THE INVESTIGATOR

UAE General Civil Aviation Authority
Air Accident Investigation Sector

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REPORT SAFETY HAZARDS

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Foreword by H.E. Saif Mohammed Al Suwaidi

Director General - UAE General Civil Aviation Authority

The GCAA believes that the foundation of effective safety management in an organization is a safety culture that starts at the highest level, Board level, and reaches throughout the entire organization. An aviation organization that effectively manages safety has safety consciousness embedded in the most basic fabric of the organization.

Safety does not involve only the operational and technical aspects of the organization. Management decisions related to finance and resources can have an effect on safety. The organization must be constantly alert to unintended safety consequences of management decisions which sometimes are made in areas remote from front line operations. I believe that it is very important that Board members and senior management are conscious of this.

Where it can reasonably be predicted that a management decision could have safety risk implications it is the responsibility of management to seek advice from relevant experts in the operations, technical and safety areas before a decision is taken. Experts in these areas can inform management of the actual safety risk exposure, usually by way of a hazard identification and risk assessment study. Aspects of safety management must be understood by all parts of the organization. All those in the organization must clearly recognize that safety is a core value of the organization and they must be involved in safety and they must understand their safety responsibilities.

The most important characteristic of a safety management system and its contribution to the organizational safety culture is that safety only works from the top of the organization down. If safety is promoted by the highest level of management and by the board members, and then actively encouraged and managed on a daily basis by the chief executive and general management, that organization will be safety aware and a safety culture will exist and be continuously strengthened. The safety conscious attitude of mind of everyone in the organization will be a powerful foundation for continuous safety Improvement and an effective defense against incidents and accidents.

Foreword by Eng. Ismaeil Al Hosani

Assistant Director General - AAIS

As this issue of The Investigator is being published the International Society of Air Safety Investigators annual Seminar and Tutorials is taking place in Dubai. This is the first occasion on which this important air safety event will take place in the Middle East and North Africa region. The theme of the Seminar is “Future Developments and Challenges of Air Accident Investigation”. During the three days of the Seminar forty three speakers will present thirty papers on various aspects of safety investigation. Holding the ISASI Seminar in the UAE will underline across the Middle East and North Africa the important part played in improving aviation safety through the work done by aircraft accident investigators. We are very happy to welcome safety investigators and safety managers from around the world to the first ISASI Seminar and Tutorials to be held in the MENA region.

Since the beginning of 2018 GCAA-AAIS investigators have been engaged in an outreach program which provides the Chief Executives and the Post Holders of each UAE aviation entity with a one day awareness course on the contribution of accident and incident investigation to aviation safety and of their responsibilities in reporting incidents and accidents and in facilitating investigations. This is an ongoing program which will include refresher training so that there will be a good level of familiarity with aviation safety investigation, at the most senior levels, which will assist in positive stakeholder engagement in the process. Other training, for example root cause analysis and basic investigation aspects, is also provided by AAIS for UAE operators.

To the attendees and speakers at the ISASI Seminar and Tutorials I wish you a very interesting, productive and enjoyable visit to Dubai.

Khalid Al Raisi

Director AAI

Investigator Smart Manager (ISM)

The aircraft accident investigation process poses many challenges. The investigation is an integrated management system which requires proper documented procedures, training, job–aids, etc. There are about 66 tasks (called events in Doc 9756, Part II) that each require a specific checklist. Any missing event will lead to the investigation missing an important aspect resulting in the investigation being incomplete and not achieving its objectives. Tracking evidence is a very important aspect of an investigation and therefore evidence handling must be assured, accurate and according to the standards.

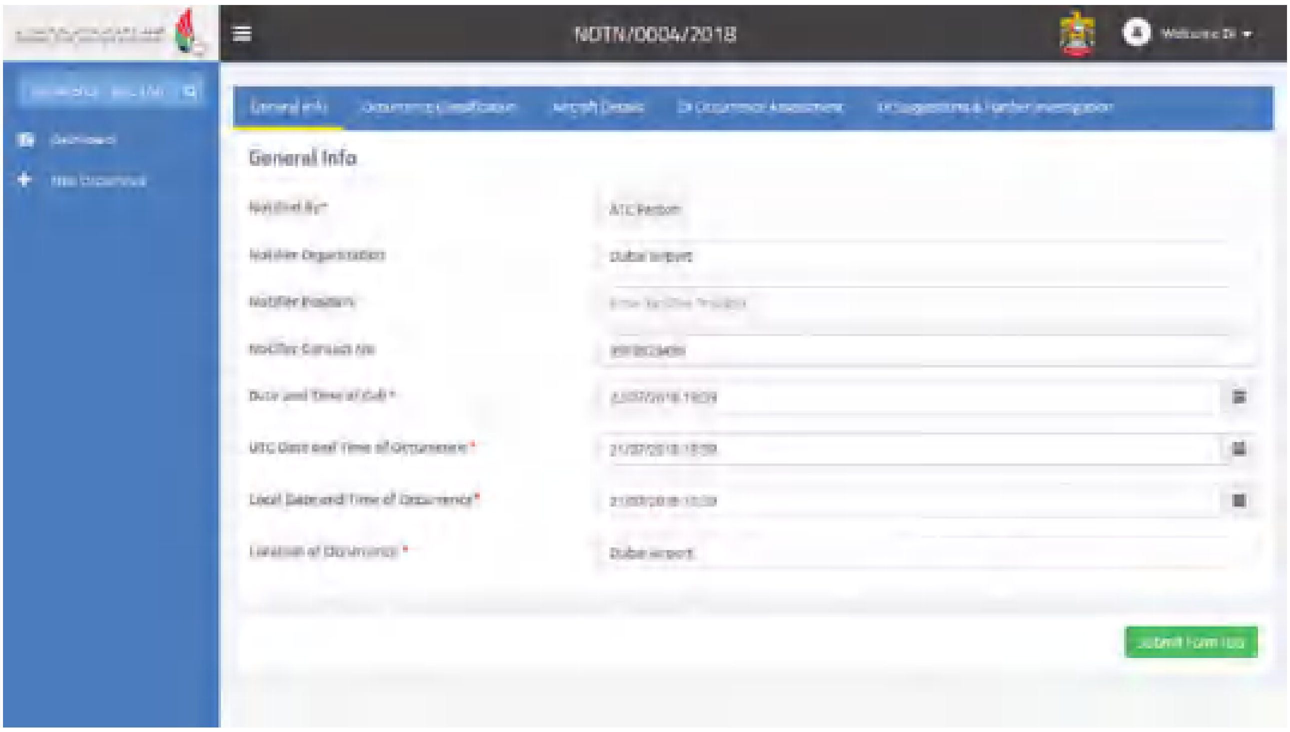
GCAA-AAIS management evaluated the investigation process and decided that there would be significant benefits in automating many aspects of the n work and it was decided to develop a software program for this purpose. The program would be called Investigation Smart Manager (ISM).

Over a period of several years ISM has been developed and includes the following features:

- Contains all of the investigation processes
- Documents all stages of the investigation
- Provides alerts to the IIC and the management as critical items require action
- Contains a dashboard view for the AAIS management
- Measures productivity
- Provides query generated reports, etc.

This system is the first of its kind worldwide.

In 2017 due to the heavy workload of IT resources available within the GCAA, the decision to outsource the final ISM development phase to an external software development company was taken.



Characteristics of ISM

The Accident Investigation Procedure Manual processes and forms are integrated into ISM to allow all the business processes to be carried out through the System.

ISM is a web-based online application with global access for business continuity. The users are categorized as

Management, Investigator and ISM System Administrator.

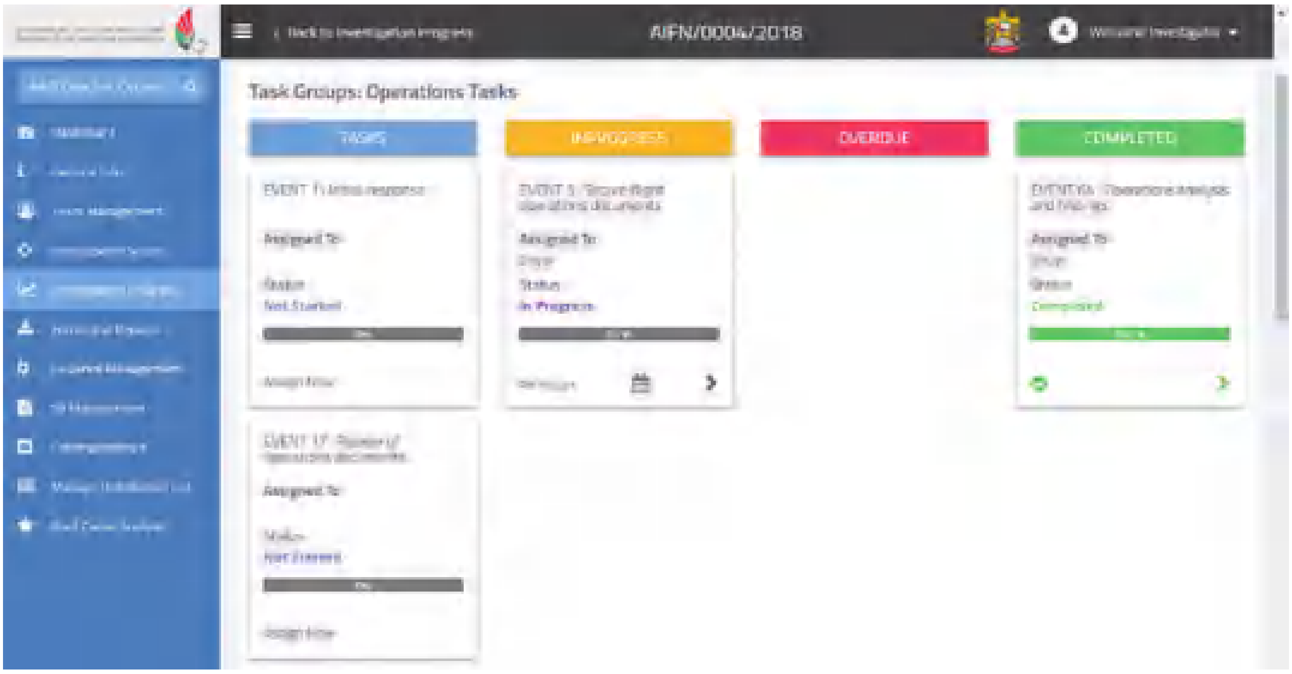
The management users' login provides live information on a dashboard with three live charts, which consist of information related to on-going Investigations, Occurrence Notifications received and the status of safety recommendations. The Director of Investigations assigns the investigation to an investigator listed in the system.

The investigators are notified by email of their assignments When an investigator logs-in to the system, he will get live information on all of the investigations and tasks assigned to him.

The main modules in the ISM system are Notifications, Investigation Process, Correspondence Management, Evidence Management, Reports Management, Safety Recommendations Management and Inventory Management.

Unique features:

The ISM system provides features that allow the investigators to customize the scope of every investigation based on the magnitude and severity of the occurrence. The ICAO Doc 9756 sixty six events guidelines, are incorporated and the system can manage full or partial investigations.

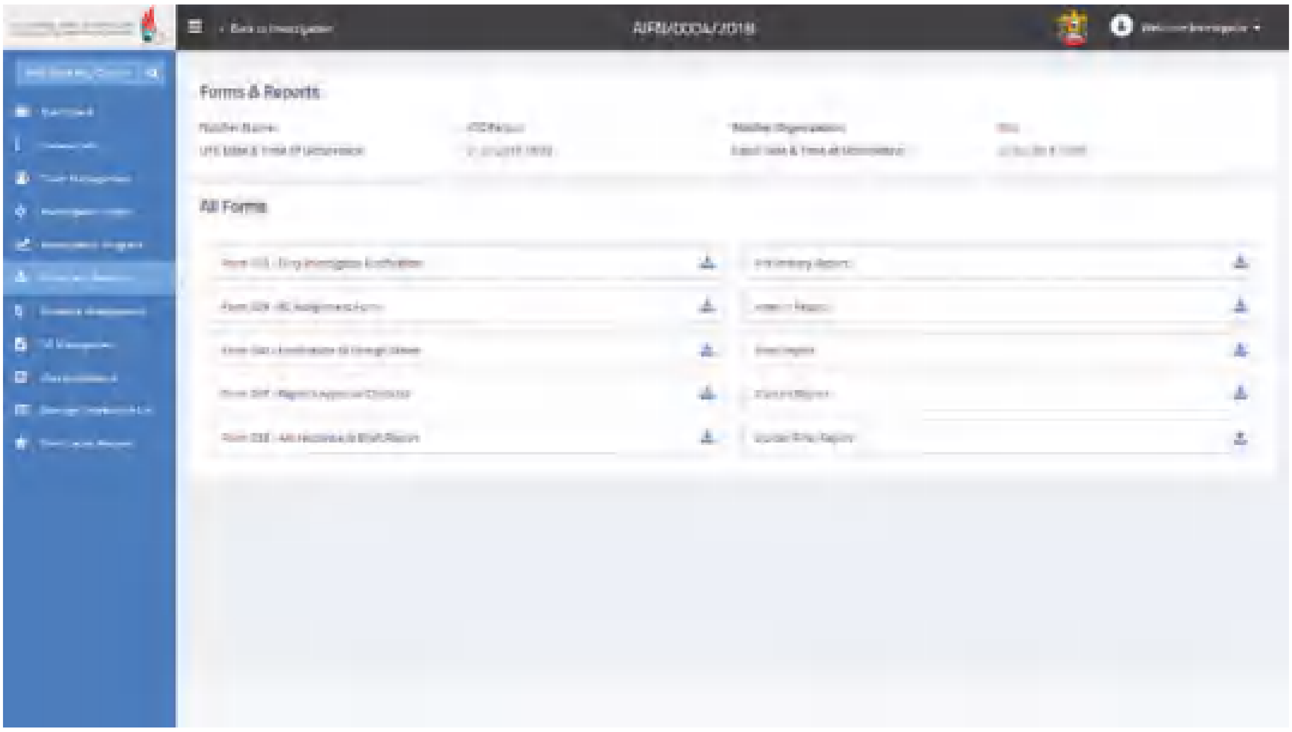


The ICAO Doc 9756 event guidelines are divided into sub-tasks which can be assigned to the investigation team members. The investigation team members are notified by email of the sub-tasks assigned to them. During the execution of these sub-tasks guidance text is displayed for reference. Sub-tasks have individual provisions for the attachment of evidence, data and information collected, with a text box for details of the outcome of the sub-task to capture for use in the analysis and/or findings.

