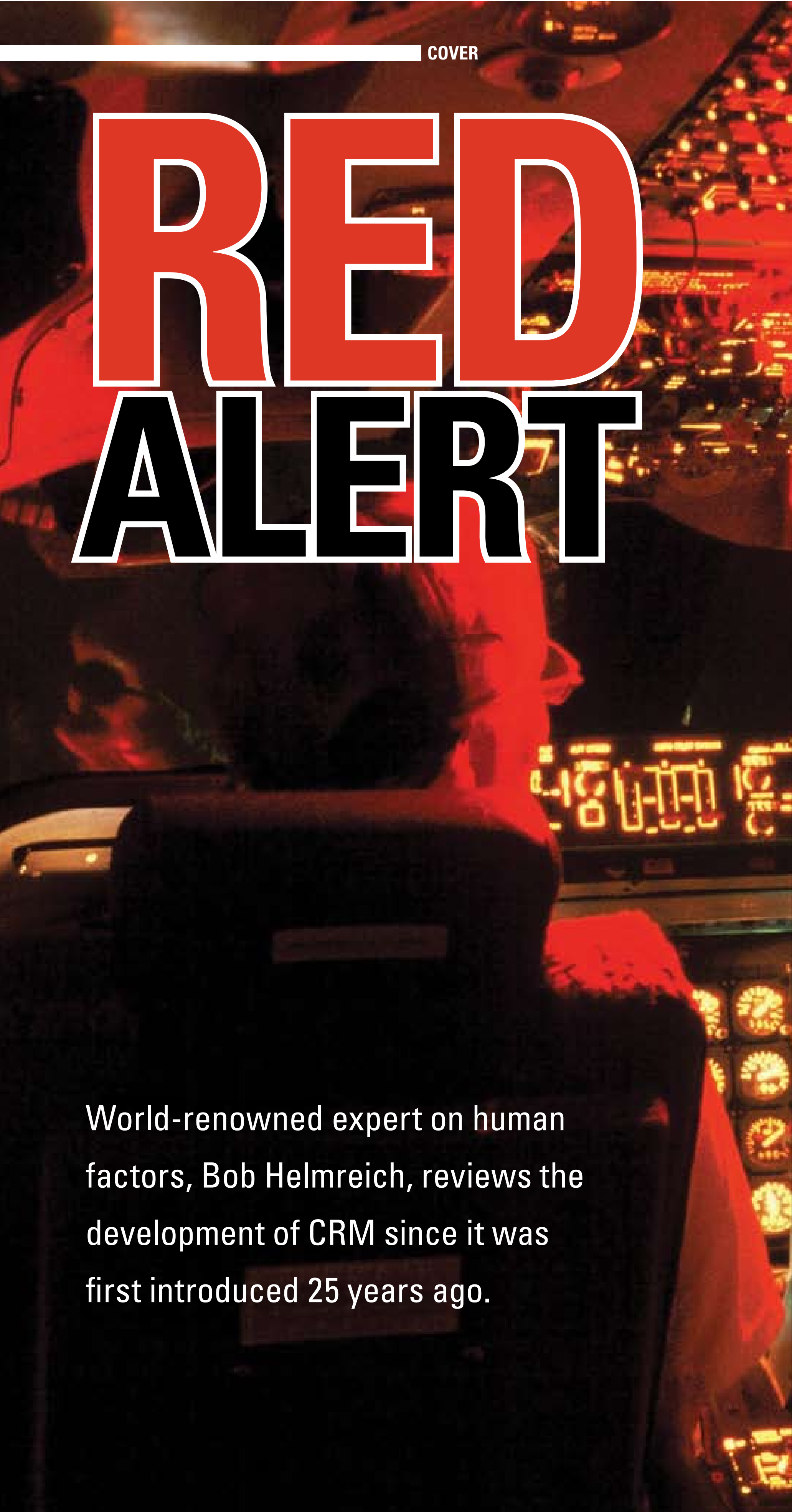


RED ALERT

World-renowned expert on human factors, Bob Helmreich, reviews the development of CRM since it was first introduced 25 years ago.

Human error has been a concern since the dawn of aviation, and various forms of training to reduce its impact have long been a focus in military aviation. But it was not until the early 1980s that research on the causes of aviation accidents led to the introduction of structured crew resource management training in the civil aviation sector.

