistent use of good judgment and well-developed skills to accomplish flight objectives. This consistency is founded on a cornerstone of uncompromising flight discipline and is developed through systematic skill acquisition and proficiency. A high state of situational awareness completes the airmanship picture and is obtained through knowledge of one's self, aircraft, environment, team and risk.'

Aviation safety leadership

Aviation safety leadership focuses on driving quality interactions, such as:

- setting an example of a good safety mindset and actions
- encouraging good relations between management and employees
- inspiring positive behaviours
- setting clear expectations about acceptable and unacceptable actions.

A good example of leadership was exemplified by Captain Chesley 'Sully' Sullenberger when US Airways Flight 1549 struck a flock of geese and lost all engine power after take-off from La Guardia Airport in 2009. Captain Sullenberger and First Officer Jeffrey Skiles successfully glided the plane to a ditching on the Hudson River. All 155 on board were rescued.

After the double engine failure, Captain Sullenberger quickly assumed control of the aircraft and radios so that the first officer could concentrate on the checklist for an engine restart. This allowed Sullenberger to put the aircraft exactly where he wanted it and allowed the first officer to concentrate uninterrupted on an important checklist.

The captain also knew that the first officer was new on type so would know the checklist location more quickly than he did. He deferred to the first officer's recent experience from training.

Leadership is not just relevant for large commercial operations. The principles are just as essential in smaller charter operations, including single-pilot ones, because a single pilot needs to show leadership when dealing with people outside the cockpit. It may involve dealing with bad behaviour by passengers, refusing an air traffic control request, or protecting the safety interests of the flight if there is a conflict with commercial interests.[21]

How would you handle these scenarios?

- **Scenario 1** You are a pilot who has just joined an established charter company in a first officer position. You're paired with a captain who has thousands of hours experience compared to your hundreds of hours.
  The captain has been working for the company for close to a decade and has flown every route hundreds of times and knows every aircraft like the back of his hand. All the staff love him and defer to him as the 'the gun'—their most experienced captain and most valued asset in the company. He's also the best mate of the owner of the company. On your first rostered flight together, the captain shares a few jokes as he does a very cursory pre-flight inspection and walk around, then tells you to sit back, relax and watch the expert at work. You're not happy with how he inspected the aircraft and the captain is about to invite passengers to board for the flight. What would you do?

image: US Airways Flight 1549 on the Hudson River, Reuters / Brendan McDermid | stock.adobe.com

- **Scenario 2** As a single pilot for a charter operator, you've been rostered on to transport a newly married couple from their wedding reception to the local airport, where they have a tight connection for another flight to commence their island honeymoon. The bride's father is the local police station sergeant and known to be a bit of a domineering, gruff man. The couple emerge from the reception followed by an entourage carrying many heavy bags. It is immediately obvious to you that with all the baggage, you will be overweight. You raise your concerns and a heated argument ensues with both the groom and bride's father, aggressively demanding you 'just do your bloody job and load the baggage' so they can be on their way. How would you use skills such as conflict resolution, assertiveness, tact and diplomacy, learnt during single pilot CRM training to resolve this situation?

Operators may wish to refer to the non-technical competencies in the Part 61 Manual of Standards (MOS) Schedule 2.

Authority gradient

The term 'trans-cockpit authority gradient' refers to the established, and/or perceived, command and decision-making power hierarchy in a team, crew or group, and how balanced this power is. The authority gradient can have a negative effect on communication and coordination, which in turn can adversely affect safety.[13,19]

One of the early aims of CRM programs was to reduce authority gradients. The idea was to encourage first officers and other crew members to speak up (be assertive), and to encourage captains to be more inclusive and exercise joint decision-making where possible.

In essence, CRM aims to make the flight deck more democratic, given the numerous aircraft accidents (such as those below) where crew members with critical information that could have prevented the accident either did not speak up, or were ignored by the captain.[18,22]

These accidents include:

- **1977** The first officer and flight engineer aboard a KLM B-747 departing Tenerife knew that take-off clearance had not been given yet were unable to communicate their concerns to the captain, resulting in 583 fatalities.
- **1978** A United Airlines DC-8 crashed due to fuel exhaustion near Portland partly because the first officer and flight engineer did not effectively convey information to the captain about the rapidly diminishing fuel state.
- **1982** The first officer on an Air Florida B-737 was unable to communicate to the captain a concern over inadequate acceleration effectively, resulting in the aircraft crashing into the 14th Street Bridge spanning the Potomac River in Washington, DC.
- **1989** British Midlands cabin crew members did not question a captain's statement about which engine was shut down on a B-737 experiencing an engine fire, resulting in complete loss of power and a crash short of the runway.
- **1995** A Northwest DC-10 landed at Brussels instead of Frankfurt by mistake, even though the cabin crew members knew that the aircraft was heading to the wrong destination.