Reports Management

The data collected and the feedback from one or more team members is formulated into the draft final report which can be generated from the Reports Module at any stage during the investigation. The draft final report is generated into a Microsoft Word document in editable mode in a standard report writing style. The reports are customized to a pre-formatted writing style based on the approved report writing style manual of the investigation authority.

Different types of reports can be generated at each stage of the investigation. For example, during the notification phase the data collected by the on-duty investigator following the initial notification, is entered into the system. This data is utilized to generate notifications to involved State authorities or interested parties in a single click.



Evidence Management

The evidence collected during the initial stage of the investigation at the accident/incident site requires an organized process so that details can be captured and tracked systematically until the evidence is returned to the owners upon completion of the investigation. The evidence management module features a quick search facility to track the current status of evidence. The collected evidence is categorized, tagged and identified using unique identification numbers. The results of the functional testing can be attached to each item of evidence with comments included in a text box.

Correspondence Management

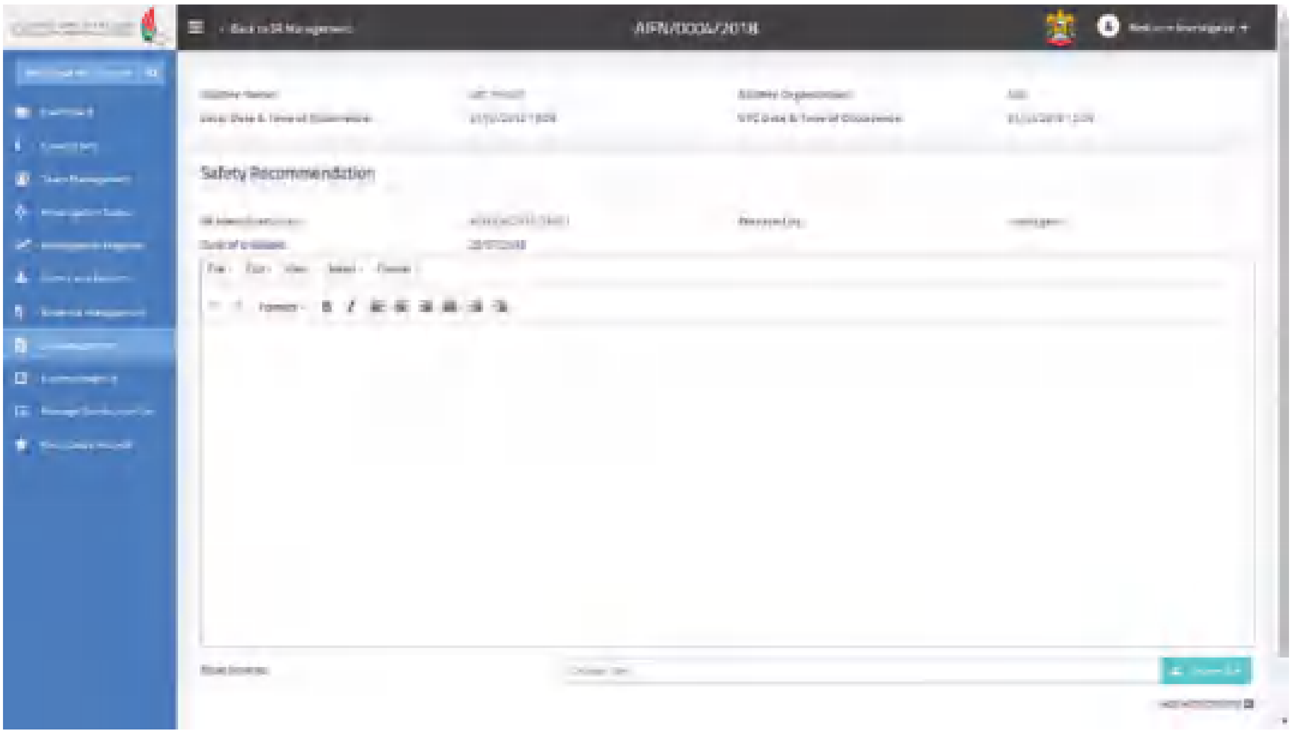
All correspondence related to the investigation is integrated within the system which has features to send reminders and notifications by email. The IIC can communicate for each investigation specifically with the appropriate stake holders and save all communications to the correspondence database. There are options to send documents for approval to the management through the correspondence management system and they can be tracked and reminders can be sent when necessary.

Safety Recommendations Management

The Safety Recommendations (SR) process is the result of each investigation A unique recommendation number is generated by the system for tracking purposes, follow-up and to record the responses and status of each SR. The automation in this module is the response from the SR recipient, when SRs' are sent through the correspondence management module by email the recipients can respond by clicking on a link which allows them to access the SR module and to reply to a specific SR assigned to them.

Once the SR assignee logs their response the IIC will receive an email notification. Based on the content of the response the IIC may accept or reject the response. If the response is rejected the SR is returned to the assignee with the reason for rejection and if the response is accepted the system sends a notification to the SR committee for their acceptance or rejection of the SR response.

If the SR response is accepted the SR is closed and notification is sent to the IIC and Director of Investigations, and if it is rejected by the SR committee it is returned to the IIC with the rejection reasoning and it then enters another cycle where it is returned to the assignee who should provide a modified response .



Root Cause Analysis

ISM contains industry standard documented processes for accident and incident Root Cause Analysis. The system incorporates three root cause analysis methods, namely the James Reason, Fishbone and SHELL models. Investigators may utilize these tools, and team discussions, to assist in reaching logical conclusions.

Inventory Management

Investigation tools and go-team equipment kits are crucial to conducting any investigation, and maintaining an equipment inventory is a basic requirement for any organization. ISM incorporates an Investigation Management module for record keeping of all Personal Protection Equipment, disposable items, equipment maintenance records and records of expiry dates for all perishable items.

The inventory module produces periodic reports to track and update quantities of items used during an investigation, reminders for the periodic maintenance of equipment and tools and also reminders to re-order items should quantities fall below set thresholds. The stock items are listed by category, with photos and serial numbers, if appropriate.

Conclusion

The ISM system provides a complete investigation process management tool, which increases efficiency, and improves and maintains the quality of investigations. Ultimately, the use of such a system by a State investigation authority leads to high quality investigation reports which improve air safety.

Captain Tony Wride

Manager Safety Risk,
Etihad Airways

Airmanship 2 – The Right Attitude

Whether you fly a huge Airbus A380 or a petite Cessna 150 they both basically operate in a similar manner in terms of flying technique – "Push and the houses get bigger – Pull and the houses get smaller – Keep pulling and the houses start to get bigger again"!! That maybe a simplistic view but what that phrase is talking about is attitude and the effect a control input has on attitude and the end result. The aircraft attitude, coupled invariably with a power setting, is normally one of the first things an instructor will teach you using the famous APT (Attitude, Power, Trim) and PAT (Power, Attitude, Trim) for various stages of flight.

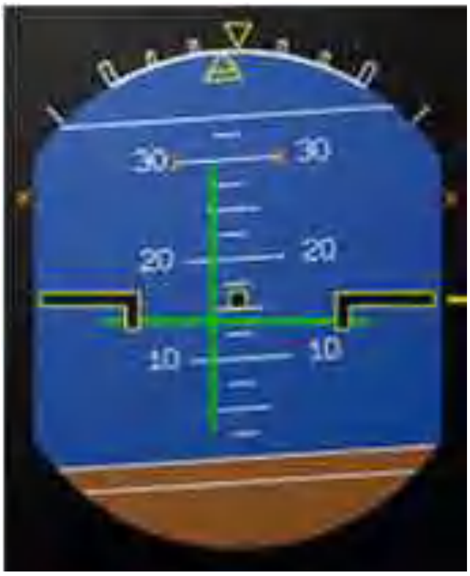
In a modern commercial airliner those basics are quite often forgotten as pilots rely heavily on the automation and the Flight Director (FD) system. They forget that if they looked at the attitude indication then their aircraft obeys all the same principals as the first small aircraft they flew. As an example, just about every commercial airliner I know has a cruise attitude of between 2° and 3° nose up with a power setting something above 70% maximum thrust. For a climb, power is increased, pitch attitude increased, and aircraft retrimmed (normally automatically), thereby following the PAT. For a level off, attitude is reduced back to cruise datum, power is reduced to maintain cruise speed, and the aircraft retrimmed (normally automatically), thereby following the APT. With the autopilot and autothrust/autothrottle engaged all of this is done for you but the aircraft is still following the same technique.

Attitude is the key and knowing what attitude to expect, or set, for the various stages of a flight is a key airmanship skill that sadly seems to be deteriorating. Two tragic accidents clearly show this and one of them is similar to the recent UAE registered B737 accident.

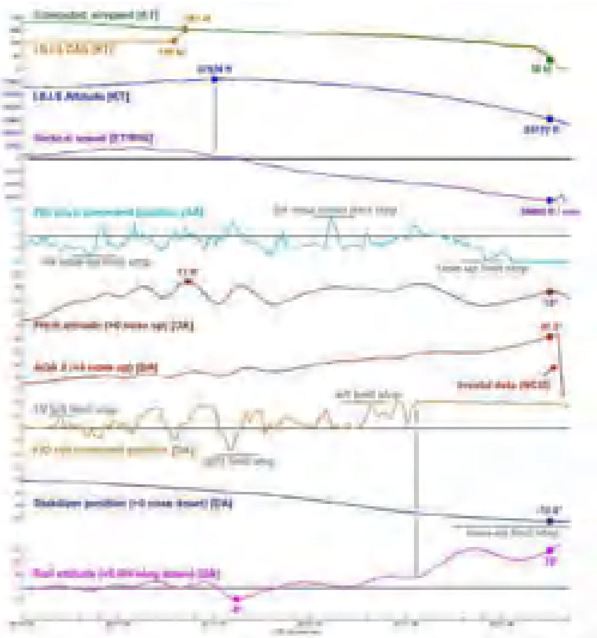
AIR FRANCE 447 – Airbus A330-200 – June 2009 – South Atlantic

This well documented accident, where 228 people were killed after the aircraft entered a deep aerodynamic stall while in the cruise at FL350, is a classic example of the pilots not flying the aircraft following a malfunction and not looking at the attitude. The aircraft was in a stable state with a pitch attitude of approximately 2.5° nose up and a relatively steady power setting. Following the blockage of the pitot system by ice crystals, resulting in unreliable airspeed indications, the autopilot and autothrust systems

disconnected. In the following few seconds the co-pilot pulled back on the sidestick setting a nose up attitude of 12° which resulted in a rate of climb of nearly 7,000 feet per minute (fpm) and the airspeed rapidly decaying from 274knots to 52knots with a high angle of attack. The aircraft climbed 3,000ft until it entered a stall and began a 10,000fpm decent to eventually impact in the Atlantic Ocean. Throughout the 4 minutes from the loss of airspeed indications to the impact, the Primary Flight Display (PFD) was indicating correctly the very high nose attitude which was way above the normal cruise or cruise climb attitude.



AF447 pitch attitude indication towards the top of 'zoom' climb and entering stall. Note confusing Flight Director indications.



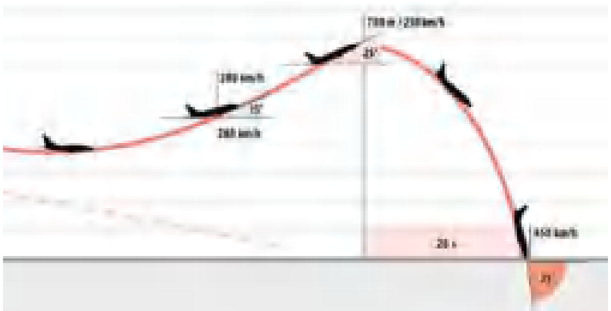
AF447 Graphical data. Note the pitch attitude (17.9° nose up) as the aircraft enters the stall and the pitch up command by the pilot, which is full nose up when fully stalled and descending at 10,000fpm.

In hindsight it is easy to judge the actions of the crew, but what we should learn from this accident is that perhaps a lack of attitude awareness by this crew, and potentially many other commercial airline pilots, is something that needs to be highlighted. There are unreliable airspeed procedures, memory items, for the various aircraft types which basically say set a particular attitude and power depending on aircraft configuration. This action gives time to get the published tables out to then set attitude and power for the required flight path. It is possible to use these published tables to get the aircraft safely back on the ground with no airspeed indications at all!

Tatarstan 363 – Boeing 737-500 - November 2013 - Kazan

Tatarstan 363 accident Site - Kazan Airport

This tragic accident, that killed 50 people, occurred following a go-around where having initiated the go-around by pressing the TO/GA switch the autopilot disengaged. No manual control inputs were made and the pitch attitude increased to in excess of 25° nose up with speed decaying to 117knots. Due to control inputs by the crew and the trim system the pitch angle decreased quickly and resulted in a final attitude of 75° nose down. It is believed that the pilot may have been a victim of a pernicious form of disorientation called "somatogravic illusion" which led him to believe the aircraft was climbing despite the attitude indicator clearly showing a significant nose down indication.



Tatarstan 363 (B737-500) Go-around profile.

There have been other similar accidents of pilot disorientation following a go-around resulting in the aircraft crashing including Gulf Air 072 at Bahrain in 2000 and Armavia 967 at Sochi in 2006.

Believe Your Instruments

Many years ago (1975) when I started my military flying, and then later teaching military pilots, a lot of emphasis was placed on disorientation and believing your instruments. I distinctly remember the instructor telling me to close my eyes while he performed a series of aerobatics that ensured I was totally disorientated then gave me control to recover the aircraft to straight and level flight using my instruments. If I was lucky the attitude indicator had not toppled and could be used but I was also taught how to use other instruments to help me recover the aircraft to level flight. The key learning point was to believe your instruments, not what you were sensing.

Modern commercial aircraft have extremely reliable attitude indicators and it is very unlikely that a pilot would be left without correct attitude information. The pitot and static systems are more likely to provide incorrect information, as happened to AF447, but the recovery procedure in event of such a failure is to set an attitude and power to give a safe stable state and time.

Attitude is a Life Saver

Knowing the various pitch attitudes, and power settings, for your particular aircraft type in different phases of flight is an airmanship skill all pilots should have and regularly practice. Whilst maximum use of automation definitely enhances safety pilots need the skill to be able to safely fly the aircraft when the automatics are not available, as in AF447.

“The manufacturer’s published airspeed unreliable pitch attitude and thrust settings could be considered as an initial recovery combination in any situation”.

You may consider that a bold statement but look at the accidents above and apply that. In the AF447 case setting 5° nose up and Climb thrust would not have resulted in the aircraft zoom climbing and entering a stall. In the Tatarstan case, and the other go-around accidents mentioned, maintaining approximately 15° nose up attitude and re-engaging the autopilot, or setting a level flight nose up attitude and power and re-engaging the autopilot, would have given the time for the pilots to recover from the disorientation.

