ISASI FORUM

"Air Safety Through Investigation"

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A 1998 emergency evacuation using exists on the right side of the aircraft. The 3R door did not open fully, and the slide did not deploy. Twenty-eight passengers reported minor injuries from the evacuation. (Photo courtesy of NLR-Air Transport Safety Institute)

ISASI FORUM
"Air Safety Through Investigation"

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AIR SAFETY INVESTIGATORS
INCORPORATED AUGUST 31, 1964

Meet the 2009 Kapustin Scholars

By Frank Del Gandio, ISASI President

You have heard me speak or have read the words of praise I have often written about the ISASI Rudolf Kapustin Memorial Scholarship program we instituted in 2002 to memorialize all deceased ISASI members. It is a program that we can all be proud of, for it has succeeded well beyond our initial expectation of awarding an annual scholarship to a college-level student interested in the field of aviation safety and aircraft accident occurrence investigation. Our hope in initiating the program was to entice a greater number of students to our Society, which is becoming increasingly aged.

The initial award was $1,500. It has since grown to $2,000. The award's intent is to grant a student membership in ISASI and to allow the recipient to attend the respective year's ISASI annual international seminar on air accident investigation. No dues funds are used to support this program. It is totally dependent upon voluntarily [tax free in the U.S.] contributions. And in that, you, the membership, have been unselfishly generous. Since the program's inception, more than $35,500 have been donated. Much of the funding has come from donations made by our chapters and societies [see "Mid-Atlantic Council Conducts Spring Meeting," page 24].

Not only have we been able to increase the monetary award, but for the past 2 years we have been able to select three recipients. Since inception, 15 students have received awards and 4 of them are now working in fields related to aviation safety and investigation. Indeed, our first two recipients of the award—Michiel Schuurman and Noelle Brunelle—have delivered papers at our annual seminar. Michiel at ISASI 2005 [see *Proceedings* 2005, "3-D Photogrammetric Reconstruction in Aircraft Investigation," page 118] and Noelle at ISASI 2008 [see *Proceedings* 2008, "Conversations in the Cockpit: Pilot Error or a Failure to Communicate," page 67].

It is with great pleasure that I introduce to you the three recipients of the 2009 scholarship: Dujuan B. Sevillian, Cranfield University, School of Engineering, Human Factors and Systems Engineering, Bedfordshire, United Kingdom; Brian Dyer, Embry-Riddle Aeronautical University, Daytona Beach, Fla.; and Murtaza Telya, Academic Institute, Massey University, Palmerston North, New Zealand.

Dujuan is a product of Atlanta, Ga., U.S.A., and an alumnus of Embry-Riddle Aeronautical University, Extended Campus. He is in his second year of graduate study for his Ph.D. in flight deck design aviation safety. His professional goal is to be an aviation safety expert, and to "work within the field of human factors and aircraft incident/accident occurrence because there is constant need to improve aviation safety throughout the world. The air transportation system is a critical component to the economy, and there is a need to ensure optimization of safety to the general public. Since the air transportation system has a very dynamic infrastructure, it is paramount that a continuous effort is made to also provide new concepts in design." Already he has trained with the NTSB; functions as a graduate research consultant, Transportation Research Board (TRB), National Academies, Aviation Safety Issues; has experience with the airline industry working as a safety specialist within the confines of the ASAP program and regulatory compliance; and serves as a part-time instructor/professor at ERAU, Worldwide. He also holds a private pilot license and is obtaining a commercial rating.

Brian hails from Charleston, S.C, Carolina, U.S.A. He holds an undergraduate degree in business aviation and is enrolled in a masters of science in aeronautics (MSA) program with a course of study in safety. He expects to graduate in December 2009. He believes that his 10 years' experience in air traffic control and airport operations and past training in aircraft accident investigation provides a solid foundation to work as an aviation consultant. He is married and has two children.

No dues funds are used to support the Rudolf Kapustin Memorial Scholarship. It is totally dependent upon voluntarily [tax free in the U.S.] contributions.

Murtaza is from Mumbai, India. He is a third-year student seeking an undergraduate degree in aviation management. He expects to graduate in 2010. At this time, his aspirations are to become a professional in fields related to airline/airport management or human factors. In explaining his hopes, he said, " I initially aspired to become a pilot, but after gaining 100+ hours of experience, I decided to switch to the aviation management program at Massey University, which specializes in various aspects of aviation such as aviation psychology, airline management, air traffic design, etc." He holds a New Zealand CAA private pilot license and lists as hobbies reading, hiking, photography, swimming, and using flight simulator software. His main interests are aviation, history, and soccer playing.

Adjoining this introduction, you will find the essay that each of these students submitted and was judged to be of sufficient superiority, each in its own right, to be declared a top submission. The theme of the essay was restricted to subject matter that addressed "The Challenges for Air Safety Investigators." I am sure you will agree that each one of them did an outstanding job.

And as you read the essay, think about the breadth and vitality of thought presented, think of those other students attending an aeronautical institution who hunger for a career in aviation but who may not realize our Society exists. Then, consider if any of your annual contributory dollars could or should be directed toward nurturing your profession and Society.

Remember, our selectees are students: no expense accounts, no jobs, no extra cash to pay for related travel and living expenses to our seminars or to gifted training courses. Corporate members in particular might consider donation of in-kind services such as air tickets or lodging expenses to travel to the seminar location or to redeem a training gift. Again, let me remind you that in the U.S., contributions to the ISASI scholarship fund are tax-deductible. ◆

The Continuous Challenge for U.S. Air Safety Investigators Assisting in International Investigations

By Dujuan B. Sevillian

NTSB investigators support the standards within ICAO Annex 13 and have assisted international investigators with aircraft accidents for several years. Sending U.S.-accredited representatives to aircraft accidents builds rapport

with international investigators. The various methods of exchanging technical expertise, the willingness of investigators to serve, and the continuous exchange of information to improve aviation safety around the world are just a couple ways that can improve communication within aviation safety. In 2003, the NTSB conducted a study regarding aircraft accidents around the world. According to the study, Africa and the Middle East maintained an accident rate of 1.54 fatal accidents per million flight hours and 3.62 per million flight departures. Several other agencies have conducted studies to determine why there are so many aircraft accidents in other areas of the world (NTSB, 2003). U.S. investigators have assisted the African continent with improving aviation safety. The United States Congress mandates that the NTSB promote aviation safety across the world, and it would seem pertinent that the NTSB would be an integral part in continuous aviation-safety-related improvement strategies.

The various methods of exchanging technical expertise, the willingness of investigators to serve, and the continuous exchange of information to improve aviation safety around the world are just a couple ways that can improve communication within aviation safety.

On April 1, 1998, a "Safe Skies of Africa" program was initiated by the U.S. Department of Transportation (DOT) and focused on aviation safety and airline security between the U.S. and nine African nations, including Angola, Mali, Namibia, and Tanzania. According to statistics, most of the accidents in Africa are related to maintenance human factors (FAA, 2004). Since the FAA regulates the continuous analysis and surveillance of maintenance programs within the U.S., it would seem practical to assist the international aviation community of Africa within these confines. From an FAA air safety investigator perspective, and beyond just investigating accidents, areas of concentration in Africa should be the development or the continuous support with facilitating effective air carrier internal evaluation programs, aviation safety action programs, and continuous analysis and surveillance systems within Africa's air transportation system, just to name a few. These programs could assist their government and airlines to continuously improve aviation safety. These types of oversight systems and the active management of these programs have helped improve the United States air transportation system considerably over the past 10 years thus reducing the number of aircraft accidents and incidents.

Recently, the Air Transportation Oversight System (ATOS) initiative was developed by the U.S. FAA to enhance the overall system safety aspect of air carrier programs and the associated departments that require oversight by the FAA for the airline industry. As air travel increases and new aircraft are developed, there is a demand for continuous surveillance of an airline's maintenance and flight operations programs. However, this program could also help air safety investigators determine a cause (s) of an accident or incident. Since ATOS is a multifaceted system, Africa's airlines could adapt to a similar system structure. Safety culture is a key aspect with the ability for this system to produce positive and meaningful results. The airline must understand that effective organizational safety culture and the acceptance of this culture from upper-level management could make the process of investigating an incident/accident easier from the air safety investigator standpoint by helping the investigator understand the airline's dynamic culture. Seemingly enough, the utilization of the ATOS system safety attributes within Africa's airlines could be a good evaluation tool to improve air safety within Africa and possibly reduce the rate of accidents from the commercial scheduled domestic air carrier perspective.