The "red alert" on human error in civil operations was first sounded in 1979 when NASA convened a conference, "Resource management on the flight deck", to discuss work at NASA Ames Research Centre on commercial airline crashes. This research found that more than 60 US jet transport accidents between 1968 and 1976 involved failures in decision making, leadership, pilot judgment, communication and crew coordination.

Among those accidents singled out at the 1979 safety summit was the 1972 crash of a Lockheed L-1011 in the Everglades, which occurred after the crew became so preoccupied with changing a burned-out nose landing gear indicator lamp that they failed to notice that the altitude hold function of the autopilot had disengaged, causing the aircraft to gradually descend and crash.

In the same year a Boeing 737 crashed at Chicago Midway Airport while attempting a go-around from a non-precision approach. The crew had focused on a light indicating "flight data recorder inoperative" and lost situation awareness. After crossing the final approach fix high, fast and not configured for landing, the crew attempted to land using speed brakes. When they realised they could not make the landing, they tried to go around with the speed brakes fully deployed and crashed off the end of the runway.

The focus on human error was given added impetus by the results of a classic study conducted under NASA sponsorship by Patrick Ruffell Smith and reported at the 1979 conference. In this simulator study, experienced B-747 crews flew a demanding full flight from takeoff to landing. Those who made effective use of all resources performed well while those with poor communications and coordination skills made a large number of errors, including a 100,000 pound error in calculating gross weight for landing.

KLM in Europe, United Airlines in North America and Ansett in Australia were early adopters of the first generation of CRM, known then as cockpit resource management. The impetus for KLM was the loss of one of the company's aircraft in a runway incursion accident at Los Rodeos airport at Teneriffe in the Canary Islands in 1977.

A KLM 747 taking off in fog slammed into a Pan Am 747 taxiing on the same runway. A total of 583 people died, and the accident remains the deadliest in aviation history.

Among the chain of events that led to the disaster was a series of communication problems, including confusion about whether a takeoff clearance had been issued by ATC to the KLM crew. It is likely that the captain mistook a clearance to fly a certain route after takeoff for an actual takeoff clearance

The KLM flight engineer expressed concern that the Pan Am 747 was not yet clear of the runway just as the captain of the KLM flight began the takeoff run, but he was overruled.

The cockpit voice recorder captured what happened.

Tenerife tower: Stand by for takeoff, I will call you.

Pan Am captain: And we're still taxiing down the runway, the clipper one seven three six.

Tenerife communications caused a shrill noise in KLM cockpit – messages not heard by KLM crew.

Tower: Roger alpha one seven three six report when runway clear

Pan Am captain: OK, we'll report when we're clear.

Tower: Thank you.

KLM Flight engineer: Is hij er niet af dan? (Is he not clear then?)

KLM captain: Wat zeg je? (What do you say?)

KLM flight engineer: Is hij er niet af, die Pan American? (Is he not clear that Pan American?)

KLM captain: Jawel. (Oh yes [emphatic].)

The accident sparked changes to communication protocols and a new focus on group decision making that down played the cockpit hierarchy.

In the United States, structured cockpit/crew resource management training was first instituted by United Airlines following an accident at Portland, Oregon when a United Airlines Douglas DC-8 ran out of fuel and crashed short of the runway in December of 1978. The crew in this accident was preoccupied with a landing gear warning and continued to circle, despite warnings by the flight engineer that the fuel state was becoming critical.

United Airlines called in consultants who had conducted training in managerial effectiveness for corporations to help the company address human error. In 1981 the airline rolled out one of the world's first comprehensive CRM programs (which they called CLR or command-leadership-resource management). CRM training for crew has since been introduced and developed by aviation organisations worldwide.

[In Australia, Ansett Airlines was among the first to pioneer the "new technology" of CRM training. After surveying the available resources, KLM materials were chosen in 1982. The package consisted of a slide-tape program, covering all aspects of flight crew behaviour, including performance weaknesses and illusions.]

... more than 60 US jet transport accidents between 1968 and 1976 involved failures in decision making, leadership, pilot judgment, communication and crew coordination.

[In early 1985, the two creators of the KLM program, Captain Frank Hawkins and Professor Elwyn Edwards, of Aston University, UK, delivered a two-week course for senior Ansett managers, "Human factors for transport aircraft operation". This course attracted representatives from Qantas, TAA, the RAAF, Air New Zealand, the then Bureau of Air Safety Investigation, the Department of Aviation (now CASA) and many others.]