Effective Training

Regular practice in flying your particular aircraft type without the automatics helps to maintain and sharpen the airmanship skills of flying the correct attitudes and power settings. I believe that some airlines actually include an additional, non-jeopardy, simulator session each year specifically to re-enforce manual flying skills and in my opinion that is to be commended. Perhaps all airlines should include more manual flying practice in the simulator, rather than constantly repeating exercises using the automation.

Manual flying on the line does have some risk associated with it which is why some airlines advocate ‘maximum use of automation’. Disconnecting the autopilot at top of descent in an airliner with 400 passengers onboard to fly an approach to an airport with a low cloudbase may not be the best time to practice manual flying! On a CAVOK day then perhaps the whole approach, including the turn onto finals, could be flown manually. Remember that as soon as the autopilot is disconnected the workload of the Pilot Monitoring increases dramatically! As a minimum consider looking at and memorizing the approximate attitudes and power settings that the aircraft flies for the different phases of flight because it might come in useful one day.

Good Airmanship Enhances Flight Safety

Mohammed Al Dossari

Director Aerodromes & ANS Department
GCAA

Essential Aviation Services Power Supply Resilience

Aerodrome Operators and Air Navigation Service Providers deliver essential operational services to airline operators and other aircraft operators employing the use of complex equipment and safety backups. Today, aviation forms the backbone of a country's economy, and provides a vital link to the global trade and tourism networks. A critical enabler to the provision of these services is the electric power supply to Aerodromes and Air Navigation Service Units.

Historically, up to the end of the 20th Century, airport and air traffic control operational equipment, such as basic radar, communications or navigation equipment, while requiring a power source to operate, was capable of being almost instantly resurrected following a minor disruption to the power supply. With the advent of more complex systems during the last decade, involving software programs which provide complex data storage, processing and automation functions through use of complicated integrated software operating systems, the operational equipment supporting Aerodrome Operations and Air Navigation Services is now more critically reliant on a stable electric power source.

Minor disruptions of electric power supply can result in lengthy system reboots, operational delays and significant safety issues, which in turn require operational contingency measures to be activated to ensure continuity of services, while maintaining acceptable levels of safety. These contingencies may include, reduction of services through aircraft air and ground traffic management, by delaying or diverting aircraft to address the non-availability of operational equipment and systems. Such restrictions to aviation services are a cause of substantial cost and damage to the image of the aviation industry and can harm other industries which are reliant on the integrity and reliability of the aviation system to support their operations.

Aviation regulations have previously required that Aerodrome Operators and Air Navigation Service Providers have adequate backup power supplies, as a contingency for power disruptions from the main power source. These backup systems are usually provided in the form of generators and Uninterruptable Power Supplies, comprising battery apparatus, which are commonly known as UPS.

The power backup devices are usually connected through a systematic series of Bus Bar connectors, Feeder Switches and Trip Switches. Electrical systems are configured in various designs to meet the power, voltage, amperage and resilience requirements appropriate for the essential services. As the necessity for more resilience increases, usually so does the electrical system complexity increase. With more complexity, comes the increased risk of failure within the system. Therefore, complex electrical systems require a more robust maintenance regime, supported by appropriately qualified and competent electrical technicians.

Aviation service providers around the world have been experiencing an increasing trend in incidents involving lengthy periods of non-availability of aviation services, caused by failures within electrical systems. Some of the causes of these failures have included generators and UPS not operating when required as a backup to the main power supply due to lack of maintenance and irregular system checks. Also deficiencies have been identified including design problems in the logic of the electrical component Feeder and Trip Switch operations, or failure of these switches. Resolution of these errors may include requesting electrical component suppliers to amend the operational logic of switches to better suit aviation essential operational requirements. Additionally, many electrical components are designed as closed, maintenance free units. Therefore, it is difficult for technicians to be able to test and detect the advent of a potential component failure, before it occurs.

Another aspect is inadequate determination and management of electrical component lifespans. Electrical component suppliers should communicate realistic maintenance and life cycle time periods, at the time of equipment tendering. Equally important, operators should monitor equipment lifespans, prepare for equipment replacement programs, and maintain all electrical components in compliance with supplier recommendations.

How can we make our electrical systems more resilient? It is becoming apparent that many service providers have, over the years, been reacting to a series of power interruption events, and have addressed resilience issues by adding additional electrical components to existing electrical systems. This results in highly complex and at times inadequately designed electrical systems.

All aviation service providers, should conduct a detailed review of their electrical system's resilience, starting with clearly identifying, documenting and analyzing the operational requirements for each essential service. Only when all stakeholders understand the optimum, minimum and critical operational service requirements, can they be expected to design a robust electrical system, which meets their resilience needs. Minimum acceptable levels of power outage or non-availability and contingency requirements should be determined to ensure that in the event of any incident, which may test the electrical system's resilience, that the electrical system design is appropriate and electrical components' integrity are supported by a robust maintenance program conducted by competent electrical technicians.

State Regulators also need to expand on present regulations to require operators to meet performance based requirements. Clear requirements need to be establish to reinforce the need for Aerodrome Operators and Air Navigation Service Providers to develop and provide detailed Service Level Agreements between all suppliers of power sources and electrical resilience systems to support essential services to an appropriate measurable level.

Power, however is only one vital element which is necessary to enable our aviation systems to operate. We also need to address the resilience of data management, transfer, analysis and cyber security. Many of our aviation systems are now dependent on creating, storing, transferring, manipulating and analyzing data, both efficiently and effectively, with the highest level of integrity and resilience.

As the Aviation Industry moves into the more elaborate and data thirsty processes, such as Airport Collaborative Decision Making (ACDM), Controller Pilot Data Link Communication (CPDL) and 4D Trajectory Operations, we need to rethink how we will design and manage our data management systems to enable the highest possible standard of resilience which will be required.

Bridging the Gap between Accident Investigation and Family Assistance

Ken Jenkins **Jennifer Stansberry Miller**

NavAid Crisis Consulting Group

Since the beginning of flight, the inevitable has occurred: aircraft have crashed. Care was given to rescue and recovery operations and investigators sought answers to make flight safer, yet there was little or no discussion about who provided care and answers to the individuals left behind when their loved ones perished.

After a series of aviation disasters in the late 1980's to mid-1990's, victims' families in the U.S. began to speak out about their experiences. Operators, local authorities and U.S. federal agencies lacked a coordinated and compassionate response, leaving family members of those who were killed in accidents with nowhere to turn for assistance. Communication from the airlines lacked vital information that loved ones were seeking. Families had little or no access to investigation updates. The victim identification process fell short; on occasion, families received human remains that had been misidentified. In several instances burials of unidentified remains were conducted without the families' knowledge.

Individuals associated with the accidents listed below advocated or supported the efforts to establish the Aviation Disaster Family Assistance Act and the subsequent US White House Task Force:

American Eagle Flight 4184

CT-43 A

KAL Flight 007

Northwest Flight 255 Pan Am Flight 103

TWA Flight 800

United Flight 232

USAir Flight 5050

USAir Flight 1493

USAir Flight 405

USAir Flight 427

ValuJet Flight 592

Families learned that identifiable personal effects of their loved ones were intentionally destroyed after the accident rather than being returned. More than once, families and friends who visited various accident sites months after remediation was completed discovered human remains, personal effects, and aircraft parts. There was a significant gap between those who investigated and responded to the accident, and the families who were directly affected by it.

The gap began to close in 1994, when a group of accident victims' family members and survivors came together to advocate for a coordinated humanitarian approach to working with individuals impacted by a commercial aviation disaster1. After two years of advocacy work by twelve aviation disaster family associations, the Aviation Disaster Family Assistance Act of 1996 (the Act) was signed into law, laying the foundation for what would become a new international standard.

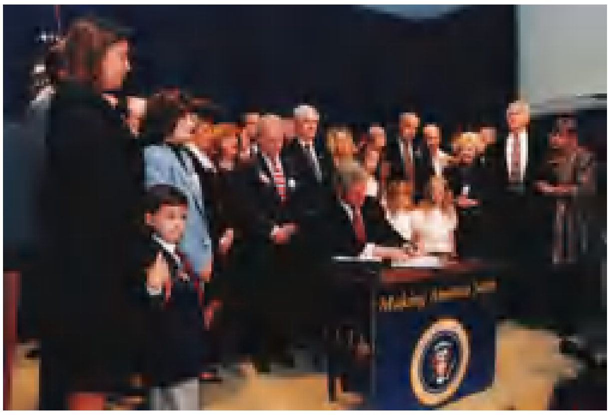


Figure 1. Surrounded by victims' families, President Clinton, the 42nd President of the United States, signs into law the Aviation Disaster Family Assistance Act of 1996.

The gap began to close in 1994, when a group of accident victims' family members and survivors came together to advocate for a coordinated humanitarian approach to working with individuals impacted by a commercial aviation disaster[1]. After two years of advocacy work by

[1] Stansberry Miller, J (2013). A Glimpse Behind the Aviation Disaster Family Assistance Act of 1996. Retrieved from https://drive.google.com/file/d/1ybSmBgWRmx9ZMxOaImTOdoL7pwNGBfw_/view

twelve aviation disaster family associations, the Aviation Disaster Family Assistance Act of 1996 (the Act) was signed into law, laying the foundation for what would become a new international standard.

The Act required the creation of a Task Force comprised of aviation disaster survivors and victims' family members, congressional leaders, attorneys, and representatives of U.S. federal agencies and the aviation industry. They were charged with working together to address the concerns raised by advocacy groups and to make recommendations on how to mitigate or correct the failures that had led to legislation.

At the conclusion of eight months of work, they issued 61 recommendations addressing a variety of family member concerns, from enlisting the American Red Cross to provide disaster mental health support, to a 45-day moratorium barring attorneys from soliciting victims' families, to consultation with families regarding common burials, to guiding the U.S. National Transportation Safety Board (NTSB) to brief families, prior to briefing the media, about progress in the investigation and about the early response efforts. Over the next few months, those recommendations evolved into a systematic model that guided the industry and resulted in the development of the ***U.S. Federal Family Assistance Plan for Aviation Disasters.***

Figure 2. ICAO leaders, global transportation officials and victims' family advocates come together following the introduction of ICAO's "Policy on Assistance to Aircraft Victims and Their Families" in 2013.

The Act marked the first time a national aircraft accident investigation authority was tasked with humanitarian responsibilities. It required the NTSB to create the Transportation Disaster Assistance (TDA) division within the agency. TDA is charged with coordinating the resources of federal, state, and local agencies, operators, and the American Red Cross to meet the needs of family members and survivors following a transportation accident. Equally important, TDA serves as the primary resource for investigation information for family members and survivors.

Additional family assistance legislation and regulations followed in the U.S., Australia, Brazil, and elsewhere. Ultimately the Act's core elements became the blueprint for the International Civil Aviation Organization's ***ICAO Policy on Assistance to Aircraft Victims and Their Families,*** the global standard guiding ICAO's 191-member states on effectively addressing the needs of family members for information and access to services.

Investigators, operator operators, and response: the relationship

According to ICAO Annex 13, "the sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents." Yet the fact is, accident investigators play a vital role in supporting affected families and survivors by providing independent factual information about the event. Families see investigators as a conduit to understanding why an accident occurred – why their loved one was injured or killed. That relationship – that conduit – bridges the 'why' to the 'what,' helping families grasp the reality of their loss, which is crucial to facilitating healing.

A recent example underscores the importance of investigative information to families. For twenty years, a father carried unresolved questions about his child's death in an air disaster. At a gathering to commemorate the anniversary of the event, members of the original government accident investigation team came to provide a family briefing and answer questions, a rare opportunity. The father, now in his late 70's, was finally able to ask his questions about why the accident occurred and how his child was killed. The investigators answered his questions honestly, clearly, and respectfully. This conversation, two decades after the crash, finally provided the bridge between the 'what' and the 'why', giving the father the facts he needed to better accept and integrate his loss. It demonstrated the unique role investigators play in the healing process of those family members left behind.

Investigators need to understand that providing accurate and timely information in an empathic and compassionate manner is essential for family members. Families appreciate the information received from investigators, even though at times they may not agree with it. The approach to communicating the information is important: the style of speech used during a briefing or personal conversation with a family is different from the technical language needed to complete a findings report. Investigators should be prepared to humanize their approach when talking with families and survivors, and should also be prepared for an array of difficult and challenging questions: How did the plane crash? How long did it take for the plane to crash? Did they suffer?

The answers may not be known, and some questions may be hard to answer, but ultimately these questions and factual answers can be necessary to facilitate healing in those affected. Investigators need to be keenly aware of the importance of providing loved ones with factual information, no matter how hard it is to convey. It is advisable for all investigators to obtain education, training, and practice in this area of communication, to understand what to say and how to say it, as these words can leave a lasting impression, especially when communication is occurring in a highly-charged emotional context.

The NTSB Training Academy provides family assistance training and many operator investigation authorities and operators have recognized the need to familiarize their investigators with the family assistance component of a response and have added it to their internal investigation training. Topics include the basics of the operator operators family assistance program and what services the operator is prepared to provide to families after an accident, such as transportation to the accident location, financial assistance, hotel accommodation, and a private and secure location to meet. Understanding this information familiarizes investigators with available resources for families, and also defines the roles and relationships between the investigation and the family assistance functions.

Former NTSB Chairman, Debbie Hersman, briefs the media at the following the Asiana Airlines Flight 214 crash at San Francisco International Airport (San Francisco, CA, USA) on July 6, 2011. (photo courtesy of NTSB Flickr)

Air accident investigation teams are often relatively small; fewer than ten people for the field investigation, depending on the accident. The investigators are typically on site from seven to ten days. By contrast, family assistance teams may be very large, and deployment may be much longer than the investigation team. Many airlines consider assigning one or two volunteer Special Assistance Team members per person (or family) on the affected flight. Considering today's aircraft may carry 500-600 passengers, the number of family assistance volunteers needed is high. In addition, depending on the accident and the airline's family assistance response, some airlines maintain their family assistance operation until the last fatality has been identified and repatriated. This may take weeks, if not longer.

To mobilize such a large response, an operator may create specialized teams to perform the tasks necessary to meet the legislative requirements of the United States and now, many other countries as well. Teams created may include a telephone enquiry centre team to answer all the telephone calls from family and friends; a logistics team to establish the multiple command centers and other meeting spaces required; an administration team to notify, assign, deploy, track, and deactivate the volunteer team; and a passenger manifest team which will quickly pull together a preliminary crew and passenger list. This is by no means an all-inclusive list of tasks or teams, but it reflects the scope and scale of resources needed for a family assistance response.