As commercial aviation rapidly expanded in the 1960s, 70s and 80s and often took on military-trained pilots, the captain's authority in the cockpit was seen as sacrosanct. Junior crew members would often fear questioning the actions and decisions of captains, some of whom had distinguished themselves as fighter pilots.

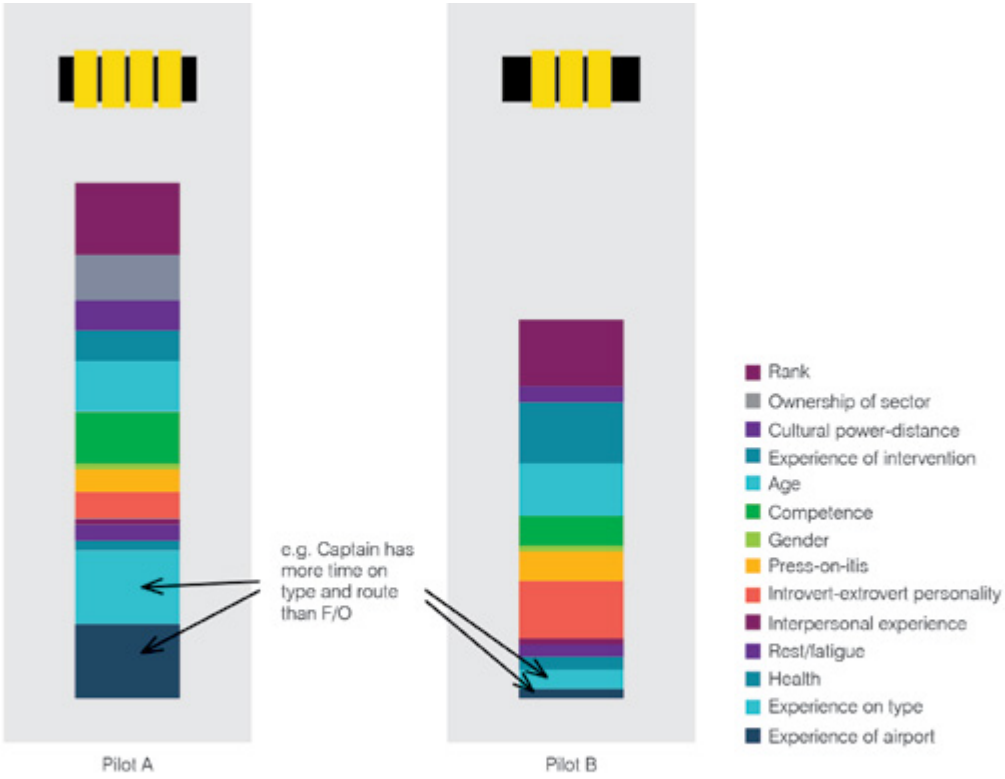
Criticism could come from the top down, but almost never from the bottom up.[18] This situation has certainly not been exclusive to aviation. There were often problems with the following authority gradients:

- A steep authority gradient, in which an overbearing or dictatorial instructor is paired with a fairly inexperienced student. The lower ranking or junior team member may be prevented from questioning their seniors, even if they think that something is unsafe or they don't understand. Teamwork will be basically non-existent.

- An inverse steep authority gradient may exist when, for example, an instructor does not properly exercise their role as pilot in command (PIC). This may have been the case in a fatal accident in New Zealand in 2014, where a UK ATPL holder, seeking an NZ commercial licence, was flying as a student. His instructor had just over 552 hours as PIC, including 137.5 as an instructor, compared with his student's 5461 hours as an RAF and corporate jet PIC.[23]
- A flat authority gradient is produced when both crew members have equal proficiency. If one makes a mistake, the other may be slower to point it out because they don't wish to cause offence.[21]

There can also be a range of other factors at play in authority gradient such as experience and skill level, fatigue and health issues, cultural factors and personality, as can be seen in the diagram below.[24]

The following two examples on page 19 show how steep authority gradients led to adverse outcomes.