The United Airlines program was conducted in an intensive seminar setting and included getting participants to analyse their own interpersonal styles (based on a questionnaire). The focus of the training was correcting behavioural deficits such as a lack of assertiveness by juniors and authoritarian behaviour by captains. Other airlines developed similar programs.

Reactions to the first generation of CRM were generally positive – with some reservations. Some referred to the program as "charm school" and the content as "psychobabble".

By the early 1990s, attitudes to CRM training had shifted. At the University of Texas, our research group surveyed crews in 1991 to find out how they assessed the usefulness of the training. We collected data from more than 15,000 crew members from 12 airlines and military organisations in the US. The majority rated the training as very or extremely useful. Additionally, the great majority agreed that CRM training had the potential to increase safety.

We also measured changes in attitudes to concepts such as communications and coordination and the effects of stressors on human performance. On each of the scales reflecting these concepts highly significant improvements in attitudes following CRM training were noted (these data were reported by Helmreich & Wilhelm in the *International Journal of Aviation Psychology* in 1991 and are not limited to first generation CRM courses).

No more dramatic endorsement of the effectiveness of CRM can be given than the judgement of Al Haynes, the pilot of a United Airlines DC-10 that managed a successful crash landing at Sioux City, Iowa, in 1989 after an uncontrolled engine failure severed hydraulic lines, resulting in the loss of flight controls.

The crew, using all their available resources, controlled the aeroplane using differential thrust on the two remaining engines. Captain Al Haynes gave credit for the outcome to CRM training the crew had received.

At a 1991 presentation on the flight at NASA's Dryden Flight Research Facility in California he said, "As for the crew, there was no training procedure for hydraulic failure. We've all been through one failure or double failures, but never a complete hydraulic failure. But the preparation that paid off for the crew was something that United … called cockpit resource management, or command leadership resource training.

"Up until [then] we kind of worked on the concept that the captain was THE authority on the aircraft. What he [says], goes. We had 103 years of flying experience there in the cockpit, trying to get that [aeroplane] on the ground, not one minute of which we had actually practised, any one of us. If I hadn't used CLR, if we had not let everybody put their input in, it's a cinch we wouldn't have made it."

From cockpit to crew: Research and experience during the 1980s led to a key shift in CRM from a focus on cockpit resource management to one on crew resource management. This change was highlighted at a second NASA workshop, held in 1986, that recognised that CRM needed to involve all crew members as well as other resources existing in the aviation system (maintenance, air traffic control, and so on). While many of the early CRM courses that were derived from general management development programs focussed on the immediate operational environment, experts saw a need to refine the CRM concept to take account of the broader complexity of aircraft operations.

Our research at the University of Texas has followed the evolution of CRM training that has occurred over the past 25 years. We have identified six "generations" of CRM, as a way of trying to make sense of the changes we have observed.

These descriptive labels try to capture significant changes in the nature of the training – although I suspect one could find early generation training programs still being delivered by some companies.

The first generation of CRM, as implemented by pioneering organisations in the US, Europe and Australia, focused mainly on resources in the cockpit, teamwork, leadership and effective communication.

Second generation CRM was typified by a name change from cockpit to crew resource management, reflecting growing awareness of the involvement of more than the cockpit crew in safe flight. Second generation courses dealt with more specific aviation concepts and became more modular as well as more team oriented. Concepts included team building, briefings, situation awareness and (in some cases) stress management. Criticisms regarding too much pop psychology still continued – for example, the concept of synergy was often derided as silly jargon.

Third generation CRM courses emerged in the early 1990s and addressed a broader segment of the aviation environment including flight attendants, dispatchers and maintenance personnel. Some organisations began to conduct joint cockpit/cabin CRM training. Attention was given to factors such as how organisational culture can influence safety. Efforts were made to present specific skills and behaviours that pilots can use to work more effectively. Some carriers also developed specialised CRM training for new captains to address leadership issues related to command. While these courses were very useful in extending the concept of crew to those outside the cockpit, they may also have inadvertently diluted the initial focus on error reduction.