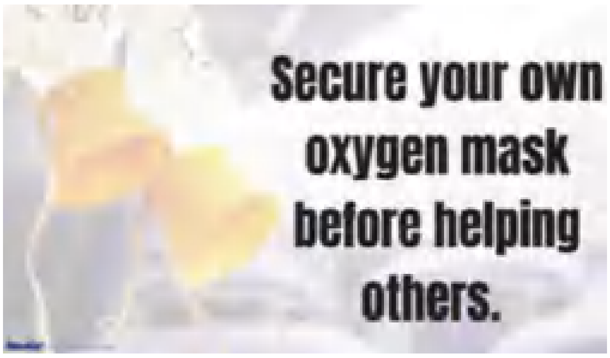
When an aviation accident occurs today, the focus is on two main areas: the investigation, and how well families, survivors and those impacted by the disaster are being cared for. While these are two distinctly different areas of focus, they are definitely connected. Accident investigators, whether from the State investigation authority leading the investigation, or the operator investigation team, have information the families and friends so anxiously want to hear.

Yes, an aircraft accident is devastating; yes, it is highly emotional; but make no mistake, families and friends want to know what happened and why. This is where the investigation process and family assistance intersect. In order to have an effective response, the affected airline and the investigation authority must work closely together to provide the needed information and services to the people impacted by the tragedy. While each stakeholder will have their own response plans, they have to collaborate in order to have a seamless, efficient and effective response.

Monument from Comair Flight 5191 -Blue Grass Airport (Lexington, KY, USA) – August 27, 2006 – 49 fatalities and one sole survivor. (photo provided by Jennifer Stansberry Miller)

Critical Incident Stress in Investigators

As the awareness of caring for those affected by an aviation accident has grown, so has the awareness of caring for those charged with responding. Whether it is an investigator on-scene, one who listens to the CVRs, or one who reviews crash scene photos, everyone is emotionally affected to some degree. When interacting with family members and survivors, the emotional impact may be even more intense. Today, it is important to have a plan in place to mitigate the psychological and emotional impact of critical incident stress.



Emotionally, psychologically, and spiritually readying oneself to respond begins today, before the event. A strong support network of colleagues (peer support teams are encouraged), friends, hobbies, spending time away from work, limiting alcohol and caffeine, eating well, and above all else, getting some exercise and sleep, will help.

Critical Incident Stress Management teams are frequently deployed and widely encouraged as a resource to support responders. Whether it is offering defusing, formal debriefing, stress management workshops, one-on-one assistance, or a combination of all four, having a critical incident stress management plan in place is an important element in both individual and organizational resilience.

Keep your plan alive and not left on the shelf: combating complacency

Complacency means different things to different people. For some it may mean not exercising their plan as often as they should. For others, it is not investing in the research and development necessary to create a good plan. To the survivors and family members affected by an accident, complacency may mean the organization did not provide the resources necessary to respond in the aftermath of an accident.

Complacency is not the opposite of compliance; in fact, complacency can sometimes masquerade as compliance. For instance, operators have complied with family assistance laws and standards by creating strong emergency response plans that address family assistance fundamentals. But what is being done with these plans? How are the plans being validated? There are many well-intended, well-written emergency response plans which look great on paper, but which have not been adequately tested, exercised or validated.

A strong and comprehensive emergency response strategy will not succeed if the response cannot be tactically performed. To mitigate complacency, airlines need to schedule multiple drills and exercises each year, encompassing all aspects of the plan: accident investigation, go-team deployment, station response, telephone enquiry center, special assistance team member (“CARE team”) assignment and deployment, logistics, and establishing a family assistance center. Though sections of the plan may be tested individually, time must always be dedicated to testing the entire plan from start to finish.

Exercises are not only the purview of operators; other agencies and organizations need to take a similar approach to ensure an effective response. Better still, operators, State investigation authorities, and other responding organizations should periodically exercise together. Exercising and working with stakeholders to practice and refine plans identifies potential gaps in plans. It also identifies elements that may negatively impact affected families and survivors. By practicing and drilling, the response community develops the skills and muscle memory to effectively respond in a crisis.

In the end

Families, loved ones, survivors, and the public at large rely on the aviation investigation community to keep them safe. However, accidents and incidents will continue to occur, and sometimes people are seriously injured or killed. When this happens, everyone involved in the response, from accident investigators to those assisting the survivors and family members, needs to remember that compassion, empathy, integrity, truth, and knowledge are both powerful, and healing.

An inscription found on the outside of the NTSB Training Center reads, From tragedy we draw knowledge to improve the safety of all. The goal of an investigation is to prevent future harm – a goal that is fully aligned with compassionate family assistance. Every responder plays a vital role.

Ken Jenkins

Ken Jenkins is a Founder and Principal/Crisis Response Strategist for NavAid Crisis Consulting Group, partnering with clients to design customized crisis response strategies prioritizing human needs following a critical incident or disaster. In his thirty-plus year career, Ken has responded to more than a dozen fatal transportation disasters including the terrorist events of September 11, 2001 for American Airlines. He has personally assisted air crash survivors and victims’ family members; directed large corporate response teams and commanded multiple Go-Team deployments.

Ken served as the Vice President of Transportation Services for BMS CAT after leaving American. BMS CAT specializes in transportation accident response, coordinating the recovery, restoration, control of personal effects; documentation of recovery efforts; personal effects claims handling; temporary mortuary services and repatriation of remains; and recovery and disposal of wreckage. Most recently he co-authored the newly published Airport Cooperative Research Program Report 171, Establishing a Coordinated Local Family Assistance Program for Airports. He is the author of Resilience: Stories of Courage and Survival in Aviation Accidents and is the host of the Podcast series: The Black Box with Ken Jenkins. Ken holds a Masters degree in Aeronautical Science.

Jennifer Stansberry Miller

Jennifer Stansberry Miller is a licensed clinical social worker and aviation disaster victim’s family member

blending her personal and professional expertise to protect the human element in emergency preparedness. Jennifer advocated for the Aviation Disaster Family Assistance Act of 1996 (Act) and has provided education to federal, international and state agencies, air carriers, and emergency response personnel on the significance of family assistance. In addition, she reviewed and provided input on ICAO Policy on Assistance to Aircraft Accident Victims and their Families, under the umbrella of the late Hans Ephraimson-Abt's, Air Crash Victims Families Group.

She has co-authored two research projects surrounding aviation disaster family assistance. As Principal, she developed and co-authored The Aviation Disaster Family Assistance Project, a first-of-its-kind survey that was distributed to US victims' families of multiple aviation disasters to assess the effectiveness of the Act sixteen years out from its passage. The results quantified the strengths and weaknesses of the current family assistance response process. She was also a co-author for the Airport Cooperative Research Program Report 171: Establishing a Coordinated Local Family Assistance Program for Airports. Jennifer brings over twenty-five years of experience in social services, crisis intervention, disaster response, and hospital emergency preparedness. Currently, she is a Principal and Crisis Response Strategist with NavAid Crisis Consulting Group, partnering with clients to design customized crisis response strategies prioritizing human needs following a critical incident or disaster.

Monument from Northwest Airlines Flight 255, Detroit Metropolitan Airport (Detroit, Michigan, USA) – August 16, 1987 – 154 fatalities, two fatal on the ground, and one sole survivor. (photo provided by Jennifer Stansberry Miller)

Hans Meyer

Senior Air Accident investigator
GCAA

The sequence of events – A helicopter accident investigation

Accident Investigators like to remind the public that an accident is often the result of a sequence of unlikely events, in which defenses failed, or were not in place. Investigators are frequently confronted with to the question: "What are the chances…?". While accident investigations have the advantage of hindsight, one of the challenges for investigators is to mentally place themselves in the position of the people involved at the time of each single contributory event, and to observe the sequentially falling dominoes, as the accident approaches.

This article describes a recently investigated accident and highlights each contributory event and its designed defenses. It demonstrates how there are often small actions that can stop the continuation of the chain reaction, which otherwise only stops when, for instance, a helicopter ends up in the sea.

On 29 April 2017 both pilots and the sole passenger onboard an AgustaWestland AW139 helicopter were on their way to hospital for a medical check-up, after they had been rescued from a life raft which was floating next to a capsized helicopter in the Arabian Gulf, off the coast of Abu Dhabi. Medical examination cleared the occupants of any physical injuries as a result of the accident. The helicopter was written off.

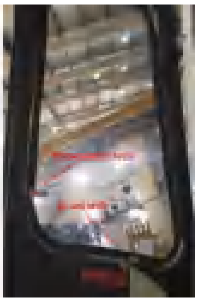
The helicopter was fitted with an emergency life raft system for all passengers and crew, consisting of two rafts located in each side sponson. Deployment of the rafts is achieved by two pull-handles, one on each side of the cockpit near the door. All three occupants found themselves in one life raft after evacuation because the right side life raft failed to deploy when the captain pulled the activation handle before evacuating.

The investigation team inspected the deployment mechanism after recovery of the helicopter and identified that the right pull-handle safety clip had been released by the captain and the handle pulled out of the stowage position. It was found that the handle mechanism exhibited excessive play and it appeared that this prevented the full extraction of the handle to initiate the deployment of the right hand side life raft.

Raft deployment handle, life raft sponson location and deployed life raft assembly

For passengers and the flight crew to exit the helicopter in an emergency, the doors cannot be opened, as this may damage the inflated flotation bags. To exit the cabin following the ditching, the passenger pushed one of the left cabin emergency exit windows out and climbed into the life raft. The copilot attempted to pull the left cockpit exit window panel in, as described on the labels attached to the window. This required the removal of a seal cord prior to the pulling of a strap handle, attached to the window panel. However, instead of opening the exit, the force applied on the strap handle created a small hole in the window panel. The copilot, faced with a blocked emergency exit, used the small hole to obtain a grip on the window panel and he pulled it in to evacuate the flight deck from the left side and he boarded the life raft. Unfortunately this window panel was lost at sea and could not be examined by the investigation team.

Cabin and flight deck emergency windows



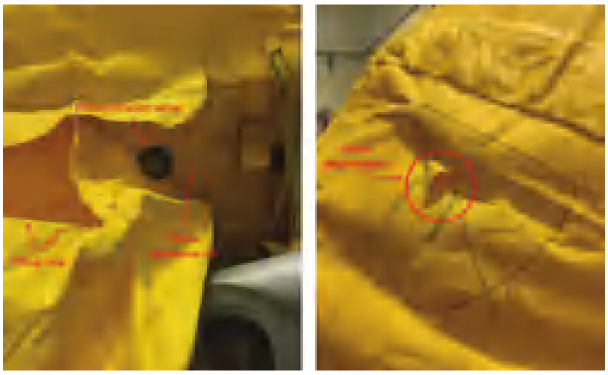
Cockpit emergency window

After the three occupants had separated the mooring line of the life raft from the helicopter, the helicopter started to tilt and it then capsized. The inflated ditching bags had kept the helicopter upright and afloat until then, but the left side aft inflation bag had slowly deflated. The investigation identified that the inflation bag fabric showed two delaminated seams and additional tear-damage which caused the slow release of air.

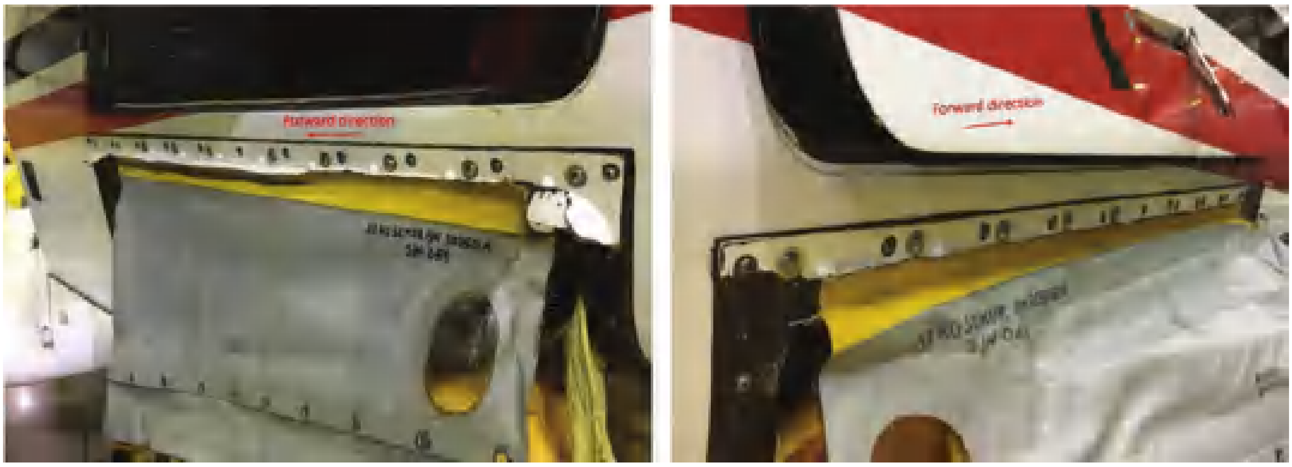
Prior to the accident, the operator had identified that a number of flotation bags had failed during the annual inflation test, mainly due to seam delamination and relief valve flange damage. The flotation bag manufacturer reduced the inflation test pressure to address the failure rate.

The tear in the inflation bag was identified as being caused by a cracked flotation bag cover, which did not deploy from the fuselage as designed. It was found that the cover attachment shear-bolts did not shear and fragments of the cover remained attached to the fuselage.

The helicopter ditching system is designed to automatically deploy the flotation bags, when contact with water is made. Aircraft certification tests had shown that if the flotation system is activated inflight, the deployment force is directed downwards instead of sideways, resulting in a fragmentation of the fuselage covers. The helicopter was equipped with a multi-purpose flight recorder, which records flight data and also stores cockpit voice recording. The recording identified that the flotation system had been activated during the descent at a height of approximately 120 feet.



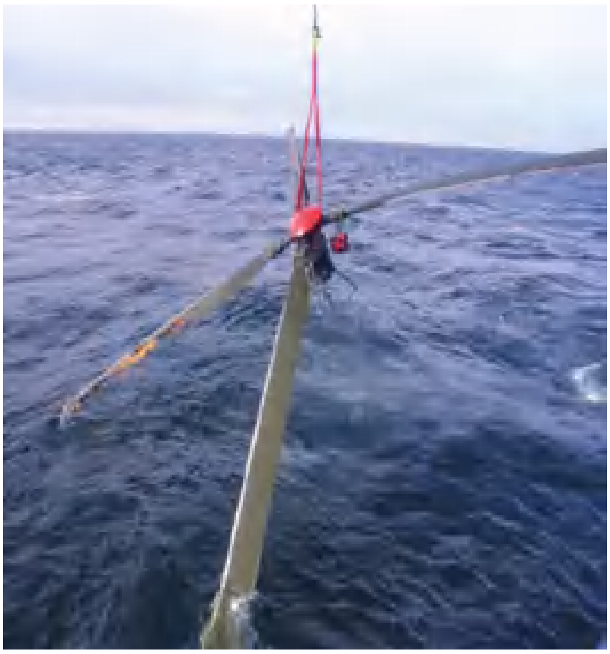
Left aft float damage



Left and right aft composite cover damage

The helicopter's quick reference handbook, or QRH, does not provide specific ditching instructions but instead refers to the ditching procedure supplement in the rotary flight manual, the RFM. The ditching procedure in the RFM contains extensive information about the flotation system limitations, and also a warning not to deploy the flotation bags inflight.