The six ATOS system safety attributes are responsibility, authority, procedures, controls, process measurements, and interfaces. These attributes would capture areas of satisfaction and related areas of needed improvement within particular areas such as manual currency, flight operations, personnel and training, and compensatory rest requirements. Moreover, airlines would have the opportunity to utilize safety attribute inspections (SAIs) to determine if their entire processes incorporate the six safety attributes, thus meeting the requirements of Africa's Civil Aviation Agency (ACAA), and then provide an assessment to the airline utilizing elemental performance inspections (EPIs). These types of analysis and the associated results that are documented by the airlines and the ACAA could aid U.S. investigators when they proceed with assisting the applicable agency (s) with the accident or incident investigation (s). U.S. investigators would have the opportunity to share information and assist "as needed" with helping determine a cause of the incident or accident if this process is followed by utilizing the source data from the inspections. However, as stated earlier, the safety culture could be a pivotal factor in determining any primary or final cause of an incident or accident depending on the organizational safety culture make-up of the airline.

The U.S. has implemented the Commercial Aviation Safety Team (CAST), which focuses on the reduction of aircraft incidents and accidents within the U.S. The CAST team has been very successful in the reduction of aircraft accidents and incidents since its inception almost 10 years ago. The development of a similar team in Africa would seem most practical from the organizational standpoint and could aid with accident and incident investigations by providing more information regarding the aviation-safety-related incident or accident. The CAST team could be a similar infrastructure from the U.S., teaming with industry partners and other related government officials to reduce the rate of aircraft incidents and accidents in Africa. After implementing this team in Africa, there could be more of an awareness of the underlying "common threads" causing incidents and accidents within the African continent. Team investigators could meet and discuss air-safety-related incidents and accidents.

The reduction of incidents and accidents could possibly decrease the global percentage and could decrease Africa's current rate if other factors such as safety culture and organizational safety are considered. Since human-factors-related incidents and accidents continue to remain prominent within the world airline industry's flight operations programs and maintenance programs, there is a need to enhance human-factors-related programs within the airline industry. The CAST program, ATOS program, or similar types of programs could be essential to Africa's air safety enhancement and could aid air safety investigators with African-related air safety investigations; however, these types of programs will present more challenges to the air safety investigator in Africa but could reduce the amount of times the investigator is "kicking' tin." ◆

Caring for the Mental Health of Air Safety Investigators

By Brian Dyer

Today's aviation industry possesses many challenges for air safety investigators. Some of these challenges include, but are not limited to, composite materials, jagged edged metals, environmental hazards, wildlife, blood-borne pathogens, parachute systems, hazmat, and aviation fluids. Among all these challenges, there is one that receives very little attention: the mental health aspects or mental preparation of air safety investigators

The International Civil Aviation Organization (ICAO) training guidelines for aircraft accident investigators (Circular 298-AN/172, page 5) recommends that investigators be trained in investigator safety, including psychological stress. The accident site safety (Section 4.1.2.5, page 8) of that same document mandates that the subject of dealing with the psychological stress of investigators and other personnel exposure to an accident site must be covered. This training does not imply that the investigators are trained to be emotionally tough. It merely prepares them for what is anticipated at an accident site.

Aircraft accident investigators (AAI) generally arrive at the scene of an accident after the emergency services personnel. However, there are instances where the investigators are exposed to the chaotic, traumatic, and emotional situations at the scenes of accidents. While exposure to extreme psychological stressors does not always bring about negative reactions in aircraft accident investigators, there is empirical evidence that the exposure to these critical events does pose a challenge. Understanding the cases in which the investigators allow an event to become a traumatic stressor is both important and essential for diagnosis and to provide timely mitigation measures.

Recently, the awareness of the psychological impacts of traumatic and critical events has increased, and post-traumatic treatments have received considerable attention. This attention has brought greater interests in the events that are likely to lead to post-traumatic stress symptoms. Empirical evidence has found that post-traumatic stress symptoms may develop after a single exposure to a critical event. However, although clinical procedures have been developed primarily for assisting first responders, military personnel, and public safety employees (police, EMTs, firefighters) with symptoms of acute distress, there is currently no specific program developed for intervention and prevention of distress experienced by aircraft accident investigators (Coarsey-Rader, 1993).

The traumatic effects of aircraft accidents on aircraft accident investigators have received very little attention since the primitive aviation days of early aviation enthusiasts and the Wright Brothers. Aviation accidents are sometimes fatal, and aircraft accident investigators often experience graphic exposure to severe injuries, mutilated bodies, mass destruction, the stench of burnt flesh, and aviation fluids at the scenes of these accidents.

In the search for the probable causes of these accidents, the investigators are also required to conduct interviews with surviving participants, along with coworkers and the family members of the deceased crew. It is also a common practice to listen to the cockpit voice recorders (CVRs) capture the last transmissions of the pilots' conversation with air traffic control (ATC). In these final moments prior to impact, it is not uncommon to hear the vivid screams, outcries, and panic among the crewmembers as they face certain death on these doomed flights. All of these factors may contribute to the accident investigator experiencing the effects of traumatic distress and other psychological symptoms if the coping skills of that individual are overwhelmed.

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It has been recognized that immediate intervention following a traumatic experience will reduce the long-term impact of acute stress and other psychological-related problems. In an attempt to mitigate the psychological effects of the traumatic exposure, formal clinical interventions have been adapted. These interventions include critical incident stress debriefing (CISD), critical incident stress management (CISM), crisis counseling (CC), and resiliency management (RM). However, despite the popularity of the many clinical applications to mitigate psychological distresses, there has been some controversy about how best to address the onset of exposure to the critical events.

Research from the International Critical Incident Stress Foundation (ICISF) demonstrated that more than 90% of individuals involved in a traumatic event would develop some type of adverse psychological effect. These psychological effects are enhanced by a number of risk factors that include, but are not limited to, previous traumatic exposure, limited intelligence or awareness, limited social support, genetics, prior mental illness, and problems associated with personal family life (Flannery, 1999).

In 1994, the American Psychiatric Association (APA) published a table of common symptoms of psychological trauma and post-traumatic stress disorder. According to the table, those who are traumatized will develop symptoms that may include intrusive recollections of the critical event, avoidance of the traumatic situation with a numbing of general responsiveness, and increased physiological arousal. An individual experiencing substantial and long-lasting cognitive, emotional, behavioral, and physical change must be treated immediately to prevent additional problems. It has been proven that early intervention can greatly reduce the time and expense of the treatment process, as each individual may have a different reaction to the traumatic distresses (Flannery, 1999). However, individuals have a tendency to feel that asking for support is a sign of weakness and results in that person ignoring the side effects, which may have irreversible effects.

It is prudent to develop a training package similar to that of OSHA's blood-borne pathogens course that may provide investigators with the mental conditioning required to address the traumatic events that are most likely to occur at accident sites. This course may include procedures to evaluate the resources within an organization and training investigating teams to develop effective communication channels for the flow of sensitive information. In addition, institutions conducting training for personnel involved in accident investigating should provide early psychological intervention, training, and/or services as a critical component of their respective programs.

In the interim, communication and educational awareness regarding exposure to critical events must continue in earnest throughout the aircraft accident investigating community. While we cannot prevent exposure to these emotional and psychological situations during the discourse of our duties, the failure to provide awareness and training may result in the investigators themselves becoming the silent victims of the disasters. ◆

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Impediments to ASI Investigations

By Murtaza Telya

Aviation safety investigators (ASIs) are undervalued and berated quite often, but the fact of the matter is, ASIs are crucial and intrinsic to commercial aviation. Being an ASI can also be perilous at times; stepping into a hazardous area surrounded by debris and toxic fumes to investigate an accident can pose a serious threat, but it must be done to find the root cause of an accident and to improve aviation safety. ASIs deserve credit for improving air safety within the past decade. The average accident rate has dropped to only 1.6 per million departures between 1998 and 2007 (Boeing, 2008); however, there are still many issues that need to be addressed to improve global air safety, especially for ASIs. Some of these issues are cultural factors, detrimental news media coverage, and judicial and legal duress.

The first issue that needs to be addressed is the role of cross-cultural factors in accident investigations, particularly national cultural factors. Cultural factors are pivotal and have a significant impact on the methods of accident investigation and the interpretation of events leading to an accident. All accident investigators don't necessarily concur on the causes of an accident. For example, after the crash of Flash Airlines Flight 604 in Egypt, the NTSB and the BEA concluded that both pilots on the aircraft were insufficiently trained and attributed the accident to human error; however, Egyptian authorities persistently disagreed with the assessment and stated that the plane crashed because of a mechanical failure (Sparaco, 2006). Such biases can impede the investigation if they are not tackled properly. These differences can be attributed to the fact that Egyptians tend to be more collectivist

Improper accident investigation is one of the primary causes of poor safety, and even though there have been many advancements in the area of accident investigation, cultural factors, detrimental news media coverage, and unnecessary regulatory and legal duress can be cumbersome for the ASI. These issues need to be dealt with promptly and efficiently.

than Westerners, which means their society is more integrated and cohesive and they don't encourage individual reprobation (Staunch, 2002). Methodologies can differ from culture to culture as well. A recent study conducted on 16 Taiwanese and 16 British ASIs found that while Taiwanese investigators focus on accidents in a holistic manner and try to understand how all the casual factors leading to an accident interact with each other, British investigators basically focus on preferred patterns of explanations and an object-oriented method of accident investigation; in other words, Eastern cultures use a holistic approach to investigate accidents while Western cultures use a more individualistic approach (Li, Young, Wang, & Harris, 2008). These cultural conflicts become quite prevalent when international accidents occur, and one must learn to utilize the differences in culture to one's advantage instead of trying to eradicate them.