Fourth generation CRM training reflected the introduction of the US Federal Aviation Administration's advanced qualification program (AQP). The AQP program gave airlines the ability to develop innovative training reflecting the needs and cultures of their organisations. Two of the requirements of AQP have been the integration of CRM into technical training and the provision of full mission, non-jeopardy simulation (line oriented flight training, or LOFT). As part of this integration of CRM with technical training some airlines began to "proceduralise" CRM by adding specific behaviours to their checklists and to require formal evaluation of crews in full mission simulation (line operational evaluation or LOE).

One of the most positive developments I have observed among airlines has been the willingness of organisations that are fierce competitors in the marketplace to share information.

Fifth generation CRM represents a return to the original of CRM as an error reduction and management strategy. Underlying fifth generation CRM is awareness that error is ubiquitous and inevitable. Behaviours that are taught and reinforced can be understood as countermeasures against error and strategies to mitigate the consequences of error. The success of this generation of CRM is contingent on organisational recognition that errors happen and that a non-punitive attitude towards error is needed (except, of course, for intentional violations of procedures or rules).

Sixth generation CRM is a logical extension of the fifth generation. It reflects the fact that flight crews must not only cope with human error within the cockpit but also with threats to safety that come from the operating environment. In this framework an ATC error (for example an erroneous communication that could cause a mid-air) is a threat that must be managed. The difference between fifth and sixth generation training is significant in the fact that it reveals a much greater awareness of the contextual risks that must be handled.

Pilots exposed to the sixth generation of CRM training have been enthusiastic about

HIGH RISK ENVIRONMENTS

Under pressure: Systematic observation techniques developed to study group interaction in aviation have been applied in other high-risk environments, including undersea habitats, and increasingly to study interpersonal dynamics during surgery.

the addition of threat recognition and management. While error management is a reality, in some ways the focus on pilot error has been somewhat limited by being seen to concentrate on those at the "sharp end".

One of the most positive developments I have observed among airlines has been the willingness of organisations that are fierce competitors in the marketplace to share information. For many years those involved in CRM have met regularly to share approaches to training and, in many cases, resource material, and to exchange experiences in the delivery of CRM training. As a result, I think it most appropriate to say the evolution of CRM that we have seen has reflected industry's shared successes and failures in training.

At a global level, initial attempts to export CRM to other cultures (or indeed to other organisations within the same culture) have sometimes met with resistance. Within a culture, crews might apply the NIH (not invented here) response to denigrate programs acquired from another carrier. There are, of course, some organisations that have delivered effective CRM training to pilots in a variety of cultures by being sensitive to local issues and by using local subject matter experts to validate the approach and material employed. "Local solutions for local issues" appears to be the most effective approach.

Airlines that have developed their programs locally or showed sensitivity to cultural issues (such as deference to hierarchy) seem to have been quite successful in implementing CRM. These companies have stressed the responsibility crews have to the health of their organisation.

There is, of course, a lot of variability in the quality of courses, the amount of time devoted to the training, and the degree of support demonstrated by senior management to CRM.

Systematic observation: Contemporary CRM involves looking at how crews utilise all available resources to manage threat and error. But to understand how crews manage threat and error you need to know what is actually happening during normal flight.

One way of doing this is to use systematic observation methods that have been well validated through research in social psychology. At the University of Texas we have employed systematic observation in a variety of settings, including people living in undersea habitats during projects SEALAB and TEKTITE and in operating theatres during surgery.

Courtesy Robert Helmreich

University of Texas psychology professor Bob Helmreich is one of the modern-day pioneers of aviation human factors and CRM. A former US Navy officer, his interest in human behaviour led him to doctoral studies in personality and social psychology at Yale University.

His key interest is the study of high-demand and high-risk environments where team performance plays a critical role.

Supported by NASA, the National Science Foundation, the National Institute of Mental Health and the Federal Aviation Administration, he has worked with crews from airlines around the world to establish an extensive database of information about crew performance in operational settings.

Helmreich is head of the University of Texas Human Factors Research Project (formerly the Aerospace Crew Research Project), a research group dedicated to investigating individual, team and organisational factors that influence performance and safety in aviation, space and medicine.