The flight crew decided to ditch the helicopter while they were diverting to a closer island because a main rotor gearbox (MGB) oil temperature warning had alerted the pilots that the oil temperature had increased beyond the operational range. This, together with a sudden loud rubbing noise coming from the main gearbox area, was interpreted by the flight crew as an imminent gearbox failure, with a potentially catastrophic outcome, similar to that of the Super Puma crash in the North Sea. In 2009, a Eurocopter AS332 Super Puma crashed in the North Sea, off the coast of Scotland, when the rotor main gearbox experienced a catastrophic failure and separated from the fuselage. All fourteen passengers and two crew died.



Super Puma Accident 2009 [Source: AAIB] Report 2/2011]

The flight crew followed the procedures in the QRH, which stated that if the MGB high oil temperature warning was observed, together with an abnormal noise and/or vibration, the helicopter must land/ditch immediately. The MGB oil temperature had risen from 86° Celsius to 119° Celsius, which exceeded the operational limit.

The helicopter diverted to the closest alternate landing port on Mubarras Island, because six minutes earlier and one minute after taking off from an oil rig, the MGB oil temperature had reached the warning temperature of 109° Celsius. The flight crew discontinued the climb to the cruise altitude to reduce the load on the MGB, and descended to an initial altitude of 500 feet and subsequently to 200 feet, in anticipation of a possible ditching.

The helicopter had landed on the oil rig to offload four passengers. Undetected by the flight crew, the MGB oil temperature had reached 103° Celsius when the helicopter landed and had remained at that value during the subsequent take-off after two minutes. While the general Before Takeoff checklist includes a check of engine and MGB oil pressure and temperatures, the Offshore Before Takeoff checklist for taking off from an oil rig did not include this check.

The investigation identified from the flight data recording that the MGB oil temperature had started to increase approximately one minute and 40 seconds prior to landing on the oil rig, as the flight crew were handling the approach and landing. The reason for the increase in oil temperature was the failure of the MGB oil cooling fan assembly.

A post-accident examination of the fan assembly showed that at this point, the fan impeller had separated from the fan shaft because of contact made with the outer shroud. This contact resulted in an over-torque and subsequent failure of the nut and the separation of the impeller from the shaft. The fan impeller was no longer rotating and providing cooling airflow.

The fan impeller contacted the outer shroud because the upper fan shaft bearing failed and over-heated to such an extent that the bearing disintegrated and deformed. It was later examined and found to have expanded from its normal width of 11 mm to 18 mm. Ten and a half minutes after the fan impeller separation, the lower fan shaft bearing failed as a consequence of excessive lateral forces. This resulted in a loose fan shaft, which rattled in the fan motor housing, creating the loud rubbing noise.

Fan shaft damage and damaged fan impeller

Oil cooling fan shaft during post-accident examination

The cooling fan manufacturer reported that 23% of all cooling fans which were prematurely returned to the workshop were received with a request for testing or repair. Of these, 42% exhibited noisy or rough running bearings, which is an indication of excessive bearing wear. Additionally the investigation identified that, the fan manufacturer provided a shelf life of 5 years for the complete fan assembly, as opposed to a two-year shelf life imposed by the bearing manufacturer on the bearing. The bearing selection for the cooling fan assembly and the maintenance program were suspected to have contributed to the premature cooling fan failure due to excessive wear.

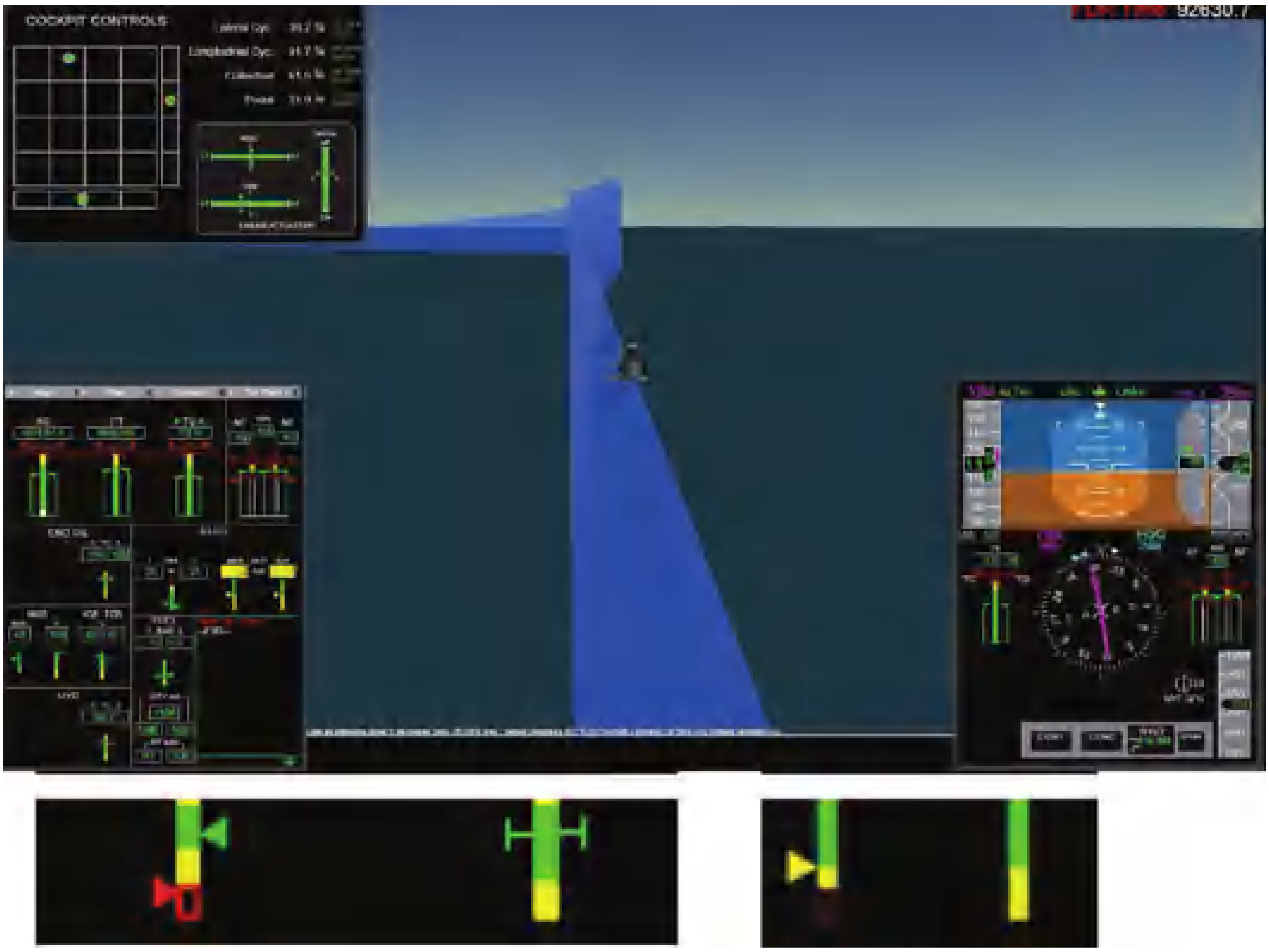
Additionally, the Investigation identified that the automatic deployable emergency locator transmitter (ELT) system did not deploy the emergency beacon when the helicopter ditched. This system is designed to automatically deploy and activate the emergency transmitter, when either the 'G'-switch senses an excessive load, the flight crew selects manual deployment, the aircraft crash switch is activated, or when the water activated switch is immersed in water. The Investigation determined that the helicopter ditched at a rate of descent that prevented the crash switch, or 'G'-switch, from signaling an emergency, and that the flight crew did not select manual deployment. An examination of the water switch indicated that it had not been fully submerged in water and so the switch cavity did not fill. It is possible that the in-flight deployment of the flotation bags prevented water from entering the switch cavity and the subsequent beacon deployment.

The investigation concluded that the helicopter was lost because of unreliable flotation bags and the introduction of an operator internal procedure for in-flight deployment of the flotation bags. While it was acknowledged that the flotation bags were designed to keep the helicopter afloat until all occupants had successfully evacuated, this accident has shown that the evacuation time is significantly reduced by a flotation bag failure. It has also identified that an evacuation is slowed down by tilting of the helicopter after ditching, problems with the emergency exit windows and the failed deployment of a life raft. It has to be recognized that had the cabin been fully occupied with 15 passengers instead of only one, the outcome of the accident could have been very serious in terms of potential fatalities. It was recommended that EASA review the flotation bag reliability and that the operator review their ditching procedure to ensure that the procedure is compatible with the helicopter certification standard.

The investigation recommended a review of the cooling fan design and maintenance program, with the intention of increasing its in-service reliability. It also recommended the introduction of an MGB oil temperature alert range, similar to the engine oil temperature indication system, to attract the attention of the flight crew prior to reaching the critical temperature.

With the advantage of the investigator's hindsight and looking back at the chain of events, some defenses are more obvious than others. Had the QRH provided additional ditching information, would the crew have used the automatic after-ditching deployment of the flotation system? Had the flotation bags been automatically deployed, would the seam damage still have occurred resulting in air being released from the flotation bag? Had the crew monitored the rise of the MGB oil temperature prior to departing the heliport, would they have identified the cooling fan failure? Had the cooling fan design been more robust, would the helicopter still be operating safely today?

We will never know.



Engine and MGB indications
[Source: Leonardo Helicopters]

Mohammed Abdul Bari

Air Accident Investigator
GCAA-AAIS

Future of Automation in Aviation Safety Investigations

"We cannot solve our problems with the same thinking we used when we created them"
–Albert Einstein

Introduction

When we talk about the advancement in systems automation, whether it is a smart phone, computer system or an aircraft system, the rate of change is so quick that any failure or problem in these sophisticated systems can take a long time to resolve..

During an aviation occurrence, Investigators are involved to identify the root cause when a failure occurs in an aircraft that had an impact on the safety of passengers or the operation of the aircraft. To identify the root cause of problems or failures of complex systems that sometimes are interdependent and may function simultaneously investigators must have a good understanding of the characteristics of such systems to enable the identification of the root causes of problems. Modern techniques and tools are being developed to support training in investigation of complex systems.

The aviation industry is utilizing augmented reality, virtual reality and artificial intelligence for systems failure analysis and for training proficiency skills in various sectors such as Air Traffic Services and Management, Aircraft Simulator training, flight crew safety training and training in aircraft maintenance. The sophisticated training methods are not limited to these areas.

Virtual Reality and Augmented Reality

Virtual Reality (VR) technology creates an environment in which the user feels and senses that they are moving inside a computer-created virtual world in the same way that people move inside the natural environment; while immersed in the virtual world, the user cannot perceive the real world which still surrounds him.

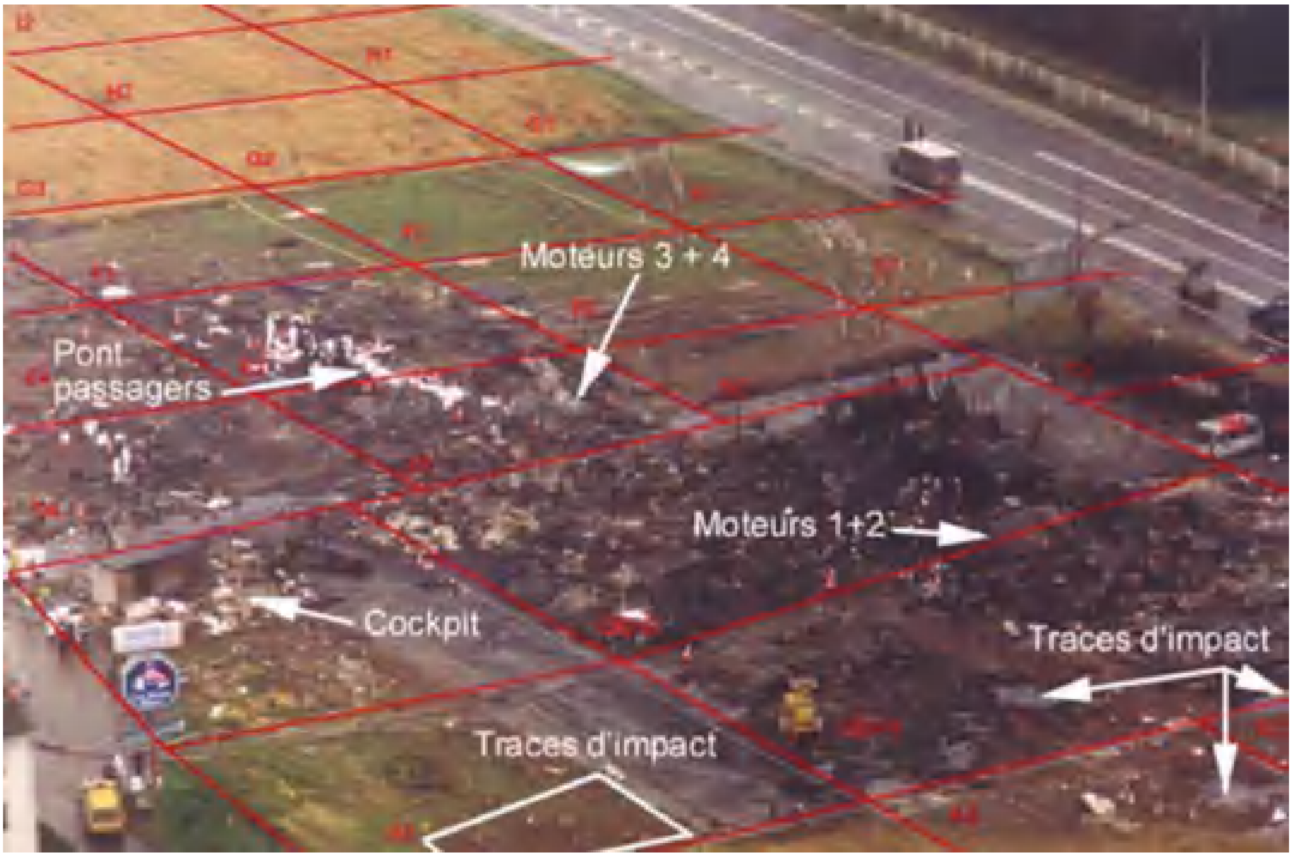
Virtual reality is currently used for aircraft cockpit, cabin and ground handling safety training. This technology can be utilized for aircraft occurrence investigations training and to convert aspects of historical accidents into virtual reality to illustrate lessons learned to investigators.