Real world: steeper cross-cockpit authority gradient. Many factors involved, which are harder to overcome by CRM training and other emphasis on SOP instruction to intervene.

Train guard fails to take action

- At 0714 on 31 January 2003, a four-car outer suburban Tangara passenger train, designated G7, travelling from Sydney Central railway station to Port Kembla, left the track at high speed and overturned approximately 1.9 km south of Waterfall railway station in Sydney's south. The driver and six passengers were killed. The train's guard and the remaining 41 passengers suffered minor to severe injuries.
- While an autopsy found that the driver suffered an incapacitating heart attack at the controls, the investigation also found that the guard failed to take any action, including using the emergency braking system, to stop the train.
- Human factors investigators identified that the guard's failure to act in a timely manner was partly due to a recognised steep authority gradient between drivers and guards. Many guards testified that there was a general reluctance to question the actions of the driver for fear of reprisal.[25]

The State Rail Authority of NSW failed to regularly refresh or reinforce procedures for train guards on what action to take in the event of an out-of-control train. Neither drivers nor guards received any initial or refresher rail resource management (CRM equivalent) training such as critical communication, situational awareness and team decision making to better manage authority gradient issues.

image: The Waterfall rail accident scene | Dallas Kilponen/ Fairfax Syndication

First officer's question dismissed

A relatively inexperienced first officer on a cargo flight in the US did not press her concerns about continuing an unstable approach, in the belief that her very experienced captain knew what he was doing.

- When a flap problem was experienced by the crew of an ATR 42-320 on approach to Lubbock, Texas, on 27 January 2009, the first officer was aware that both crew members should have called for a go-around or referenced the quick reference handbook procedure for addressing flap anomalies. The captain, without discussing any plan of action with the first officer, instead began a non-standard response to try to troubleshoot the problem while the first officer continued to fly the approach.
- Neither pilot adequately monitored the airspeed. However, the aural stall warning and the stick shaker activated 'multiple times', another criterion for performing a go-around manoeuvre. The first officer finally asked the captain if she should perform a go-around, but he dismissed her request.
- When the aircraft reached 700 ft, the captain took the controls and continued the unstabilised approach. The stick shaker continued to activate; at 500 ft AGL, just below the clouds and descending at 2050 feet per minute, the terrain awareness and warning system (TAWS) generated a 'pull-up' warning. Procedures for responding to either the stick shaker or the TAWS warning require the immediate application of maximum engine power. This was not done, and the aircraft crashed short of the runway.
- The captain was seriously injured, and the first officer received minor injuries in the crash, which substantially damaged the aircraft. The first officer told investigators that when the captain told her not to perform a go-around, she 'felt that he had a good reason for not wanting to go-around and that she trusted that he was making the right decisions'. After the captain took control, the first officer stated that she was still concerned and that she should have called again for a go-around manoeuvre, but ultimately could not give a reason why she did not do so.
- The investigation characterised the first officer's failure to speak up as result of the 'steep authority gradient in the cockpit'. The captain had 13,935 flight hours, extensive experience in flight at that location and those specific conditions and was referred to by his colleagues as a 'guru', while the first officer had 2109 flight hours and very limited experience at that location and in those specific conditions.

Teamwork lessons across industries

In safety-critical environments we are faced with the added factors of high-risk, time-critical and high-stress operational environments. When a safety-critical system or operation fails, the result could well be death or serious injury. The aviation industry is well aware of this and we have seen great advances in safety initiatives, so much so, that other industries have made concerted efforts to apply the same lessons.[26] The successful application of CRM in aviation, for example, has been recognised and equivalent training methods are now widely applied in a range of other high-risk industries including rail, emergency services, maritime and medicine.

The medical industry is a good example. It has sought to emulate aviation advances and learn the benefits of checklists, sterile cockpit principles and programs like CRM, formalised safety management systems (SMS) and safety culture enhancements.

Life and death decisions

Comparisons have often been made between safety management in aviation and healthcare; and between the roles of pilots and doctors. Both professions sometimes have to make life-and-death decisions in seconds, and both can involve hours of boredom (passively monitoring for instance) punctuated by moments of high stress and workload during emergencies.[2,26]

Nearly two decades ago, Professor Bob Helmreich from the University of Texas was instrumental in introducing lessons from aviation into healthcare.