Another prominent challenge that aviation investigators face is detrimental news media coverage. News media attention can be very cumbersome for investigators, since many news media outlets tend to propagate conjuncture and incomplete reports; the news media coverage of the Colgan Flight 3407 crash corroborates the aforementioned statement. News media reports propagated that the crash was caused because the plane was on autopilot in icing conditions, even though there were other factors involved, thus undermining the official investigation and misinforming the public (Learmount, 2009). Similarly, news media outlets such as *The Times* of London and *The Sun* published many inaccurate articles related to the Air France Flight 4590 crash before the investigation had concluded; they incorrectly speculated that the supposed cracking of the Concorde's wings and metal fatigue in the fan blade caused the accident (Johnson, 2003). Such misinformation can be very harmful. The news media frenzy after airline accident in certain countries is so great that investigators in Russia are compelled by the news media to finish their investigations within a year, or else they are bound to face excessive scrutiny and badgering (Bills, 2007). Finishing an investigation within a year may sound efficient; but in many cases, gathering and analyzing evidence takes a long time, and sometimes excessive pressure can compromise the quality of an investigation.

The last issue that needs to be mentioned is that of judicial and legal duress. Legal and judicial authorities tend to complicate investigations because of their unnecessary interference and unwarranted criminalization of aviation personnel involved in an accident. This needless meddling from legal authorities has become increasingly prevalent, especially since the September 11 attacks. Judges and prosecutors constantly tend to seek criminal sanctions against aviation personnel in the wake of accidents involving human error, even though the facts do not support the findings of sabotage, criminal negligence, or willful misdemeanors (Quinn, 2007). This has been illustrated in many accidents, such as Gol Airlines Flight 1907 crash, where the surviving pilots of the Embraer jet that crashed into the Gol aircraft were charged with involuntary manslaughter, even though there is no evidence (Quinn, 2007). The maintenance crew of the Concorde aircraft that crashed on July 25, 2000, experienced similar treatment from the French government, which prosecuted four Continental Airlines maintenance crewmembers for manslaughter (Quinn, 2007). Such legal pressures can have drastic ramifications for the ASI, since it discourages personnel from providing accident information that would make them susceptible to unnecessary prosecution. At times, prosecutors and judiciaries even tend to withhold valuable information from investigators; case in point, after the crash of a Cessna citation in Rome on Feb. 7, 2009, Italian authorities confiscated the cockpit and flight data records and refused to disseminate them to the ASIs, in order to conduct their criminal investigation before the accident investigation could be concluded (Flight Safety Foundation, 2009). Authorities must realize that unless there is solid evidence of sabotage or criminal negligence, crucial evidence cannot be withheld from authorities and personnel cannot be incriminated either, or else the investigation process will be hampered and safety will be compromised.

Improper accident investigation is one of the primary causes of poor safety, and even though there have been many advancements in the area of accident investigation, cultural factors, detrimental news media coverage, and unnecessary regulatory and legal duress can be cumbersome for the ASI. These issues need to be dealt with promptly and efficiently. They must be solved by improving cultural training, improving relations with news media outlets to disseminate accident information in a responsible and accurate manner, and by urging authorities to change regulations that can impede an accident investigation. These are not quick-fix solutions, but the only way to improve safety and enhance aviation is to implement them. ◆

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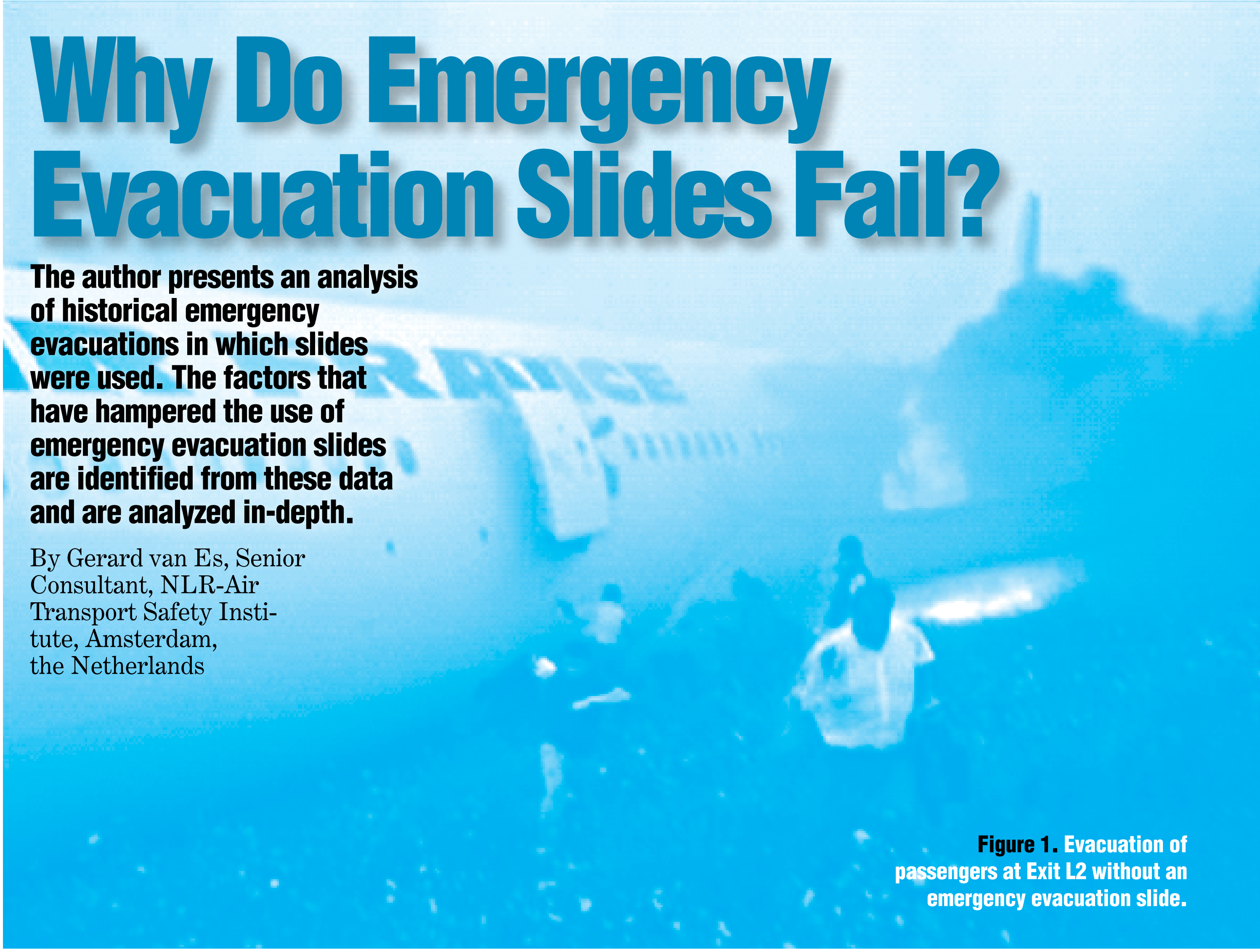
Why Do Emergency Evacuation Slides Fail?



The author presents an analysis of historical emergency evacuations in which slides were used. The factors that have hampered the use of emergency evacuation slides are identified from these data and are analyzed in-depth.

By Gerard van Es, Senior Consultant, NLR-Air Transport Safety Institute, Amsterdam, the Netherlands

Figure 1. Evacuation of passengers at Exit L2 without an emergency evacuation slide.

(This article is adapted, with permission, from the author's paper entitled Problems in Operating Emergency Evacuation Slides: Analysis of Accidents and Incidents with Passenger Aircraft *presented at the ISASI 2008 seminar held in Nova Scotia, Canada, Sept. 8-11, 2008, which carried the theme "Investigation: The Art and the Science." The full presentation, including cited references to support the points made, is on the ISASI website at www.isasi.org.—Editor)*

On Aug. 2, 2005, an Air France Airbus A340-300 aircraft departed Paris, France, on a scheduled flight to Toronto, Canada, with 297 passengers and 12 crewmembers on board. While approaching Toronto, the flightcrew members were advised of weather-related delays. On final approach, they were advised that the crew of an aircraft landing ahead of them had reported poor braking action, and the Air France aircraft's weather radar was displaying heavy precipitation encroaching on the runway from the northwest. The aircraft landed long down the runway, and reverse thrust was selected late after touchdown. The aircraft was not able to stop on the 9,000-foot runway and departed the far end. The aircraft stopped in a ravine and caught fire. The cabin crew ordered an evacuation within seconds of the aircraft stopping because fire was observed out the left side of the aircraft, and smoke was entering the cabin. All passengers and crewmembers were able to evacuate the aircraft before the fire reached the escape routes. A total of 2 crewmembers and 10 passengers were seriously injured during the crash and the ensuing evacuation.