For example, the TWA Flight 800 accident involved a Boeing 747-100 that exploded and crashed into the Atlantic Ocean on 17th July 1996. The reconstruction of the aircraft structure and components from the accident wreckage was done with intense detail. If such data and visual imagery is converted into a virtual reality training module investigators can utilize the lessons learned and also use such accident data as a reference for different aircraft types involved in major accidents.

Augmented Reality (AR) allows the user to see the real world, augmenting it with superimposed virtual objects. In other words, while VR replaces reality, AR supplements it, creating an environment in which real and virtual objects harmonically coexist. AR exploits users' perceptual-motor skills in the real world, creating a special type of human-machine interaction.

Augmented Reality mixes virtual and actual reality, making available to the user new tools to ensure efficiency in the transfer of knowledge for several processes, and in several environments.

If investigators are equipped with technology such as AR during accident or serious incident investigations, such tools can be used for identification of aircraft parts or aircraft systems. In a situation where aircraft parts and debris are scattered AR technology can be used to identify parts and it can also be used to search the aircraft database using the AR system to recover the part number.



For Example: The Air France AFR4920 accident at Roissy, Charles de Gaulle Airport, on 25th July 2000, the aircraft crashed shortly after take-off as the fuel tank ruptured due to tire failure caused by debris on the runway. The wreckage was spread over a large area. AR technology can be utilized during crash site investigation or on collected wreckage in the hanger.

How does it work?

The operation of both VR and AR systems involves four stages; User Interface, Inference Engine, Knowledge Base (rules) and Working Memory (Facts). The user, or operator, interacts with the machine through a User Interface by providing information about a particular problem to be solved. Based on the rules in the Knowledge Base the Inference Engine gives commands to the Working Memory to fetch the problem-specific data, and it then sends information back to the operator by way of the User Interface. Augmented Reality mechanisms are used in the User Interface to enhance the system's capability. The mobility of the system is achieved by using light and portable devices.

Augmented Reality in Aircraft Maintenance or Inspections

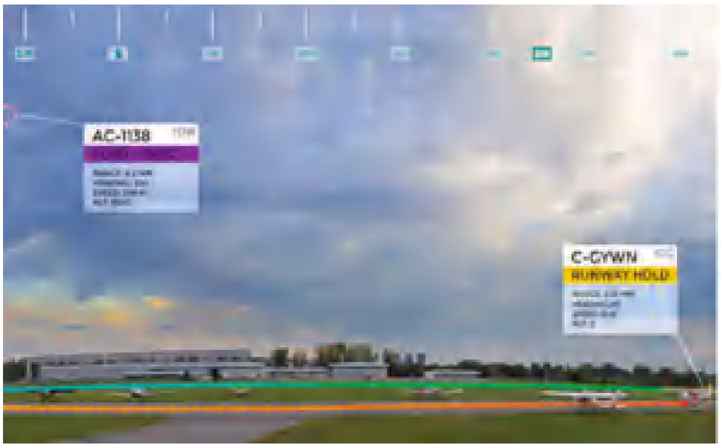
Virtual Reality mixed with actual reality is called Augmented Reality. It provides users with new tools to execute complex operations like aircraft maintenance efficiently. There are proposals by researchers for improvements in existing operations and there are flaws that undermine its implementation. Aircraft maintenance personnel can utilize this technology as an additional aid in rapid identification of locations and elements currently being serviced or repaired.

Lockheed-Martin›s application is used in the F-35 and F-22 fighter programs for final fighter assessment and repair. An inspector looking at the fighter through the glasses sees part numbers and plans projected over the physical aircraft. The inspector then uses a handheld device to enter any defects or repairs. This technology is replacing the checklist and clipboard method with the inspectors walking around the aircraft and logging the areas for repair., This reduces the time, effort and errors since the maintenance personnel access the same system to identify parts, locations and procedures.

Depending on the state of the post-accident wreckage this technology could be utilized by aircraft accident investigators at the accident site to identify aircraft parts, provide the history of the maintenance records and also details of the functions of specific parts during the operation of an aircraft.

Augmented Reality for Air Traffic Controllers

Air Traffic Controller operations are challenging during low-visibility conditions. The visual situational awareness of Controllers can be impaired, leading to a reduction in efficiency. As part of the Single European Sky ATM Research (SESAR) program a European company conducted research called Resilient Synthetic Vision for Advance Control Tower Air Navigation Service Provision (RETINA). The concept was demonstrated to the potential stakeholders in January 2018.



Using synthetic vision and augmented reality technologies, RETINA has developed goggles through which the controllers can see synthetic information overlaid on the actual “out-of-the-window” view. Using the goggles, the controllers can have a head-up view of the airport traffic, with the aircraft call sign and type, supplemented by additional information, such as wind velocity and direction, airport layout and runway status superimposed on the view, even during low-visibility procedures.

There are many two and three dimensional software ATC Virtual reality applications available that provide Tower Simulation to facilitate Air Traffic Control monitoring. Advanced ATC Training for example, developed a 3D

Tower Simulator for training purposes with a complete control console of features, including radio, intercom, meteorological and NAVAID simulations. Emergency procedures training, often dangerous and impractical to do in real life, is easily performed in 3D simulators. This package could lead to creating new methods of ATC data presentation, exploiting 3D technology using real-time airport database visualization.

Mixed Reality Proto-space

NASA's Jet Propulsion Laboratory (JPL) and the SpaceX company are in the process of developing an augmented reality application utilizing Microsoft HoloLens AR headsets to assist JPL engineers, in a virtual world context, in the construction of a spacecraft for future Mars missions. The innovators develop their creations in the virtual world before it is produced in reality in factories or production plants.

The Proto-space project is presented to scientists with a virtual model of the Mars rover. The virtual model can be interacted with in full scale for size and construction details in ways which cannot be achieved on a 2D computer screen.

The scientists and engineers can interact with the model by walking around the rover, accessing the interior and opening virtual panels to closely inspect the internal parts. These types of virtual reality mockups help engineers to fill the gaps and find hidden problems which would not be possible using traditional design tools.

The physical construction phase of traditional designs may differ in dimensions from the design blue prints and potentially slow down production progress and can cost significant amounts due to delays in project completion. AR produces an entire product design and construction process and product virtually, avoiding such losses.

The mainstream adoption of technology such as virtual reality, augmented reality and mixed reality for innovators and enthusiasts is just beginning and the future of such technology is very promising.

Conclusions

Every major aircraft accident is a unique experience for aviation safety investigators. An aircraft accident investigator may not experience investigation of a large accident during their professional career, but they must be constantly prepared for such an eventuality.

The use of aircraft accident investigation training incorporating innovative aspects of virtual reality or augmented reality for onsite activities is an attractive thought For instance, it would allow the integration of historical major accident data as a training tool to develop investigator skills. It may be anticipated that virtual reality tools will be developed as training aids and on-site aids for safety investigators in the near future...

Nose Gear Tire delamination on takeoff followed by engine failure

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The work of an Accident Investigator often involves looking at all the things that went wrong and resulted in the unfortunate outcome of an accident with the loss of an aircraft or the loss of lives. It is frustrating in those investigations, when milestones are identified, where the right action, often minor, could have prevented an accident.

Sometimes though, investigators witness successfully applied procedures and training, positive communication, good teamwork and timely decision-making.

On the 27th of September 2016, a Boeing 777 passenger aircraft operated by Etihad Airways was scheduled to operate a flight from Abu Dhabi International Airport to Sydney Kingsford Smith Airport in Australia. Onboard the full aircraft were 335 passengers, two flight crewmembers, two augmenting flight crewmembers, and 13 cabin crewmembers.

The captain, first officer and the augmented crewmember occupying the observers' seat in the cockpit, were in a good mood, while the aircraft taxied for take-off from runway 13 right (Figure 1). The weather was good, with clear visibility and a temperature of 36° C.

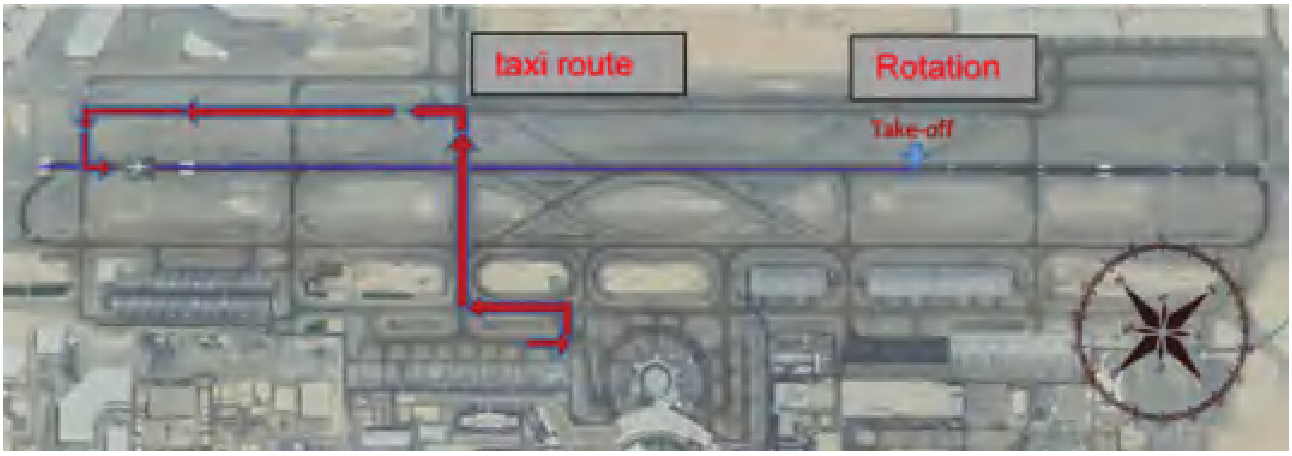

Figure 1. EY450 taxi route to runway 13R

The calculated takeoff weight for the long flight to Sydney was 347,807 kg, resulting in a decision speed of 174 kt and a rotation speed of 181 kt.

During the take-off roll, as the aircraft passed the decision speed and continued accelerating towards VR the flight crew felt vibration in the cockpit. Shortly after rotation the flight crew heard a loud bang with associated high exhaust gas temperature on engine No.1, followed by a "L ENG FAILURE" message on the Engine Indicating and Crew Alerting System. The number 1 engine vibration monitor increased from below "1" unit to "5" units while the fan speed indication dropped significantly. The engine then automatically shut down.

The Commander continued the climb. At an altitude of 369 ft, the airspeed had dropped to 172 kt. The flight crew concentrated on continueing the positive climb. They trimmed the Aircraft and engaged the autopilot at approximately 400 feet. The landing gear was selected to 'up' at 539 ft, while the airspeed slowly increased to 182 kt.

Once the aircraft was slowly climbing away and the flight crew had secured the unserviceable engine, the captain declared a MAYDAY and advised air traffic control that they were returning to the airport. ATC acknowledged the Mayday call and alerted the airport fire and rescue services. The runway safety team was instructed to inspect the runway for debris.

The flight crew were informed that tire debris had been found on the runway and they concluded that the aircraft had most likely suffered a nose landing gear tire failure. The condition of the damaged nose wheel tire, or the second tire, were unknown and a cause of some concern to the crew.

The aircraft climbed to 4,000 ft over the next 12 minutes and 25 seconds, and remained at that altitude for about 14 minutes during which time the flight crew prepared for an overweight landing on runway 13 Left. The crew requested the fire and rescue services to be in attendance and they discussed the use of foam at the end of the runway with ATC. The cabin crew and passengers were informed that the flight would be returning to Abu Dhabi and the reason for the return. Passengers were instructed to adopt the 'brace' position for the landing.

ATC offered to provide a visual assessment of the nose landing gear if the flight crew elected to fly a low altitude fly-by. The Commander declined because of the single engine operation and the increased drag with the extended landing gear.

After 33 minutes and 47 seconds flying time, the Aircraft touched down 1,280 meters beyond the runway threshold, 90 tonnes above the maximum landing weight. It came to a stop having travelled 2,590 meters in 50 seconds, with a runway distance remaining of 230 meters.

As the Aircraft was overweight and the engine thrust reversers could not be used for braking, the rollout after touchdown was prolonged, resulting in high brake temperatures. This caused the main landing gear thermal fuses to melt, and all of the main landing gear tires to deflate. Both nose gear tires maintained their pressure but the left tire was found to be delaminated . Due to the deflated tires of the main landing gear, the aircraft could not be taxied or towed to the gate and the passengers and crewmembers disembarked on the runway using two passenger stairs positioned to the two left forward doors.

No passengers or crewmembers were injured in this incident.

The investigation found that the left nose gear tire had shed its tread during the take-off roll. Portions of the tire tread were later found on the runway. Parts of the tread were ingested by the No.1 engine, causing damage to the fan blades and the engine core, which resulted in the automatic engine shut-down. Additional damage was identified to the lower fuselage, aft of the nose landing gear bay, and to the nose landing gear steering cable. In addition, there was evidence of tire debris impact on the inboard fan cowling of the No.2 engine.

Figure 2. Nose gear No.1 tire damage

Figure 3. Damage to lower fuselage aft of nose gear bay

Figure 4. No.1 engine fan blade and Inlet damage

The tire damage observed may have been caused by a towbar-less tug, sharp edges of the parking bay lights, or by lose foreign object debris on a taxiway or runway. The airport was not equipped with an automated runway FOD detection system but did conduct visual surface inspections for debris.

The investigation identified a number of airport stand ground light fittings which exhibited sharp edges. It was identified that towbar-less tugs, while disengaging from the nose wheels, can potentially cause tire damage.

This was a serious event with significant potential had tire debris also been ingested into the number 2 engine. It was identified that Boeing did not conduct a risk assessment for the very unlikely event of nose gear tire delamination, or failure, causing damage to both engines during take-off.