An obvious, but astute difference Professor Helmreich made between the two industries in 2000 is the transparency and visibility of adverse events:[2]

- Commercial aircraft accidents are infrequent, highly visible, and often involve massive loss of life, resulting in exhaustive investigation into causal factors, public reports and remedial action. Research by the National Aeronautics and Space Administration (NASA) into aviation accidents at the time found that 70 per cent involved human error.
- By contrast, adverse medical events happen to individual patients and seldom receive national publicity. More importantly, there is no standardised method of investigation, documentation and dissemination. The US Institute of Medicine estimates that each year between 44,000 and 98,000 people die as a result of medical errors in the US alone.
- Nearly 20 years later, it is reassuring that aviation safety has continued to improve. The number of worldwide commercial flight hours has doubled in the past 20 years, yet the number of fatalities has halved. Compare this with healthcare, where preventable deaths have doubled, with an estimated 200,000 every year in the USA.[26] This is the equivalent of almost three fatal commercial airline accidents every day.

When 'Miracle on the Hudson' pilot Captain Chesley Sullenberger noted the comparison and became aware of the number of deaths in the medical industry, he stated:

'If such a level of fatalities was to happen in aviation, airlines would stop flying, airports would close, there would be congressional hearings and there would be a presidential commission. No-one would be allowed to fly until the problem had been solved.'

While other industries have learnt from aviation, there are undoubtedly things which aviation can learn from other industries. Consider how the examples below might apply to aviation teamwork, roles, communication and even hangar layout.

A Formula One (F1) race can be won or lost in the pits. Every millisecond counts when a driver hurtles in for new tyres or a repair, with each highly trained mechanic performing a precise role in super-quick time. While most of the time the techniques and processes work well, when it goes wrong the potential for disaster reminds us how high-risk the operation can be.[27]

One of the most dramatic incidents at a pit stop in F1 racing occurred to Jos Verstappen and his Benetton team at the 1994 German Grand Prix when the fuel hose sprayed fuel over everyone in the pit after refuelling. The fuel rapidly ignited and engulfed Verstappen and his pit crew in flames.[28]

image: The Fire in the Benetton Pit at the German Grand Prix, Reuters / Joachim Herrmann |stock.adobe.com

From Formula One to neonatal resuscitation

In 2016, a neonatal resuscitation team at the University Hospital in Cardiff, Wales, considered the parallels between resuscitating newborn babies and F1 racing. It asked the Williams F1 team for help in streamlining roles and procedures and improving teamwork and operational efficiency to help babies like Otis Bowie Earls, who was born three-and-a-half-months prematurely and had to be resuscitated.[29]

image: Premature baby / ondrooo | stock.adobe.com

F1 pit stops and hospital emergencies both require a team to work seamlessly in a time-critical and space-limited environment. Williams has a dedicated human performance specialist who works with its pit crew to fine tune the technique, processes, teamwork, and the health and fitness of team members.

The medical staff at the University Hospital noticed how their work in many ways mirrored that of pit-stop mechanics, where time is crucial to the outcome. The hospital asked the team to show them how they could boost the speed and efficiency of essential aspects of their work to save vital seconds which could mean the difference between life and death for a struggling newborn.

Keen to assist, the Williams team helped hospital staff make improvements in three key areas.[27,29]

Firstly, they made changes to the resuscitation equipment trolley, improving the layout of important equipment and removing any tools that weren't absolutely necessary for the task in hand to ensure that equipment could be located as quickly as possible.

Navigating tight spaces was also a key factor for the hospital staff. The Williams team suggested marking maps on the floor so that staff could work together more efficiently. The neonatal team now has a standardised floor space in delivery theatres to clearly show the area for the neonatal resuscitation team to work in; copying the customised floor map the Williams team takes to races to map out the specific pit box requirements at each track.

Finally, the F1 team offered tips on team dynamics to ensure everyone knew their precise role and was able to communicate clearly and effectively during an emergency procedure. Based on F1 communications and analysis techniques, the hospital team implemented the use of a 'radio-check' before resuscitation, greater use of hand signals rather than verbal communication, and video analysis to look at team performance during a resuscitation, with debrief meetings as standard. Medical staff have also started to use head-based GoPro cameras for debriefs and training scenarios.