The aircraft was equipped with emergency evacuations slides as required by certification rules. At one exit (L2) the evacuation slide did not deploy and the passengers had to jump out (see Figure 1). Of the 16 passengers using this exit, 2 were seriously injured: one when he jumped from the exit (10-12 feet above the ground), and the other when pushed

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out of the exit by another passenger. The slide at another exit (R3) deployed correctly. However, shortly afterward this slide deflated and Exit R3 was assessed as unusable by the cabin crew.

The slide at Exit L1 partially deployed/inflated. Given the nose-down, left-wing-high attitude of the aircraft, neither the intermediate tie restraint device nor the toe tie restraint device separated from the slide. As a result, the slide came to rest folded in half against the fuselage. When passengers jumped from Exit L1, some became trapped in the folded portion of the slide and were unable to extricate themselves before other passengers jumped on top of them.

During the evacuation, the slide at L1 deflated completely. Post-occurrence examination of the slide revealed that it had been punctured in two areas. While the slide at emergency Exit R1 deployed automatically as designed, the angle of the slide was very shallow because it was almost perpendicular to the aircraft. As a result, the rate of descent was slowed considerably. At the bottom of the slide, vegetation on either side of the deployment path pushed against the slide, causing it to curl inward, forming a tube. At one point, the R1 cabin attendant had to stop the evacuation to wait for passengers already on the slide to pass through this tube.

Other problems with several of the slides on the Air France A340 hampered the evacuation and also caused serious injuries to the passengers. In the end, the evacuation was successful due to the training and actions of the whole cabin crew.

Study objective and scope

The above occurrence and the experiences of emergency evacuation slide use is but one example of the problems that hamper slide use. Thus, the main objective of our study, Analysis of Problems Using Aircraft Evacuations Slides, National Aerospace Laboratory NLR, Report NLR-CR-2004-371, 2004, was to make an inventory of common problems when using emergency evacuation slides. The study was limited to Western-built passenger aircraft equipped with evacuation slides.

In order to make an inventory of common problems when using emergency evacuation slides, data of historical evacuation occurrences were analyzed. For the purpose of this study, an evacuation is defined as the disembarkation of passengers because of an existing or perceived emergency. The term evacuation is used in a generic sense and includes precautionary evacuations and emergency egress situations.

First we analyzed some of the available studies on aircraft emergency evacuations. Secondly, evacuation occurrences involving passenger aircraft were identified using several data sources. The first data source to be used was the NLR Air Safety Database, which covers accidents and (major) incidents with civil aircraft worldwide. The accidents in the NLR Air Safety Database are often related to occurrences involving (significant) damage to the aircraft and/or injuries to the passengers. Since such occurrences are rare, it was also necessary for this study to analyze evacuations with less serious consequences. These are often precautionary evacuations. For this purpose, data from the following mandatory occurrence reporting systems were used: the Canadian Civil Aviation Occurrence Reporting System (CADORS), the UK's Mandatory Occurrence Reporting Scheme (MORS), and the U.S. FAA Accident Incident Data System (AIDS). Additional data for U.S. operators were obtained from a survey made by Hynes and Associates for the FAA in 1999.

All the data from the previous-mentioned sources include occurrences with aircraft that are equipped with evacuation slides as well as aircraft that do not have evacuation slides. The evacuations with this last category of aircraft were excluded from this study in light of its objectives.

Analysis results

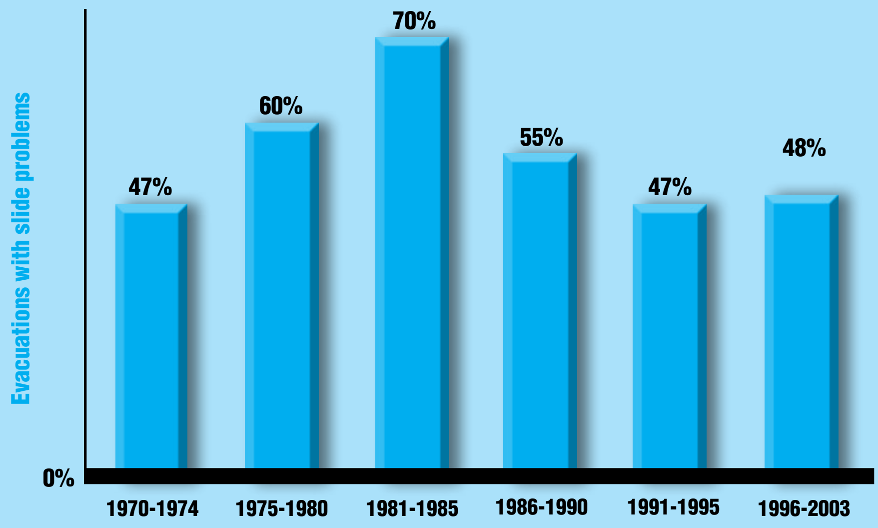
A literature survey of previous investigations on problems with evacuation slides was conducted. Many relevant studies were found, and the most interesting results (in light of the present study) are briefly discussed here.

In a review of techniques used in crash protection and emergency egress from transport aircraft, deficiencies with emergency escape equipment were summarized by R.G. Snyder in Advanced Techniques in Crash Impact Protection and Emergency Egress from Air Transport Aircraft, AGARD AG-221, 1976. The deficiencies quoted by Snyder are inflation problems, problems due to wind, burnt slides, punctured slides, and aircraft attitude. These problems are based on NTSB reports concerning accidents that occurred during the early 70s.

The CAA UK studied the reliability of slides by analyzing slide occurrences from 1980 to 1994 with UK-registered aircraft. The study looked both at problems that occurred with slides during maintenance/test deployment and the use of slides during actual evacuations. Some of the problems identified during maintenance/test deployment are incorrect assembly of the slides (29%), grit-bar mechanism failure (15%), misrigging (11%), inflation device malfunctions (7%), and failure to deploy with no obvious cause (6%). In the period studied by the CAA UK, 62 actual emergency evacuations (with slides involved) occurred with UK-registered aircraft. In nine cases (15%), slide problems were identified. No fatalities were recorded with these evacuations indicating that these were minor events only (incidents). The study conducted by the CAA UK does not report any reasons for the slide problems.

Detailed studies on emergency evacuations were conducted by the accident investigation organizations from the U.S. (NTSB) and Canada (TSB). These organizations reviewed past emergency evacuation accidents with U.S.- and Canadian-registered passenger-carrying aircraft covering different periods in time (NTSB, 1974; NTSB, 2000; TSB, 1995; and Fedok, 2001). The TSB study, A Safety Study of Evacuations of Large Passenger-Carrying Aircraft, Transport Safety Board Canada, Report SA9501, 1995, showed that in 47% of the evacuations where slides were used, some problem occurred with the slides. The Emergency Evacuation of Commercial Airplanes, National Transport Safety Board, Safety Study NTSB/SS-00/01, 2000, found that in 37% of the evacuations involving slide use, the slides did not operate correctly. In a 1974 NTSB study, an almost similar percentage was found (40%). This leads to a combined slide problem rate of 41% (combination of the results of the three studies). The problems with evacuation slides identified in the TSB/NTSB studies are listed in Table 1. Failure of the slide to inflate was identified in 46.9% of the cases and is by far the biggest problem found by the NTSB and the TSB.

Figure 2. **Relative Number of Evacuations with Slide Problems during the Period 1970-2003**



Accidents involving evacuations

Searches were conducted in the NLR Air Safety Database for survivable, Western-built passenger jet aircraft accidents involving evacuations in which emergency evacuation slides were used. The query, which identified 151 accidents, was conducted for the period 1970-2003 and covered aircraft operations worldwide. Problems with using the slides were identified in 81 (54%) accidents. As shown in Figure 2, this share increased starting from the late 70s until the early 80s. The share has dropped during the late 80s. Since then it has not changed much. An overview of the identified problems with evacuation slides in 81 analyzed accidents is shown in Table 2. The ICAO ADREP taxonomy was used for the classification of the slide problems. Eighty-nine slide problems were identified in the sample of 81 accidents.

In 25 (28.1%) cases, the slide did not inflate (not automatically nor manually). The cases in which the slide did not inflate automatically—but did directly after the manual inflation handle was pulled—were not considered as slide problems in this study. However, when there was a significant delay in deploying the slides manually, the case was considered. The NTSB/TSB results shown in Table 2 show a higher amount of problems with the inflation of slides. This is because in those cases where the slide would not automatically deploy, but did manually, the events were still counted as a slide problem by the NTSB/TSB. There did not appear to be a general explanation why some slides did not inflate properly. There are many different causes for failure to inflate, such as empty inflation bottles and incorrect assembly.