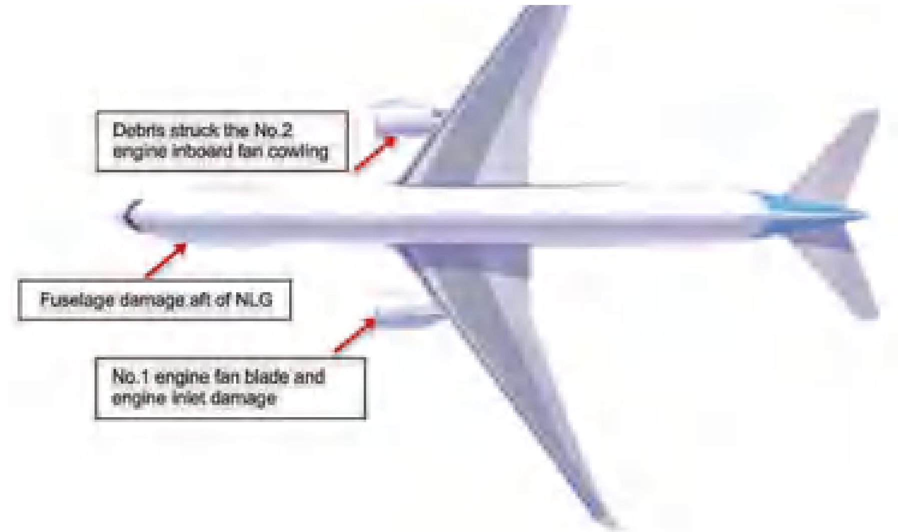

Figure 5. Locations of damage and impact mark on No.2 engine fan cowling

The investigation therefore recommended that the manufacturer assess this possible scenario. It was also recommended that all aerodromes in the United Arab Emirates should conduct regular inspections of ground light fittings, to ensure that they remain free of sharp edges that could cause damage to aircraft tires. It was recommended that Abu Dhabi International Airport install an automated FOD detection system, similar to that already in operation at Dubai International Airport, to reduce the risk of tire damage during aircraft movements.

The flight crew took calm and decisive action to continue the climb to a safe altitude, use the time available to assess the situation and gather information, prepare the aircraft and the airport for the landing, and to effectively share the workload among the crewmembers. The incident represented a professional application of CRM which assisted in a positive outcome.

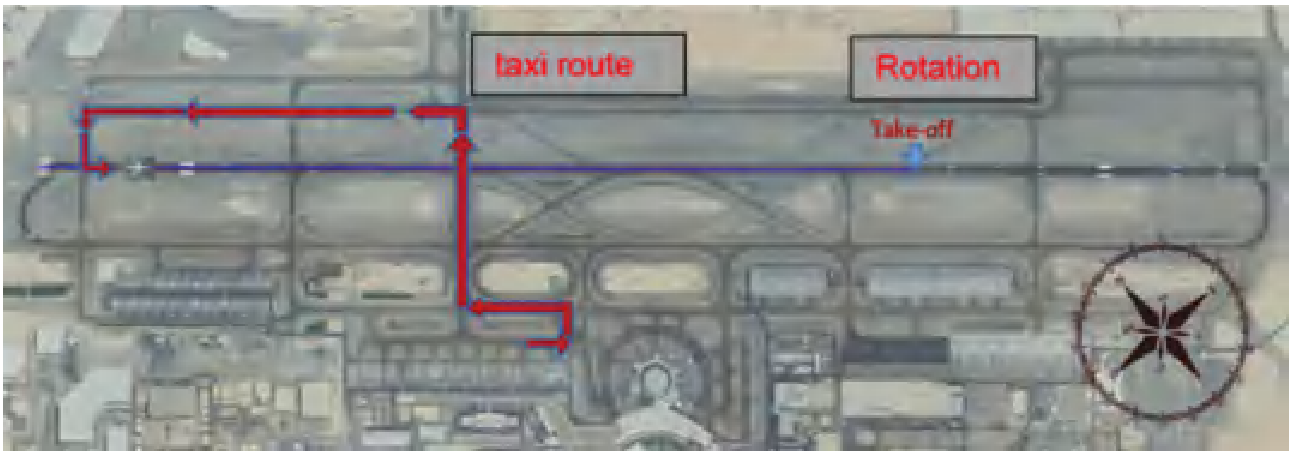

Figure 6. EY450 taxi route to runway 13R

Figure 7. No.1 engine fan blades and Inlet damage

Figure 8. Lights type used in the parking bays - OMAA

Salah Mudara

VP Operations MENA
GoCrisis

Continuous Readiness for an Emergency

Aviation is a dynamic and challenging business, inundated with many risks, most of which the industry has no control over, i.e., oil prices, financial downturns, regional conflicts, competition, and more.

For the operators, every takeoff and landing holds risk, but it is calculated risk. We hire experienced, qualified and trained professionals to manage the organization, and to fly and maintain the aircraft.

However, every now and then, things do go wrong, and we need to be in a ready position to respond accordingly. This readiness has different facets, from an individual's position, to the organizational aspects.

In simple terms, the individual has to be mentally capable (at times even physically capable) and professionally trained to cope and manage crises when they do happen. The organization has to be fully prepared with proper plans, procedures in place, along with the necessary logistics and financial aspects. Plans and procedures have to be frequently practiced, at least through tabletop exercises.

Having said that, one fact remains true, an operator is unable to fully undertake a task such as the response to a major disaster alone. They need the assistance and support of an emergency service provider with first-hand crisis and emergency management experience, with teams of specialists who have supported a variety of organisations through complex crises.

During the first hours following a major accident, the crisis management team will be severly tasked dealing with conflicting information and confusion. Once the dust settles and the crisis management team take full charge of the crisis at hand, they keep the people most affected in the forefront of their minds. Every strategic, tactical or communications decision they make that helps those most affected will also help to take care of their organization's future. The crisis management team and those involved in the response plan should keep one question in mind, "If this was my family, what would they need"?

Athletes don't reach the finish line without a lifetime of hard work and practice.

Organisations often make the mistake of being reluctant to invest in emergency preparedness, because there is no immediate benefit. You CANNOT expect to do well in a crisis situation, if you have not invested appropriately and trained for it!

Your muscles need to be strong, your mind needs to be focused, and your spirit has to have built up resilience and endurance.

When the unthinkable happens, the airline has to be prepared – way in advance – with plans, people, training, resources and pre-existing relationships with suppliers, government agencies (when possible), and partners.

In the first 24 hours, the rescue phase will be completed, the accident site will be secured by the police and the aircraft accident investigators will have started their work. When an operator hears news that one of their aircraft has been involved in an accident, the Incident Management System and emergency response plans and processes are implemented.

The organization will come under the spot light with overwhelming media coverage, an influx of telephone enquiries, the need to care for survivors, implementation of family assistance operations and multiple agency coordination. In addition there will be the recovery, identification and repatriation of the deceased and the processing and return of Personal Effects to the next of kin. The operator will also be involved as an adviser to their State investigation authority as the investigation progresses. It is also necessary to maintain normal business, so far as this is possible.

The demand for a fast, transparent and effective response and communication of the effectiveness thereof has increased exponentially as traditional and social media has become virtually instantaneous.

Social media has become the first source of information for much of the public and the media alike. Social media has accelerated the speed with which information is circulated. With each and every one of us a potential real time reporter equipped with a device in our pockets to share news with the world, organisations need to be prepared to communicate and respond as quickly as it takes our interconnected selves to click like and share.

A disaster will have a profound and a potentially life changing impact upon all those involved. The operator therefore has a responsibility to ensure that their response is performed to the highest standards, comprising both compassion and service excellence.


Panxika Charalambides
Flight Safety Director


Brian Tyrrell
Head of Flight Operations, easyJet


Capt. Christian Norden
Head of Flight Operations, easyJet

Preparing Flight Crews to Face Unexpected Events

During an approach at night-time into Glasgow Airport, the crew of an easyJet A319 experienced a strong cross-wind and turbulent conditions, which created a WINDSHEAR alert and led them to perform a go-around.

As they did this, PFD information including Flight Modes Annunciator, Flight Director bars, and characteristic speeds all disappeared from both PFDs. In addition, the rudder travel limiter function became unavailable, and the auto-thrust disconnected. The crew was facing a very challenging situation, and needed to use their training in back-to-basics flying and efficient Crew Resource Management.

This article describes the event, and provides analysis of its root cause. It also explores the training, oversight and cultural objectives in place at easyJet that have contributed to the crew's effective handling of an unforeseeable combination of factors. These were all key elements that helped the crew achieve a safe outcome.

A crew experienced a combination of factors they had not trained for

It was the crew's first sector of the day departing from London Gatwick for Glasgow. From the weather reported for Glasgow Airport, they were expecting turbulent conditions with cross-wind of approximately 26 knots and a wet runway.

The First Officer's Probe Heat Computer was inoperative prior to the departure from Gatwick and so the aircraft was operated under an MEL for the flight to Glasgow. The MEL procedure required the crew to select the Air Data selector to [FO ON 3] and set the ADR2 pushbutton switch to [OFF] prior to entering icing conditions. Icing conditions were expected during the flight, and so the ADR2 was set to [OFF] before the departure. The procedure also states that when the ADR2 has been switched [OFF], the ADR2 must remain set to [OFF] for the remainder of the flight (fig.1).

30-31-01B	**Probe Heat Computer (PHC)**

Applicable to: ALL

DURING COCKPIT PREPARATION

AIR DATA selector..F/O 3

IN FLIGHT

- If icing conditions are encountered:
  ADR 2 pb-sw...OFF

CAUTION	*When ADR 2 is set to OFF,* *- takeoff in CONF 1+F is not permitted, and* *- maximum landing capability is CAT 3 SINGLE.*

The ADR 2 pb-sw must remain set to OFF for the remainder of the flight.

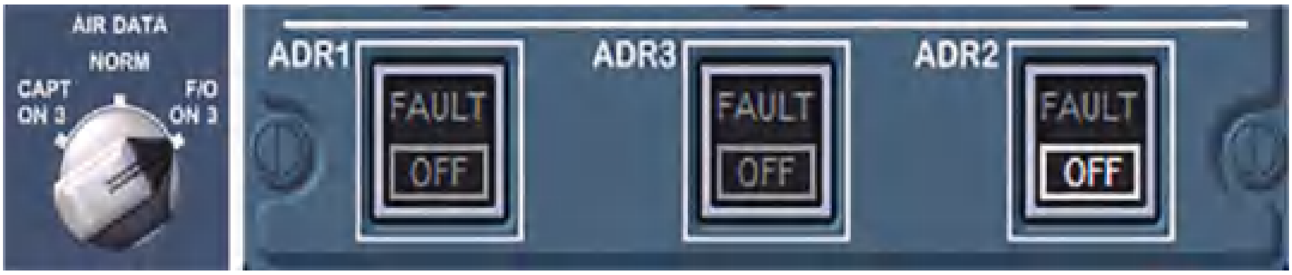

Figure 1. Application of MEL 30/31/01B for First Officer's Probe Heat Computer (PHC) inoperative.
Instructions are to select the AIR DATA to [F/O ON 3] and set the ADR2 pushbutton switch to OFF prior to entering icing conditions.

Figure 2. Primary Flight Display.
[FD] and [SPD LIM] flags are displayed in red text. They respectively indicate the loss of Flight Director bars and the characteristic speed information.

Each ADR is part of the ADIRU, and provides anemometric parameters which they compute from their associated air data probe outputs. The system architecture of A320 family aircraft includes three ADRs, called ADR1, ADR2 and ADR3.

After an uneventful flight from Gatwick, the crew reported turbulent conditions on the approach into Glasgow. They disconnected both auto-pilots while crossing one-thousand feet. The Captain was the pilot flying. Upon reaching 850 feet a reactive WINDSHEAR warning was triggered for 15 seconds.

The crew evaded the WINDSHEAR and then conducted the go-around as per standard operating procedures. However in the same instant the FMA became blank, the Flight Director (FD) bars disappeared from the Primary Flight Displays (PFD) and were replaced by the red [FD] flag (fig.2). The characteristic speed information were also no longer displayed on either PFD, and were replaced by the red [SPD LIM] flag, which was displayed at the bottom of the airspeed scale. The only information displayed on the airspeed scales were the current speed and the speed bug.

Additionally, two ECAM messages with the associated single-chime and master caution indicated they lost the Auto-Throttle (ATHR) as well as the rudder travel limitation functions. As shown in Figure 3, the ECAM messages indicated were the AUTO FLT ATHR OFF and AUTO FLT RUD TRV LIM SYS amber messages (fig.3).

As illustrated in (fig.4), the combination of the windshear, chimes and alerts created a startle effect on the crew. With the increased workload, the crew missed the AUTO FLT RUD TRV LIM SYS ECAM warning and hence did not apply the associated procedure shown on the ECAM display (fig.3).

In retrospect, if the crew had applied the procedure displayed on the ECAM they would have reset FAC1 and FAC2, and recovered all of the functions previously lost. However, on the climb from 1900 feet through to 2300 feet, during the slats and flaps retraction, three VFE (maximum allowable airspeed with flaps extended) OVERSPEED warnings sounded within 20 seconds. At the time of the second VFE triggering, the crew switched the ADR2 to [ON], which was not part of the operating procedure but resulted in the characteristic speeds and rudder travel limiter function being available again in the FAC2. This also made the Flight Director (FD2) available and it reengaged automatically on both PFD as it was still selected. Similarly the auto-thrust (ATHR) was also now available and later reengaged by the crew.

The crew successfully conducted the remainder of the flight and landed safely. Overall, the crew handled this difficult situation well, performing efficient Crew Resource Management (CRM), and applying back-to-basics in flying attitude and thrust to manage the go around phase.

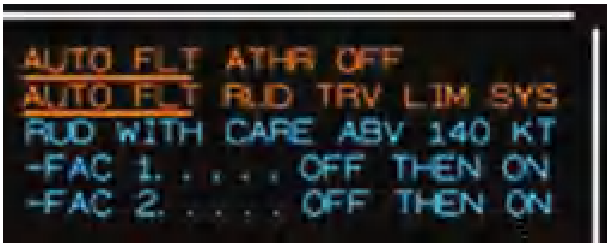

Figure 3.
Ecam messages 'AUTO FLT ATHR OFF' and 'AUTO FLT RUD TRV LIM SYS'.
Associated operating procedure to reset FAC 1 & 2 displayed with master caution and single chime.

Technical analysis of the event

easyJet and Airbus conducted a joint investigation into this event. Analysis of the Digital Flight Data Recorder (DFDR) showed a significant discrepancy between the AOA1 and AOA3 measurements at the same time that the WINDSHEAR alert was triggered. Why did the measured AOA3 increase significantly more than the AOA1 at that time? What are the consequences of this?