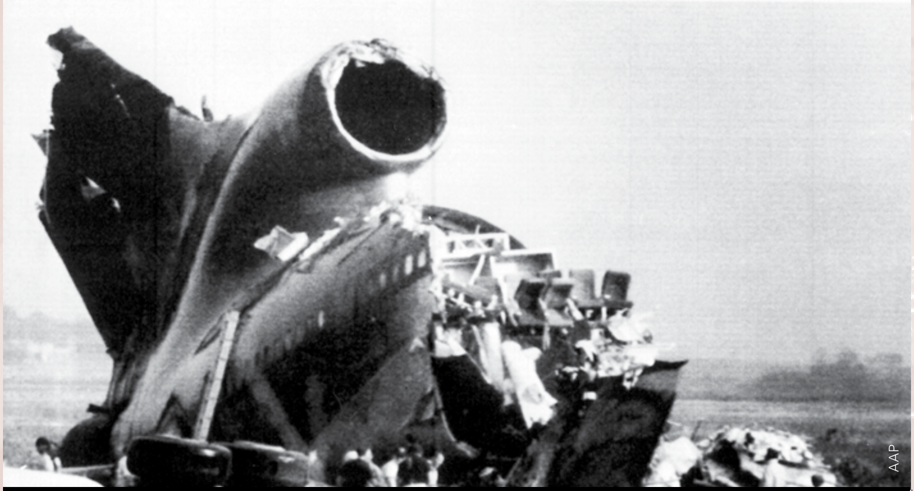
In aviation, this systematic observation technique is known as a line operations safety audit (LOSA). LOSA is a formal process that requires expert and highly trained observers to ride the jumpseat during regularly scheduled flights in order to collect safety-related data on environmental conditions, operational complexity and flight crew performance. Confidential data collection and non-jeopardy assurance for pilots are fundamental to the process.

As my colleague and LOSA expert, James Klinect, says, you could say that a LOSA is similar to a patient's annual physical examination. People have comprehensive check-ups in the hope of detecting serious health issues before they become consequential. A set of diagnostic measures – such as blood pressure, cholesterol and liver function – flag potential health concerns, which in turn suggest changes that might be needed to the patient's lifestyle. A LOSA is built upon the same notion. It provides a diagnostic snapshot of strengths and weaknesses that an airline can use to bolster the "health" of its safety margins and prevent their degradation.

LOSA is distinct from but complementary to other safety programs such as electronic data acquisition systems (for example flight operational quality assurance, or FOQA), and voluntary reporting systems (such as the US aviation safety reporting system, or ASRS). There are two major conceptual differences. First, FOQA and ASRS rely on outcomes to generate data. For FOQA, it is flight parameter exceedances, and for ASRS, it is adverse events that crews report. By contrast, LOSA samples all activities in normal operations. There may be some reportable events, but there will also be some near-events, and importantly, a majority of well-managed, successful flights.

The second major difference is the perspective taken by each program. With its focus on electronic data acquisition downloaded directly from the aircraft, FOQA can be said to have the "aeroplane perspective". ASRSs provide the "pilot perspective" by utilising pilots' voluntary disclosure and self-reporting of events. ASRS reports

THREE KEY DISASTERS THAT TRIGGERED AN INCREASED FOCUS ON HUMAN ERROR



Everglades: Among the accidents singled out at a 1979 NASA safety summit was the 1972 crash of a Lockheed L-1011 in the Everglades, which occurred after the crew became so preoccupied with changing a burned out nose landing gear indicator lamp that they failed to notice that the altitude hold function of the autopilot had disengaged, causing the aircraft to gradually descend and crash. Ninety-nine of the 176 on board perished.

Chicago: One of the initiating factors in the crash of a Boeing 737 at Chicago Midway Airport in 1972 was crew pre-occupation with a light indicating "flight data recorder inoperative". Crossing the final approach fix high, fast and not configured for landing, the flight crew tried to land using speed brakes, but couldn't make it. On go-around with the speed brakes fully deployed, the aircraft crashed off the end of the runway. Forty-three of the 61 aboard died.

Tenerife: A total of 583 people died in a 1977 runway incursion accident in which a Pan Am B-747 and a KLM B-747 collided at Los Rodeos Airport at Tenerife in the Canary Islands. The accident remains the deadliest in aviation history. Among the chain of events that led to the disaster was a series of communication problems, including confusion about whether a takeoff clearance had been issued by ATC to the KLM crew. It is likely that the captain mistook a clearance to fly a certain route after takeoff for an actual takeoff clearance.

provide insight into why events occur, as seen from the crew's perspective. LOSA provides an observer's perspective of how threats and errors are handled on every phase of flight, regardless of the outcome. Most LOSA observers are pilots from the airline, with some 20 per cent of observations conducted by observers outside of the airline. All three perspectives provide useful data to an airline's safety management system.