In 14 (15.7%) cases, the aircraft attitude at rest was such that some of the slides were either too steep, did not reach the ground, or curled up under the aircraft (due to limited space to deploy it properly). Unusual aircraft attitudes were mainly the result of the collapse of the nose gear or the main aircraft landing gear. However, in some cases the aircraft ended in a ditch or over an embankment. Steep slide angles appear to be the biggest problem for evacuees. At a slide angle of approximately 48 degrees, evacuees have a tendency to hesitate before entering the slide because of its steep appearance. Such steep angles were reported in a number of cases.

Wind had an adverse effect on the use of escape slides in 11 (12.4%) cases. In these cases, the wind blew the slides up against the sides of the aircraft preventing their use. Table 3 lists the 11 cases. The mean wind during these evacuations varied from

Table 1: **Problems with slides identified by NTSB and TSB**

Identified problem	Amount (%)*
No (automatic) inflation of slide	46.9
Problems due to wind	12.5
Problems with slides due to extreme attitude of the aircraft	12.5
No deployment of slide due to problems with emergency exit door	9.4
Slide broke loose of aircraft	9.4
Slide inflated inside aircraft	6.3
People injured because they loose stabilization on descent	3.1

* One accident can have more than one slide problem assigned.

Table 2: Problems Identified with the Use of Slides in 81 Accidents Analyzed

Identified problem	Amount (%)*
Slide not inflated	28.1%
Aircraft attitude	15.7%
Other	13.5%
Wind	12.4%
Slide burnt	11.2%
Incorrect rigging	7.9%
Slide ripped	6.7%
Unknown	4.5%

* One accident can have more than one slide problem assigned.

Table 3: Cases with Slide Problems due to Wind as Identified in the Accident Sample

Date	Location	Aircraft type	Wind speed (kts)
7-30-1971	San Francisco, USA	B-747-100	20
1-02-1982	Sault Ste. Marie, Canada	B-737-200	22 gusting to 36
5-12-1983	Regina, Sask, Canada	DC-9-32	18 gusting to 28
11-05-1983	Johannesburg, South Africa	B-747-B	6
3-25-1987	Chicago, USA	DC-10-10	14
2-01-1990	Baltimore, USA	DC-10-10	12
3-05-1994	Regina, Canada	DC-9-32	22 gusting to 27
12-24-1997	Schiphol, the Netherlands	B-757-200	32 gusting to 42
7-09-1998	San Juan, Puerto Rico	A300-600	13
7-12-2000	Wien, Austria	A310	13 gusting to 17
11-30-2000	Shannon, Ireland	B-737-800	28 gusting to 42

6 to 28 kts. A similar range of wind values (3-25 kts) was found for those evacuations in the sample in which wind did not cause a problem when using the slides. An explanation for this last observation in the data could be that the wind direction relative to the aircraft's position also plays an important role.

The slides were burned in 10 (11.2%) cases. In all these cases, slides were deployed at the side of the aircraft where a fire was present. Due to the intensity of most of the fires, the burning of the slide was unavoidable.

Incorrect rigging of the slide was identified as the cause of the slide problem in seven cases (7.9%).

In six cases (6.7%), the slide was ripped. In four cases, it was determined that this was caused by the shoes some of the evacuees were wearing.

There are a variety of problems with slides that were listed under the category "other" in Table 2. Some examples are slides falling off the aircraft after being deployed and slides that inflated into the aircraft itself.

Incidents involving evacuations

The accidents analyzed in the previous section were often related to occurrences involving (significant) damage to the aircraft and/or injuries to the passengers. To have an understanding of slide problems that have occurred during less serious events, incidents involving slide use were analyzed (including precautionary evacuations). These incidents were also used to estimate the slide use frequency of occurrence. This frequency can be used to determine the probability of emergency evacuation slide use in mean wind conditions higher than 25 kts. Evacuation data from the following mandatory occurrence reporting systems were used: the Canadian Civil Aviation Occurrence Reporting System (CADORS), UK's Mandatory Occurrence Reporting Scheme (MORS), and the U.S. FAA Accident Incident Data System (AIDS). The U.S. data were expanded with additional evacuation occurrences obtained from other sources including an airport survey. The overall time period ranged from 1987-2003. However, each of the three sources had slightly different time periods. The Canadian data covered the period 1995-2003, the UK data 1987-2003, and the U.S. data 1988-1996. Narratives were available for all the reported evacuations with Canadian- and UK-registered aircraft in the time periods considered. However, this was not the case for all of the U.S. data.

For the period 1995 through 2003, 12 slide-involving evacuations with Canadian-registered aircraft were identified. There were no reported slide problems with these 12 evacuations.

For the period of 1987 through 2003, 63 slide-involving evacuations with UK-registered aircraft were identified. In three cases (4.7%), problems with the slides were reported. There was a case in which the slide twisted on inflation, another in which the slide was punctured (possibly by high-heeled shoes). In the last case, the slide deployed partially into the galley.

M.K. Hynes, in Frequency and Costs of Transport Airplane Precautionary Emergency Evacuations, FAA Report DOT/FAAJAM-99/30, 1999, evaluated precautionary emergency evacuations with U.S.-registered aircraft that occurred during the period 1988 through 1996. The primary data sources used for the evaluation included the FAA, the NTSB, and NASA, as well as the records of airport managers (through a survey sent to 63 airports). Additional data were obtained from airlines, insurance adjusting firms, and litigation records. The final data sample contained a total of 130 emergency evacuations involving the deployment of slides. For 80 of the 130 evacuations, narratives were available. Analysis of the 80 evacuations revealed that in seven cases (8.8%) the slides did function as expected. In three cases, the slides would not inflated; in one case the slide fell off the aircraft. The reasons for slide problems in the remaining three cases were not reported.

Discussion of results

The problems with evacuation slides as identified in this study are similar to those identified in previous studies. The data analyzed in this study suggest that the basic problems with evacuation slides in accidents have not been resolved over the last 33 years. Safety organizations such as the NTSB of the U.S. have addressed the problem of proper functioning of evacuation slides in the past. The importance of having proper functioning slides follows from the examination of the fatality rate of the analyzed evacuation accidents in this study. The fatality rate in those evacuations where problems with the slides occurred is 1.7 times higher than for those evacuations where no problems were encountered with the slides. Clearly, properly functioning evacuation slides can reduce the number of fatalities during survivable accidents.

The share of problems (54%) with slides found in the analyzed accidents is much higher than found in the incidents (6.5%, combined result). There are several reasons for this difference. Accidents often are related to damaged aircraft, fires, and collapsed nose and main gears resulting in rather unique problems with evacuation slides. By definition, such problems will not be found with incidents. However, it was expected that inflation problems would have occurred at a similar rate for both accidents and incidents (in the order of 28%). It is believed that the incident reports examined in this study do not always mention problems with evacuation slides when they occurred. The level of detail of the information provided in the incident reports is normally far less than the information that is given in accident reports. Detailed information regarding evacuation means is often not provided in incident reports; therefore, the number of problems with evacuation slides identified in incidents in the present study could be underreported.

The most significant problem with slides identified in this study is that the slides would not inflate. An analysis of service difficulty reports (SDRs) filled by U.S. operators also showed that the vast majority of SDRs related to slides (28%) would have resulted from slide inflation problems. Improper packing/installation and improper maintenance cause many of these problems.

Problems with slides due to wind have been identified in several cases. The problems occurred under moderate as well as severe mean wind conditions, which indicate that the mean wind speed itself is not a decisive factor. This is further shown by the fact that numerous evacuations with slides occurred without any problems due to wind, despite the fact that the wind conditions were very similar to those when problems did occur due to the wind. Most likely the wind direction plays an important role. With an unfavorable wind direction, even moderate wind conditions can cause problems when using slides. Another factor could be the gust levels of the wind. When having moderate wind conditions, strong gusts can cause difficulties when operating the slide. The influence of strong gusts upon the proper functioning of slides has not been examined to the knowledge of the author.

The current EASA CS/FAR 25, Section 25.810 emergency egress assist means and escape route, states that "*An approved means to assist the occupants in descending to the ground must have the capability, in 25-kt winds directed from the most critical angle, to deploy and, with the assistance of only one person, to remain usable after full deployment to evacuate occupants safely to the ground.*" This rule became effective Aug. 20, 1990. The rule originates from a proposal made in the 80s. Except for the B-737-800, all aircraft listed in Table 3 were certified before 1990. This means that the involved aircraft were certified for manufacture prior to the introduction of the requirement JAR/FAR 25, Section 25.810, regarding the maximum wind speed under which slides must function and are therefore exempted from this requirement. The B-737-800 listed in Table 3 was certified in 1998. During this accident, the mean wind was 28 kts, which is slightly higher than the maximum wind under which the slides should be able to function without problems due to the wind.