Improving teamwork

Teamwork skills

Teamwork and coordination are important in most aviation operations, and there may be considerable risks to safety if they break down. Characteristics of good teamwork include leadership, followership, effective communication, trust building, motivation and praise giving.[7]

The following issues should be discussed, clarified, agreed and understood by all team members:[30]

- a clearly defined and maintained aim or goal(s)
- each team member's roles and responsibilities
- communication messages and methods
- limitations and boundaries
- emergency procedures
- individual expectations and concerns
- what defines a successful outcome?
- debriefing arrangements
- team dismissal arrangements
- opportunities for questions and clarification.

A team's effectiveness can also be improved by selecting members with a broad range of experience and skill sets, and through practice and rehearsal.

Research has identified a set of eight major teamwork skills that are beneficial for all team members:[3,7,14]

- adaptability
- communication
- coordination
- decision making
- interpersonal relations
- leadership/team management
- performance monitoring/feedback
- shared situational awareness.

Acknowledging the whole team

Apart from teamwork skills, training and competencies, one of the biggest determinants of successful and sustained teamwork is the motivation of the crew or team. This can be targeted by ensuring the efforts of all are acknowledged and they feel valued.

It is important that when the 'face' of a team has a success, there is also acknowledgement of those who supported the team behind the scenes, not just those who are highly visible.

A great example of this was observed with Apollo 11—the first manned mission to land on the Moon. That major event back on 20 June 1969 is generally associated with the names Neil Armstrong and Buzz Aldrin, even though the crew actually had three crew members.

While Armstrong, the mission commander, and Aldrin, the lunar module pilot, descended to the surface of the Moon, Michael Collins, the command module pilot stayed in orbit.[31]

Armstrong and Aldrin would forever be known as the first men to walk on the Moon, but at every opportunity the astronauts called the world's attention to the efforts of Collins, as well as their many teammates back on Earth. The Apollo 11 team included hundreds of thousands of people led by program and project managers at the National Aeronautics and Space Administration (NASA).

On 26 July 1969, their last night in space, Armstrong made a special television broadcast acknowledging the efforts of the entire team:[32]

'We would like to give special thanks to all those Americans who built the spacecraft; who did the construction, design, the tests, and put their hearts and all their abilities into those craft. To those people tonight, we give a special thank you.'

Don't ever underestimate the value of acknowledging successful teamwork and ensuring all people feel part of the team.

image: The Three crew members of Apollo 11 in 1969 | NASA

Key points for professional pilots

Crew coordination and effective teamwork are as important for flight safety as technical proficiency. The ability to share problem solving, workload and decision making can reduce and mitigate potential errors.

Teamwork also leads to greater efficiency because it uses existing resources in a structured way, improving in-flight management. Regardless of your role or experience level, as a professional pilot, you need to embrace the key principles of teamwork as a key risk management strategy.

Key points for charter operators

Teamwork applies equally to multi-crew and single-pilot operations. A sole pilot has access to many resources which should be used if the situation calls for it.

Charter operators should ensure that there are regular opportunities to reinforce teamwork through team debriefings, discussion of lessons learnt from incidents, and ensuring that geographically isolated team members come together on occasion to share successes and opportunities for improvement.

Resources

KEY TERMS

authority gradient or cockpit gradient Refers to the established, and/or perceived, command and decision-making power hierarchy in a team, crew or group situation, as well as how balanced the distribution of this power is experienced within the team, crew or group.

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 coordination The interaction of crew members necessary for the safe, efficient and effective performance of tasks.

crew resource management (CRM) The application of human factors knowledge and skills to the conduct of flight operations with the objective of using all available resources (equipment, systems and people) efficiently to achieve safe flight operations.

followership A process where followers (people in subordinate positions to those in senior ones) engage in constructively critical thinking and interact with, and support, the leader to help achieve a task.

high-performance teams Teams that are highly focused on their goals and achieve superior results.

leader A person in a position who recognises the desires of the team or crew, sets an example and uses persuasion to create an understanding of goals that need to be met.

leadership The act of influencing and possibly changing the thoughts and the behaviour of others through ideas, actions, examples and persuasion.

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.

team A small number of people with complementary skills who are equally committed to a common purpose, goal and working approach for which they hold themselves mutually accountable.

teamwork A dynamic process involving two or more professionals with complementary background and skills contributing in the most effective way to the overall tasks and goals of the team.

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