The foundation of LOSA grew out of the need to find out how threats and errors are managed and how well CRM training translated into line operations.

In the US LOSA was introduced after Delta Airlines put in place a very intensive CRM program in the early 1990s. Delta management was eager to discover whether the training was working, and approached our research group to find out. We were asked to observe crews to obtain these data, with guarantees of confidentiality of individual information. Later, in 1996 Continental Airlines and The University of Texas refined the concept and observations were conducted that included recording threats and errors as well as ratings of CRM practices.

To date some 5,500 LOSA observations have been completed with around 30 airlines in the US and elsewhere. The results show that there is an average of four threats per flight – most problematic are challenging ATC clearances and late changes. There is also an average of 3 errors per flight (20 per cent are error free). The most frequent errors are procedural.

The LOSA concept is now being applied within airlines to areas outside the cockpit where important safety issues exist. For example, the methodology has been extended to ramp operations, as well as to air traffic control. Airservices Australia is the first in the world to test LOSA methodology in ATC.

Our LOSA observations have revealed the critical role of threat and error management in normal flight operations. Indeed, the concept of threat and error management seems to provide a common framework for integrating safety data from a variety of sources – from incident reporting (ASRS) to systematic observations (LOSA) to accident investigations and data recorders (FOQA). The ability to examine these components in a consistent manner should foster the development of safety cultures and allow the exchange of data across domains.

Threat and error defined: A threat can be defined as an event or error that is not caused by the crew, and increases operational complexity of a flight, requiring crew attention and management if safety margins are to be preserved.

Some threats come from the environment – adverse weather, airport conditions, terrain, traffic and ATC. Other threats arise from within the airline, such as aircraft malfunctions and minimum equipment list (MEL) items, problems, interruptions, or errors from dispatch, cabin, ground, maintenance and the ramp. Threats may be anticipated by the crew, for example, by briefing a thunderstorm in advance, or they may be unexpected, occurring suddenly and without warning, such as in-flight aircraft malfunctions. A mismanaged threat is defined as a threat that is linked to or induces flight crew error.

Results from our "10-airline" archive show the most prevalent threats by type were:

- Adverse weather (61 per cent of flights).
- ATC (56 per cent).
- Environmental operational pressures (36 per cent).
- Aircraft malfunctions (33 per cent).
- Airline operational pressures (18 per cent).

The threats that were most often mismanaged, by type, were:

- ATC (12 per cent of threats mismanaged).
- Aircraft malfunctions (12 per cent).
- Adverse weather (9 per cent).
- Dispatch/paperwork (9 per cent).
- Airline operational pressure (7 per cent).

There was little variability in threat mismanagement, shown by the small range (6-12 per cent). These results show that flight crews are good threat managers, in an environment full of threats – with over 81 per cent of flights observed encountering at least one threat.

Crew error is defined as action or inaction that leads to a deviation from crew or organisational intentions or expectations. Errors in the operational context tend to reduce the margin of safety and increase the probability of adverse events.

Broadly speaking, there are handling errors (flight controls, automation), procedural errors (checklists, briefings, callouts) and communication errors (with ATC, ground, or pilot-to-pilot).

Understanding how errors are managed is as important, if not more important, than understanding the prevalence of different types of error. It is of interest then if and when the error was detected and by whom, as well as the response(s) upon detecting the error, and the outcome of the error. As with threats, some errors are quickly detected and resolved, leading to an inconsequential outcome, while others go undetected or are mismanaged. A mismanaged error is defined as an error that is linked to or induces additional error or an undesired aircraft state.

Our error archive provides some interesting insights into flight crew errors and their management. The most common errors were:

- Automation (25 per cent of flights).
- Systems/instruments/radio (24 per cent).
- Checklists (23 per cent).
- Manual handling (22 per cent).
- Crew to external communication (22 per cent).

The most often mismanaged errors were:

- Manual handling (79 per cent mismanaged).
- Ground navigation (61 per cent).
- Automation (37 per cent).
- Checklists (15 per cent).