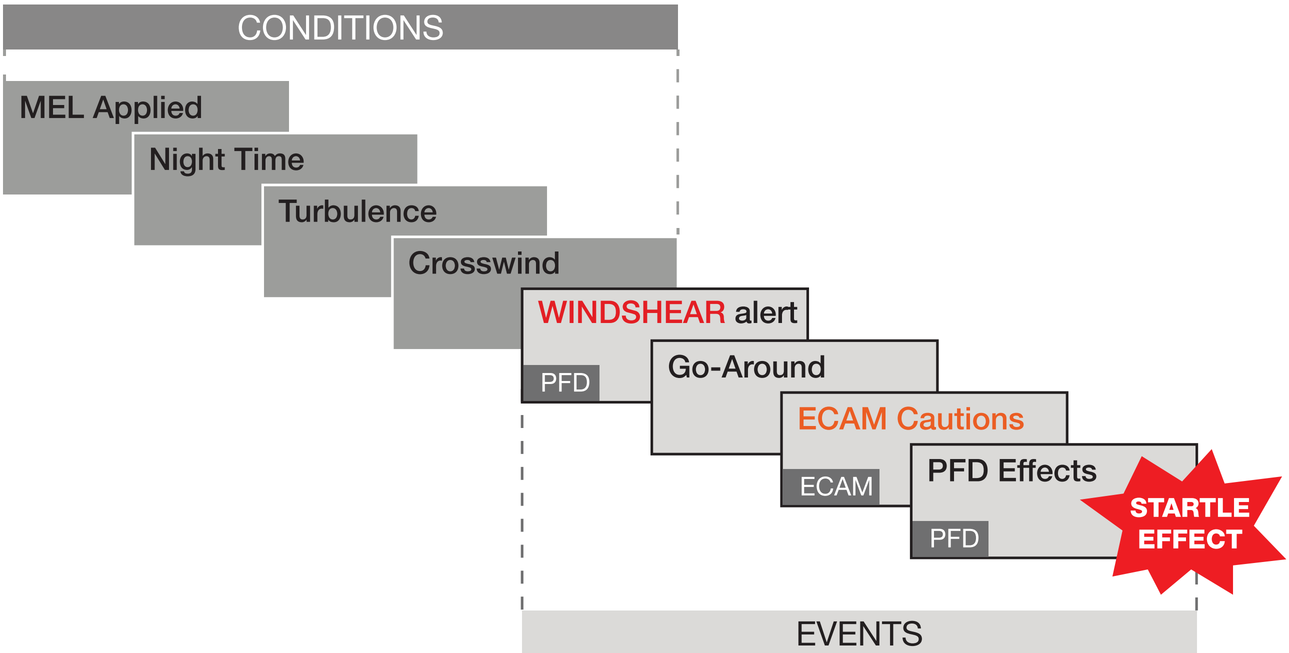

Figure 4. Combination of conditions and events which caused a startle effect.

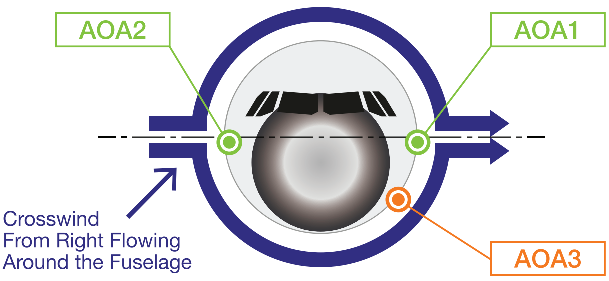

Figure 5. Lateral wind gusting across the fuselage during sideslip.

AOA3 is more sensitive to sideslip deflection, when compared to AOA1 and AOA2, due to its position below the horizontal symmetry axis of the aircraft.

The AOA3 is located below the aircraft's horizontal axis of symmetry and is therefore more susceptible to sideslip.

Angle of Attack and the Sideslip Effect Explained

This aircraft is fitted with three Angle of Attack probes that deliver three separate Angle of Attack measurements, so called AOA1, AOA2 and AOA3. The sensor vanes delivering AOA1 and AOA2 measurements are located symmetrically on the left and right sides of the aircraft close to the horizontal axis of symmetry. As illustrated in (fig.5), these locations give them a low sensitivity to sideslip.

The AOA3 is located below the aircraft's horizontal axis of symmetry. This position makes it more susceptible to sideslip because it is mainly exposed to the part of the lateral airflow which flows below the aircraft (fig.5). This is why the crosswind gust that occurred at the same time as the triggering of the WINDSHEAR alert caused there to be a discrepancy between the measured deflections of the AOA1 and AOA3 sensor vanes.

What were the consequences of the sudden AOA3 increase?

In the Flight Augmentation Computers (FAC)

Both FAC1 and FAC2 monitor certain ADR parameters, and in particular they monitor the AOA by performing a cross-comparison monitoring of all three AOA measurements provided by their respective ADR (refer fig. 6). In this event, where the applied MEL procedure called for the ADR2 to be switched to [OFF], the FACs were only monitoring for a difference between the measured values of AOA1 and AOA3.

The discrepancy between AOA1 and AOA3 measurements at the time of crosswind gust led to AOA1 and AOA3 ADR parameters being rejected by both FACs. When one ADR parameter is rejected by the FAC monitoring, then all parameters of its corresponding ADR are also rejected. Therefore, ADR1 and ADR3 were rejected by both FAC1 and FAC2. Consequently, there was now no ADR information available in either FAC.

In this condition, both FAC were no longer capable of computing the characteristic speeds, the FD bars, the auto-thrust, auto-pilot or rudder travel limiter function.

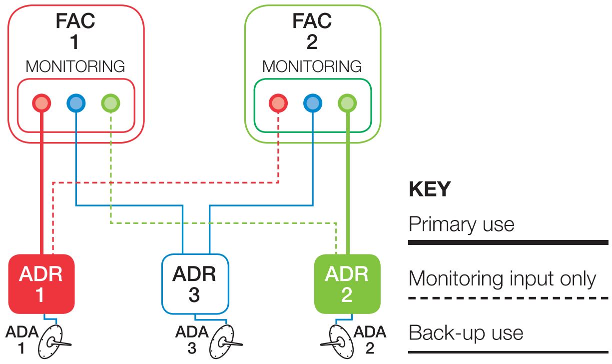

Figure 6. Simplified schematic diagram showing the system configurations for ADR1, ADR2 and ADR3 with the cross-comparison monitoring of ADR by FAC1 and FAC2 in a normal configuration.

In the Elevator & Aileron Computers (ELAC)

The sudden AOA3 increase had no consequences in the ELAC because the ELAC's monitoring is slightly different to the FAC one due to different architecture. Therefore data from both ADR1 and ADR3 remained valid in the ELAC, and normal laws including all flight envelope protections, continued to be computed throughout the flight.

On both PFD

The fact that ADR1 and ADR3 were rejected in FAC1 and FAC2 had no impact on the display of ADR parameters on the primary flight displays (PFD). Indeed, as the ADR1 and ADR3 were selected on the Captain's and First Officer's sides respectively, the current speed, Mach and altitude parameters delivered by these computers were respectively displayed on both the Captain's and First Officer's PFD until the end of the flight.

What are the consequences of turning ADR2 to [ON]?

At the time of the second VFE overspeed warning, the crew switched the ADR2 to [ON]. This led ADR2 parameters to be available again for functions computation in FAC2. Therefore the characteristic speeds, the rudder travel limiter function, the Flight Director (FD2) and the autothrust (ATHR) became available again from channel2.

However, the autopilot remained unavailable since FAC2 had only information from one ADR available.

The easyjet formula for an enhanced safety benefit

easyJet continues to learn from events like the one analyzed in this article in order to prepare its pilots to face unexpected events and manage situations to have a safe outcome. It has a specific structure that it has put in place for managing remote bases and this reinforces the dissemination of safety, technical and training materials. Through the development of its "Just" culture, crews have confidence to report events so that their experience can be shared.

The importance of encouraging pilots to practice manual flying skills

Practicing manual flying in various conditions and to use automation appropriately

easyJet recommends that all of its pilots regularly disengage the automation and practice their manual flying skills in various weather conditions. It is at the pilot's discretion to choose when to fly without the auto-pilot or without auto-pilot and auto-thrust. easyJet places emphasis on using automation appropriately to reduce workload, and for the crew to fly manually when they feel they have the right conditions to do so without reducing their overall capacity. Manual handling skills are further reinforced in the easyJet simulator sessions.

The aim of encouraging regular practice of manual flying skills, both on the aircraft and in the simulators, is to ease the management of any unexpected events that could lead to less aircraft automation being available. Additionally, this reinforces the confidence of the pilots in their manual flying capabilities, which can help them to minimize the startle effect from unexpected events. In the flight described in this article, it was evident that the Captain was confident to manually fly the aircraft in the turbulent conditions on the approach into Glasgow as he disconnected the auto-pilot from one-thousand feet.

The importance of "Just Culture"

Encouraging the reporting of events to share the lessons learned and enhance safety

easyJet promotes a "Just Culture" for reporting events, which ensures that they can be objectively resolved and with a standardized recorded outcome. The reporting of an event by the crew and the subsequent investigation allows easyJet to collect all of the relevant facts in order to accurately rebuild the scenario. The aim is to share these experiences with other pilots, and to recognize positive behaviors that the crew exhibited when faced with a rare and unpredictable event. For easyJet, a "Just culture" means that when their crews are capably acting with their best intentions, to the capacity of their knowledge and experience levels, they can perform their responsibilities without the worry of an inconsistent reproach from the easyJet management.

What is "Just Culture"?

"A culture in which front-line operators or other persons are not punished for actions, omissions or decisions taken by them that are commensurate with their experience and training, but in which gross negligence, willful violations and destructive acts are not tolerated."

This definition of "Just Culture" was formally enacted by European Commission Regulation for the reporting, analysis and follow-up of occurrences in civil aviation.

The meaning is that under "Just Culture" conditions, individuals are not blamed for 'honest errors', but are only held accountable for willful violations and gross negligence.

Role of the Base Standards Captains in supporting event reporting and knowledge sharing amongst the pilots at a remote base

For the pilots who are located at bases away from the easyJet headquarters, a network of Base Standards Captains (BSCs) are in place. These BSCs distribute new procedures into each base in the easyJet route network, to ensure the procedures and other safety related changes are understood and adopted.

A BSC will carry out regular performance monitoring and standards assessments to ensure the continued capabilities of all pilots operating in their base. All of easyJet's BSCs are line training Captains who are embedded within the day to day front line operation and therefore are best placed to engender a supportive atmosphere at the base in which pilots can operate, share their experiences and report events, or seek out knowledge if required.

Importance of operators updating their training packages

Enhancement of training with the lessons shared from event reports to train for outcomes rather than from specific tasks

easyJet invests significantly in providing both remedial and supportive training packages for all of its crew and has over 10 years' experience in using Alternative Training and Qualification Program (ATQP). This has provided more effective, operations specific training packages. The packages are designed using data from both industry wide and specific company safety events, as well as statistical analysis of data in order to identify additional areas that need to be trained.

With over 400,000 sectors a year flown across the fleet, easyJet has a rich stream of internal flight data to analyze. Their training team can define additional training priorities based on what they see in both the operations and in simulator sessions. They also draw upon the available industry information, including the lessons learned and recommendations from accident and incident reports. These are made available to all easyJet pilots for review.

The easyJet system is designed to "train for outcomes" rather than for specific scenarios. It includes training for upset recovery in normal law and multiple training cases for unreliable airspeed, which are opportunities to emphasize importance of "pitch and thrust" flying. All of the easyJet pilots are immersed in this training philosophy.

Reinforcing safety of operations though training enhancements

easyJet's training highlights the importance of crews going back-to-basics to ensure a positive outcome for the safety of their flights, and the importance of efficient Crew Resource Management (CRM) when facing unexpected events.

For the event described by this article, it was clear for the First Officer as the pilot monitoring that his priority was to closely monitor the parameters, and in particular to always remain aware of the aircraft pitch attitude and bank angle during the go-around phase. The Captain as the pilot flying followed the standard operating procedures and applied back-to-basics attitude and thrust flying with the priorities to "Fly, Navigate and Communicate". This allowed them to manage the situation and have a positive outcome to this startle effect event.

It is impossible to train every pilot in scenarios that will cover every potential threat. However, easyJet believes that by training their crews to 'manage outcomes' and to manage complex failures as a team for events, such as upset recovery or unusual attitude, they get an enhanced safety benefit across their entire fleet for all of their customers and crews.

Reprinted courtesy of Airbus SafetyFirst publication.

Dubai

United Arab Emirates

ISASI Seminar and Tutorials

"The Future of Aircraft Accident Investigation"

The annual seminar and tutorials of the International Society of Air Safety Investigators will take place at the Intercontinental Hotel, Festival City, Dubai,

from

29 October to 1 November 2018

Attendees of the Seminar are encouraged to join one of the Tutorials on 29 October:

- Future Developments in Aircraft Accident Investigation
- Basic Failure Analysis- Failure Mode Identification at the Accident Site
- Military Aircraft Accident Investigation

For more information about the ISASI Seminar 2018, please visit:

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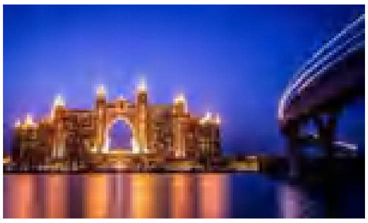
ISASI Seminar 2018
29 October - 1 November

Companion Program

During the ISASI Seminar there will be a Companion Program which will include 2 days of touring, breakfast each morning and all the social events. Companions can attend a Welcome Reception on Monday night, Tuesday Night Dinner Cruise and the President›s Reception & Awards Banquet on Wednesday Evening. Lunch will be included during the tours on both days. More details are available at http://isasiannualseminar.com/

Day 1 Tuesday



Starting at 10:00

Pickup from hotel

First Location:
Etihad Museum

Second Location:
Atlantis the Palm

Third Location:
Burj Al Arab

Fourth Location:
Burj Khalifa

Day 2 Wednesday

Starting at 10:00

Pickup from hotel

First Location:
Al Fahidi Museum

Second Location:
Abra Ride across The Creek

Third Location:
Gold & Spice Souq

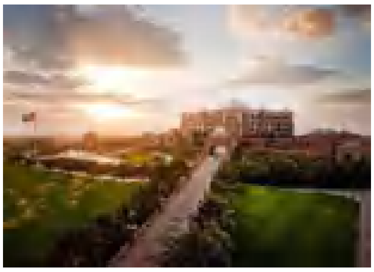
Fourth Location:
Dubai Frame

Friday Tour- 2nd November

To provide you with an opportunity to see Abu Dhabi, the capital of the United Arab Emirates, before you return home, we have planned a very pleasant and interesting Tour on November 2.

Sheikh Zayed Grand Mosque

The Louvre, Abu Dhabi



Emirates Palace