Conclusions

- Examination of historical accidents involving evacuation slides showed that in 54% of all cases one or more slides did not function properly.
- Examination of historical incidents involving evacuation slides showed that in 6.5% of all cases one or more slides did not function properly.
- The most important slide problems identified in evacuation accidents are slide inflation problems, aircraft attitude, wind, burnt slide, incorrect rigging of the slide, and ripped slide.
- Problems with evacuation slides have been reported since their first appearance on aircraft. Despite many recommendations made by accident investigation boards regarding the improvement in slide reliability, problems with slides keep occurring at a similar rate.

Recommendations

- Disseminate the findings of this report to all interested parties (including civil aviation authorities, transport safety boards, aircraft manufacturers, slide manufacturers, and airlines).
- Analyze the influence of strong gusts upon the proper functioning of slides.
- Analyze service difficulty reports related to slides to identify the relation with problems found during accidents and incident evacuations and to monitor any influence of regulations regarding slide reliability. ◆

Acknowledgement

The author gratefully acknowledges the cooperation and assistance given by Joji Waites of the CAA UK SRU; Jennifer McCarthy of Transport Canada, System Safety; and Günther Raicher of the Flugunfalluntersuchungsstelle of Austria.

A Complete Service?

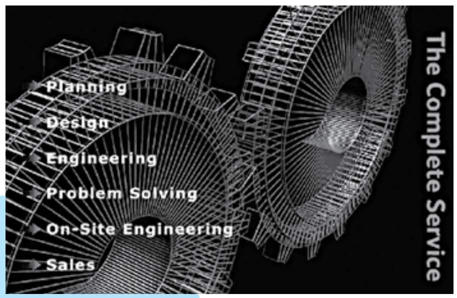
Using examples from investigations to illustrate the article's content and to confirm or challenge the notion of completeness, the author discusses improvements that could be made to enhance the investigation process, including advances in technology.

By Phil Taylor, Senior Inspector of Air Accidents (Operations), UK AAIB

(This article is adapted, with permission, from the author's paper entitled Accident Investigation--A Complete Service? *presented at the ISASI 2008 seminar held in Nova Scotia, Canada, Sept. 8-11, 2008, which carried the theme "Investigation: The Art and the Science." The full presentation, including cited references to support the points made, is on the ISASI website at www.isasi.org.—Editor)*

One of my brothers who is a dental surgeon once told me that one of the things that attracted him to the profession was the fact that when a patient comes to him with a dental problem, he can follow their treatment all the way through to the end. Does this also apply to air accident investigation? Who are our patients or, more appropriately, stakeholders? At face value, it might seem obvious; they are the operators, the manufacturers, and regulators, the bodies to whom we make our recommendations. However, those affected by our work also include passengers, bereaved relatives and friends, and, in some instances, the public at large. Do we provide all of them with a complete service?

In searching for a suitable definition of complete service, I came across many companies that claim to provide what they term a complete service (Figure 1).



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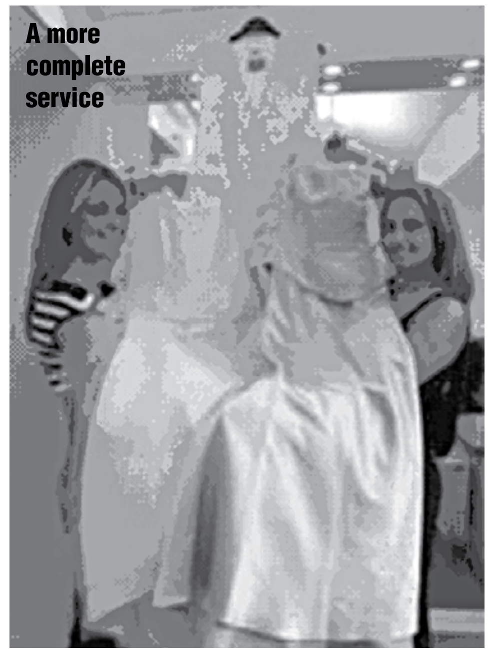

One dictionary definition of "complete" is "perfect in quality or kind." For "service" it gives "performance or work for another." Combined this gives "work, perfect in quality, for another."

There were other definitions for "complete," including "finished," and for "service," "a periodic overhaul made on an automobile or machine"—making a "complete service" a "finished periodic overhaul on an automobile or machine." But that doesn't apply here!

Insofar as the sole objective of accident investigation is the prevention of accidents and incidents, our work is clearly not finished, but is it perfect in quality? One Irish

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***Phil Taylor** joined the AAIB as an operations investigator in 2002 and has investigated accidents and incidents to most classes of aircraft, both fixed and rotary wing, in the UK and overseas. He holds ATLP licenses for aeroplanes and helicopters and maintains his fixed-wing currency by flying online operations with a commercial operator. He has recently converted to the Boeing 757 and Boeing 767 and continues to fly helicopters, as he did while with the Royal Navy prior to retiring after 17 years. He is also an aeronautical engineer.*

Figure 2

poet once wrote, "Finality is death, perfection is finality; nothing is perfect, there are lumps in it." However, an English cleric said, more optimistically, "Perfection is the child of time."

The procedure for the notification of accidents and serious incidents is clearly laid out in the appropriate manuals and, with rapid means of communication, the transmission and receipt of this notification is often very speedy. This enables investigation teams to be formed quickly and, with modern-day transport, reach very remote accident sites, assisted in the location process by emergency locator transmitters. Thereafter, the analysis of evidence, witness statements, and data often produce reports that are able to provide comprehensive findings and causes from which appropriate safety recommendations can be made.

In August 1985, a Boeing 737, registration G-BGJL, suffered an uncontained failure of the left engine during its takeoff from Runway 24 at Manchester in the UK (Figure 2). A wing fuel tank access panel was punctured, and leaking fuel ignited as the takeoff was rejected.

Tragically, during the subsequent fire and evacuation, 55 of the 137 passengers and crew on board lost their lives, and the aircraft was destroyed (Figures 3 and 4).

The investigation team had access to the damaged aircraft, recorded data, medical and pathological information, and witness statements. The investigation included much testing and research, and the comprehensive final report on the accident made 31 recommendations to the regulator, operators, and manufacturers.

In that investigation, as in many others, a lot of data and witness evidence were available to the investigation team. However, that is not always the case—particularly where there is no requirement for the aircraft to be equipped with an FDR or CVR and few witnesses.

In October 2004, a Reims Cessna F406, G-TWIG, took off from Stornoway, in the Outer Hebrides, to the west of Scotland, to return to Inverness on the mainland (see Figure 5).

The aircraft had earlier delivered newspapers and magazines to the Orkneys and Shetland Islands and was returning empty with only the pilot on board.

The aircraft climbed to its cruise level of Flight Level 95 where it flew in or between cloud layers in much the same conditions as it had encountered flying in the opposite direction earlier that morning (see Figure 6). The pilot of another aircraft that followed the same route about 20 minutes later stated that there was no icing or turbulence at his level, FL75. Shortly after G-TWIG began its descent for the approach to Inverness Airport, it disappeared from radar at FL78 and contact with the pilot was lost.

A day later, the remains of the aircraft and the pilot were found in a remote location on the Scottish highlands within a few hundred meters of the position of the final radar return (see Figure 7).

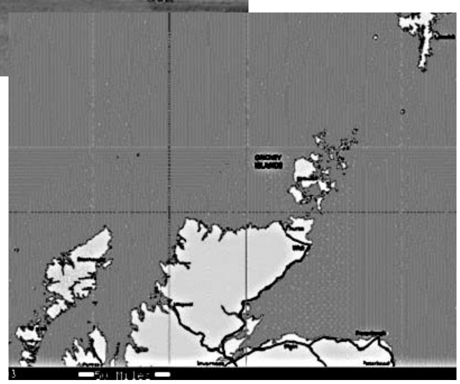
The aircraft was very badly fragmented, so much so that from the air it was difficult to distinguish from the surrounding rocks and vegetation and was ultimately discovered by a mountain rescue team that had joined the search.

It was established that the aircraft was structurally intact when it struck the ground in an estimated 70° nose-down attitude with its longitudinal axis at an angle of 68° to the ground at impact, i.e., left wing low (see Figures 8 and 9). The extreme fragmentation of the wreckage suggested a high impact speed, probably in the region of 350 kts. Evidence suggested that the engines were producing a significant amount of power and that the elevator trim actuators were near to their full nose-down position.

What caused the aircraft to carry out an apparently dramatic maneuver could not be established, and there was nothing to indicate that the pilot contributed to the aircraft's departure from its flight path.

This was an unusual accident. Those with a close interest in the final report were the airline, other F406 operators, the manufacturer and the pilot's family, friends, and his fiancée. Ultimately we were unable to determine what had happened or why. We considered it possible that the pilot may have become incapacitated. Internationally agreed-upon standards did not require G-TWIG to carry either a flight data recorder or a cockpit voice recorder. Had it been, we would have stood a better chance of determining what had occurred, although

Figure 3



Figures 4, above, 5, left, and 6, below

Figures 7, top, and 8, above

the why may still have eluded us.