After 10 years of examining how flight crews manage error it is clear that there is one thing that all successful crews do. They all co-operate to rigorously monitor and cross-check to make sure they pick up threats and errors early. These crews are actively engaged in checking and verifying every setting and action that can affect safety.

This requires excellent co-ordination and a good cross flow of communication. Rather than any particular personality trait, the key marker for a good pilot is a sense of professionalism, and an appreciation of backup.

Good leadership is essential, in which a tone of professionalism sets the standard. Leadership must be decisive, yet allow for input.

CRM performance is not the magic bullet, but one of many things flight crew have to do to manage threats and errors. In the future we will see sixth generation CRM more fully integrated into training, and an increased emphasis on understanding and reacting to how all elements of the aviation system respond to threat and error.

Additional material from James Klinect, researcher at the University of Texas Human Factors Research Program, and head of the LOSA Collaborative, which offers LOSA implementation services to airlines world-wide.

Assistance is acknowledged from University of Texas human factors researchers, Ashleigh Merritt, project data specialist, and Chris Henry, principal investigator, University of Texas normal operations safety survey (NOSS).

CRM SINGLE-PILOT OPERATIONS

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SINGLE-PILOT OPERATIONS

MAINTAINS EFFECTIVE LOOKOUT

1 Maintains lookout and traffic separation using a systematic scan technique at a rate determined by traffic density, visibility and terrain.

2 Maintains radio listening watch and interprets transmissions to determine traffic location and intentions of traffic.

3 Performs airspace cleared procedure before commencing any manoeuvres.

MAINTAINS SITUATION AWARENESS

1 Monitors all aircraft systems using a systematic scan technique.

2 Collects information to facilitate ongoing system management.

3 Monitors flight environment for deviations from planned operations.

4 Collects flight environment information to update planned operations.

5 Analyses aircraft systems and flight environment information to identify actual and potential threats or errors.

ASSESSES SITUATIONS AND MAKES DECISIONS

1 Identifies and reviews problem causal factors.

2 Systematically and logically breaks down problems or processes into component parts.

3 Applies analytical techniques to identify solutions and considers the value and implications of each.

4 Generates, in the time available, as many solutions as possible.

5 Assesses solutions and risks.

6 Decides on a course of action.

7 Communicates plans of action and directs crewmembers to clearly specified tasks.

8 Takes actions to achieve optimum outcomes for the operation.

9 Monitors progress against agreed plan.

10 Re-evaluates plan in line with changing circumstances and is improvement focused to achieve optimum outcomes.

RECOGNISES AND MANAGES THREATS

1 Identifies environmental or operational threats that could affect the safety of flight.

2 Analyses threats and develops options to mitigate or control threats.

3 Implements an option (action) that mitigates or controls threat.

4 Monitors and assesses flight progress to ensure a safe outcome; or modifies actions when a safe outcome is not assured.

RECOGNISES AND MANAGES ERRORS

1 Applies checklists and standard operating procedures to prevent aircraft handling, procedural or communication errors; and identifies committed errors before safety is affected or aircraft enters an undesired aircraft state.

2 Monitor aircraft systems, flight environment and crew members, collects and analyses information to identify potential or actual errors.

3 Implements strategies and procedures to prevent errors or takes action in the time available to correct errors before the aircraft enters an undesired aircraft state.

RECOGNISES AND MANAGES UNDESIRED AIRCRAFT STATES

1 Recognises undesired aircraft state.

2 Manipulates aircraft controls or systems, or modifies actions or procedures to maintain control of the aircraft or situation, in the time available.

SETS PRIORITIES AND MANAGES TASKS

1 Organise flight, navigation, communication and passenger management tasks and sets priorities to ensure that the workload at any phase of flight allows, in the time available, the pilot to safely manage the flight.

2 Prioritises and organises workload to ensure completion of all tasks relevant to the safety of the flight in the time available.

3 Puts the safe and effective completion of every task or operation of an aircraft ahead of competing priorities and demands.

4 Plans events and tasks to occur sequentially.

5 Critical events and tasks are anticipated and completed in the time available.

6 Uses technology to reduce workload and improve cognitive and manipulative activities.

7 Avoids fixation on single actions or functions.

MAINTAINS EFFECTIVE COMMUNICATIONS

1 Establish and maintain effective communications and interpersonal relationships with all stakeholders to ensure the safe outcome of a flight

2 Applies standard phraseology to radio communication

3 Communicates with stakeholders in an effective and efficient manner to achieve all requirements for safe flight

4 Defines and explains objectives to applicable/involved stakeholder

5 Demonstrates a level of assertiveness that ensures the safe completion of a flight

6 Encourages passengers to participate in and contribute to the safe outcome of a flight.

CRM MULTI-CREW OPERATIONS

MULTI-CREW OPERATIONS

OPERATES AS A CREW MEMBER (CO-OPERATION)

1. Establishes an atmosphere to encourage open communications.
2. Listens critically and provides feedback to clarify information.
3. Applies assertive strategies when working with others.
4. Presents ideas in a way that shows respect for others.
5. Conveys information that is appropriate to the receiver.
6. Considers the condition (capability) of other crewmembers to perform crew duties.
7. Monitors and appraises crew members performance.
8. Interacts with crew members in a supportive and constructive way.
9. Assists other crew members in demanding situations.
10. Motivates and encourages other crew members.
11. Identifies the signs, stages and possible causes of conflict.
12. Implements strategies to deal with conflict.
13. Establishes communications that encourage constructive responses to conflict.

LEADERSHIP AND MANAGEMENT

1. Manages cockpit gradient relative to task.
2. Ensures that all crew members have a clear picture of the objective.
3. Manages changing priorities and if necessary, re focus crew members to accommodate the changed priorities.
4. Maintains crew members commitment to task.
5. Monitors the crew to ensure that they achieve specified standards of performance.
6. Corrects individual or crew members deviations from standards.
7. Insists on clarification of roles and functions.
8. Establishes and maintains clear, orderly systems.
9. Sets realistic performance standards.
10. Monitors outcomes, evaluates and measures performance.
11. Collects information and identifies key issues and relationships relative to achieving determined roles.
12. Monitor aircraft systems, flight environment and crew members, collects and analyses information to identify potential or actual errors.
13. Implements strategies and procedures to prevent errors or takes action in the time available to correct errors before the aircraft enters an undesired aircraft state.
14. Applies checklists and standard operating procedures to prevent aircraft handling, procedural or communication errors; and identifies committed errors before safety is affected or aircraft enters an undesired aircraft state.
15. Recognises undesired aircraft state.
16. Manipulates aircraft controls or systems, or procedures to correct undesired aircraft state in the time available.
17. Breaks down goals and establishes courses of action to accomplish specified goals.
18. Ensures that all crew members have role clarity and relevant information to achieve goals.
19. Allocates sufficient resources and time to complete workload.
20. Maintains patience and focus when processing large amounts of data or multiple tasks.
21. Manages time and resources to ensure that work is completed safely and effectively.

MAINTAINS SITUATION AWARENESS DURING MULTI- CREW OPERATIONS

1. Monitors all aircraft systems using a systematic scan technique.
2. Collects information to facilitate ongoing system management.
3. Monitors flight environment for deviations from planned operations.
4. Collects flight environment information to update planned operations.
5. Identifies environmental or operational threats that could affect the safety of flight. Analyses threats and develops options to mitigate or control threats.
6. Analyses threats and develops options to mitigate or control threats.
7. Reports aircraft systems and flight environment information for analysis.
8. Analyses aircraft systems and flight environment information to identify actual and potential threats or errors.

MAKES DECISIONS

1. Identifies problems causal factors and reviews these with crew members.
2. Breaks down systematically and logically problems or processes into component parts.
3. Employs analytical techniques to identify solutions and considers the value and implications of each.
4. Generates, in the time available, as many solutions as possible amongst crewmembers.
5. Implements an option (action) that mitigates or controls threats.
6. Assesses solutions and risks with other crew members.
7. Decides on a course of action.
8. Communicates plans of action and directs crew members to clearly specify tasks.
9. Takes actions to achieve optimum outcomes for the operation.
10. Monitors progress against agreed plan.
11. Monitors and assesses flight progress to ensure a safe outcome; or modifies actions when a safe outcome is not assured.
12. Re-evaluates plan in line with changing circumstances and is improvement focused to achieve optimum outcomes.

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Note: CRM competencies should be customised to reflect the specific operating environment, culture and standard operating procedures of individual operators.