In July 2002, a Robinson R22 helicopter, registration G-VFSI, took off from an airfield in the middle of England for a sightseeing flight around the town of Warwick. On board were the pilot and his girlfriend's father. The pilot had already completed three flights earlier that day with a friend and, separately, his girlfriend's mother. The weather was good and the aircraft followed the same route as it had on the previous flight. We established this from data that were later retrieved from GPS equipment recovered from the wrecked aircraft.

Abeam the western edge of Warwick, with the aircraft flying level at a height of about 1,500 feet and cruising at about 70 kts, it was seen to break up in flight and descend into a field. Evidence also included various eyewitness accounts and photographs that had been taken by a camera that was recovered from the helicopter. The data from the GPS equipment and the photographs gave us information on the aircraft's altitude and groundspeed shortly before the accident and an indication of what the passenger had been doing seconds before the aircraft broke up. We also recovered radar data that corroborated the aircraft's track and showed the flight paths of other aircraft in the area, which was of assistance in determining whether wake turbulence had been a factor. It was considered not to have been (see Figure 10, page 16).

Evidence suggested that, as a result of mast bumping, the tail cone of the aircraft was struck by the main rotor blades. This can be caused by abrupt control inputs, and in this case it was considered possible that this occurred as the result of an unintentional input on either the cyclic control or yaw pedals, or both.

Again, we were unable to establish with certainty what had caused the accident and answer the questions that were of particular interest to owners and operators of R22 helicopters, the manufacturer, and the two families and friends of the deceased pilot and his passenger. Notably, this was one of a number of investigations in which we have been able to use GPS data to establish some elements of the history of the flight.

In July 2003, a Hughes 500C helicopter, registration G-CSPJ, took off from Biggin Hill Airfield, an aerodrome near London, for a flight in the local area. The weather was good and the pilot was accompanied by his wife and their 4-year-old son. Within 2 minutes of its departure, the aircraft had descended from a height of about 400 ft, turned left through approximately 130°, and crashed into a field in an estimated 30° nose-down attitude and at a forward speed of approximately 80 kts (see Figure 11, page 17).

Witness statements were compared with radar data that recorded some of the flight. Also, radio calls between the pilot and ATC were analyzed. Shortly before the accident, the pilot was instructed to change radio frequency, an instruction that had to be repeated by ATC. The pilot acknowledged the second call by ATC and gave no indication what had distracted him from hearing the first call or that there was any problem. A brief transmission on the new frequency, which was timed just before the moment the aircraft crashed, was considered to have been made by the pilot. It was a brief distressed utterance rather than recognized RTF. This established that the pilot had success-

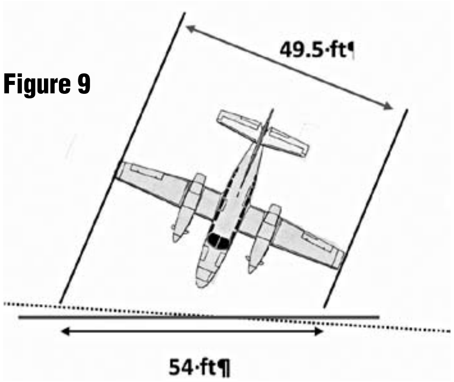


Figure 9

fully changed frequency on the combined communications and navigation equipment, on which it was possible to toggle between communications and navigation frequencies while making such a change. While it was possible that the time it took the pilot to change frequency may have been an ingredient, it was unclear why the aircraft, piloted by someone who was, by all accounts, very safety conscious, should crash in this fashion in such benign conditions.

The investigation revealed no evidence of any pre-impact faults in the aircraft. Many explanations were explored but each was flawed. As a result of insufficient information, the cause or causes of this accident, which happened in good weather and shortly after departure from Biggin Hill Airport, remain unresolved. This was unsatisfactory from two perspectives. It was not possible to state what measure or measures would prevent such an unusual accident from happening again and, secondly, those with a personal interest may never know why the accident occurred. This might not have been the case if the aircraft had been fitted with a flight data recorder or cockpit voice recorder or both. No such equipment was required or fitted on this aircraft.

Maintaining the independence of the investigating authority is surely the basis of ensuring that the perception and reality of a complete investigation is realized.

Once more, as well as other operators and the manufacturer, two families and the friends of the deceased were particularly interested in the outcome of the investigation. Also, the local population in the area, where there have been other accidents, had a vested interest in the findings.

Two recommendations were made urging the promotion of the safety benefits of fitting, as a minimum, cockpit voice recording equipment to all aircraft operating with a certificate of airworthiness in the commercial air-transport category, regardless of weight or age and, secondly, urging the promotion of research into the design and development of inexpensive, lightweight, airborne flight data and voice recording equipment. These and another similar recommendation relating to appropriate recording equipment that can be practically implemented on small aircraft were reiterated in the report on the accident involving the F406, G-TWIG.

The helicopter accidents I have referred to will be among the accidents that attract the attention of the International Helicopter Safety Team and its European partner, the European Helicopter Safety Team, as they endeavor to reduce helicopter accidents by 80% in the 10-year period up to 2016. In these and many other accidents involving light aircraft, data from suitable lightweight recorders for flight data and voice would greatly assist investigation teams. GPS equipment and cameras, which survive an accident sufficiently to provide an incomplete record of the flight, give a glimpse of how useful such recorders could be. This would not only assist the investigation teams but would also provide greater closure for those with a personal interest in an accident and present independent evidence for a concerned general public, whose fears can be fuelled if there is an absence of proven facts.

In March 2006, a Hawker Siddeley HS748, G-BVOV, overran the runway at Guernsey Airport, in the Channel Islands, while landing in poor weather (see Figure 12).

The aircraft suffered damage to two tires but was otherwise unscathed. The operator had been involved in previous serious incidents that had been investigated by the AAIB and had a history of non-conformities being raised during audits by the regulator and had been closely monitored for at least 2 years. Concerns included the operator's management structure, competencies, and its ability to maintain standards of safety. Shortly after this incident, the operator's AOC was suspended by the regulator and the company subsequently ceased trading.

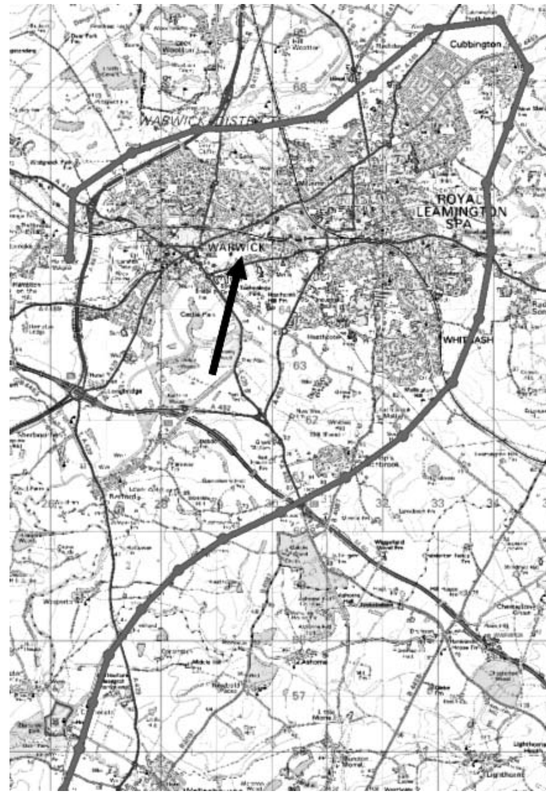


Figure 10

The investigation revealed a trend of shortcomings that were not addressed by the operator despite assurances to the regulator. The regulator had expended much effort in encouraging the operator to meet the required standard but this had not been achieved. In the final report, it was considered that a contributory factor to the incident was that close monitoring by the regulator had not revealed the depth of the lack of knowledge of standard operating procedures within the operator's Flight Operations Department until after the overrun incident. As a result, a recommendation was made to the regulator regarding its oversight of AOC holders in order to ensure that AOC holders meet and maintain the required standard. This recommendation was made only after very constructive and positive discussions between the AAIB and the regulator. While underlining the importance of good working relations between all those involved in ensuring aviation safety, it also exemplified the value of an independent investigation.

Examination of the recommendations that are made in accident and incident reports reveals that many are made to regulators. I would suggest that this is a thoroughly healthy state of affairs, and the independence of an accident investiga-

Figure 11

tion authority is important in being able to provide a complete service in which all stakeholders can have confidence.

I would briefly like to mention a third aspect of our global efforts to improve aviation safety, and it is a subject that could be a point of discussion on its own. It is the matter of mutual assistance. States have different strengths, and sharing them seems the best way to tackle aviation safety on a global scale. As technology and skills develop, strengths vary and fluctuate. That seems logical. There is the provision for assistance between states, and outreach programs provide helpful training. However, when assistance is requested, perhaps there is more that could be done. The speed with which a suitable response can be delivered raises the question as to whether more cannot be done before the perceived need is challenged.

So, who benefits from our work? It's operators, manufacturers, regulators, passengers, families and friends of the deceased and injured, and the public at large. Do we provide a complete service? There are many examples of excellent investigations that have brought about significant improvements in aviation safety. Instances in recent years where aircraft have crashed and caught fire or crashed and not caught fire and all the passengers and crew have successfully evacuated are indications of an improvement in survivability, although the avoidance of the accident in the first place is clearly the objective.

However, the introduction of lightweight recorders would be of great assistance in those investigations involving aircraft that are not currently required to carry them so that the cause, or causes, can be established and suitable recommendations for prevention can be made. If we want to reduce the rate of accidents among helicopters, I would suggest that this could be a significant step in that endeavor. I would also suggest that our global effort can be enhanced by increasing the speed of response to requests for assistance so that we are better prepared globally.

The independence of an investigation authority seems fundamental to the completeness of the service we provide, while also acknowledging that working closely with our various stakeholders—be they operators, manufacturers, regulators, or members of the public, all of whom can provide us with information that can enable us to carry out our investigations—is also important. The fact that we do not apportion blame or liability can only assist us in that aspect. The independence of an investigation surely enhances the integrity of the process and provides the beneficiaries of the results with confidence in the outcome.

In conclusion, do we perform "work, perfect in quality, for another"? It would be arrogant to suggest that we do, and I have indicated where there are some "lumps" in our endeavors to supply a complete service, although there are also many investigations that I suspect come very close to that ideal. Many investigations could be enhanced with the introduction of lightweight flight data and voice recorders on aircraft that are currently not required to be fitted with them. Also greater mutual assistance and support between states could help to achieve a more complete service globally. Not the least, maintaining the independence of the investigating authority is surely the basis of ensuring that the perception and reality of a complete investigation is realized. ◆

Figure 12

COCKPIT ‘CONVERSATIONS’

Pilot E
Comm
Failure?

(This article is adapted, with permission, from the author’s paper entitled Conversations in the Cockpit: Pilot Error or a Failure to Communicate? *presented at the ISASI 2008 seminar held in Nova Scotia, Canada, Sept. 8-11, 2008, which carried the theme “Investigation: The Art and the Science.” The full presentation, including cited references to support the points made, is on the ISASI website at www.isasi.org.—Editor)*

A crew hears an aural warning but fails to recognize that it signals an oxygen system malfunction. A warning light is perceived as a false alarm when an engine fire actually exists. During a cascading event, dozens of advisories, cautions, and warnings are displayed to the crewmembers, making it difficult for them to correctly diagnose the emergency. What do these three situations have in common? Each involves a breakdown in communication between aircraft and the crew.

Communication serves many functions—to transfer information, to develop relationships, to predict behavior, and to coordinate tasks. Communication occurs on many levels, ranging from impulses sent between molecules or cells to messages transferred between human actors and objects in their environment. Communication begins when a message is transmitted and continues through receipt, interpretation, and response. Every moment, millions of signals are communicated to us through sight, sound, taste, touch, and smell. Due to the sheer volume of these inputs, we are unable to process every message we encounter. To compensate for the perceptual, cognitive, and memory limitations of the human mind, each of us uses a system of goal-driven internal representations to recognize, interpret, and store these messages and use them to navigate the world around us. These internal representations are known as mental models.

Mental models (also known as cognitive models or schema) are developed as we explore the world around us. When we first encounter an object, symbol, task, or situation, we focus our attention on the larger elements of its structure. Over time, we discern more details, such as size, use, construction, and context. Tasks become subconscious, and key elements are arranged in patterns for retrieval at a later time. As our knowledge matures, details needed to anticipate future behaviors are added to our overall system models. Well-developed mental models of the flight environment allow expert pilots to detect and place environmental elements and detect both emerging trends and the absence of anticipated signals. When like or similar events are encountered again, these models are activated and guide behaviors and expectations. The robustness of these models is affected by the amount and quality of the information communicated during our experiences, with each repetition reinforcing the links between cues.

The development of mental models used by pilots begins long before the current flight. Knowledge and habits are communicated from instructor to student during training. These interactions result in a framework of behavior and expectations that underlie each subsequent flight. This framework influences preparation for a flight, including the type of information sought, the methods used to obtain this information, the depth of the information sought, and the expectations and goals assigned to a flight.

Once a flight has begun, pilots maintain their mental models by performing a scan of the outside environment, the flight instruments, powerplant/drivetrain instruments methodical, and the status of any utility systems. Information displayed by the cockpit indications is cross-checked with cues from the external environment, as well as the sounds, smells, and vibrations generated by the aircraft, and are

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The author asserts that the automation installed in today's advanced aircraft has assumed the role of a crewmember, and explores the conversations between the aircrew and the aircraft and how aircrew mental models are developed, maintained, and used to support situational awareness and decision-making.

By Noelle Brunelle, Field and Production Safety, Sikorsky Aircraft Corporation.

integrated into a representation of the current status of the flight. The current status of flight is then cross-referenced with previous indications and compared to predetermined expectations and goals to forecast the future status of the flight. In the early stages of a flight, these mental models can be closely aligned with actual events, but the models naturally diverge over time.

In aviation, the use of mental models is commonly referred to as "situational awareness" or "SA."

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According to Dr. Micah Endsley, as noted in her 1999 "Situational Awareness in Aviation Systems," situational awareness is composed of five elements: geographical, spatial/temporal, system, environmental, and tactical. Geographical SA refers to maintaining awareness of one's aircraft and its relation to other features such as terrain, airports, waypoints, or other aircraft. Knowledge of a flight's relationship to elements of space such as attitude, altitude, heading, and projected flight path and elements of time, such as velocity and estimated arrival times, are classified as spatial-temporal SA. System SA consists not only of an awareness of the settings, status, and functions of aircraft systems but also the impact of a subsystem degradation or malfunction of the overall system on a flight. Environmental SA is concerned with weather and regulatory environments; tactical SA includes the understanding of aircraft capabilities in reference to a task and mission timing and status. Situational awareness is maintained with communications among a pilot, the aircraft, the environment, and other crewmembers.

Multicrew aircraft (or multiaircraft flights) requires crewmembers to maintain equivalent mental models. This shared awareness includes representations of the goals and expectations of the flight, the flight environment, aircraft systems and capabilities, other actors (ATC, enemy forces), aircrew responsibilities (both individual and team), and the status of required inflight tasks.

Indoctrination training provided by a company or service is used to develop shared mental models of behaviors and expectations. Reinforcement of these models continues through preflight actions designed to coordinate goals and individual responsibilities. During flight, these shared mental models are used to plan and coordinate actions and evaluate the progress of the flight. Crew mental models are maintained by communication. Crew resource management (CRM) was developed to enhance the sharing of information among crewmembers.

Traditional vs. contemporary

In traditional cockpits, pilots monitored dials and meters to maintain awareness of system status. Over time, computers have assumed monitoring and control tasks previously performed by pilots. Course guidance, once accomplished by pilots flying a manually selected bearing to a station, is now performed by computers using satellites to triangulate an aircraft's position and execute a preprogrammed route. Engine and fuel controls previously actuated by the pilot have been replaced with computer-controlled engines programmed to optimize thrust, fuel burn, and speed. Terrain, weather, and traffic information can be integrated into displays, providing increasingly detailed representations of the external environment. Control of today's computer-based and monitored systems is provided by avionics management systems or digital cockpits. As automated cockpit systems assume tasks previously performed by human crewmembers, these digital systems are increasingly being included in the definition of cockpit crew.

In a digital cockpit, communication between cockpit crew and aircraft systems is accomplished via multifunction displays (MFD) and flight management systems (also known as control display units). Multifunction displays are full-color liquid-crystal displays (LCDs) installed on the instrument panel that use symbols, text, and graphics arranged on formatted pages to communicate the status of selected aircraft and environmental parameters to the crew. Flight management systems consist of an alphanumeric keypad and dedicated keys coupled with a color LCD screen to provide an interface for crews to direct the operation of navigation, communication, and utility systems.

To mitigate the potential for miscommunication, the presentation of information on these displays follows common guidelines. Dynamic data may be presented in dial or tape or graphic or textual form. Clockwise motion of a dial and upward movement of a tape signify an increase, while graphic information (such as attitude indications) is provided with a recognizable reference to the environment or system they reference. Color is used to supplement, differentiate, or attenuate symbols or cues; green identifies normal operating ranges, amber indicates that a limit is being approached or a sys-

EXPLORING COMMUNICATION

(1) Available Cues

• What cues were available to the crew during the event?
—Describe the pertinent signals. These descriptions should include the icon/text used, whether the cue was visual/aural/other, location of the cue, whether the cue was attenuated, coupled with another cue, constant or intermittent, and/or displayed in more than one location.
• When did the cues appear (or extinguish) during the time line of events?
—Lay out signals along a chronological scale.
—Include: whether the information updated during the course of events (if so how rapidly), whether the changes were attenuated, whether the location of the information was static or dynamic, and (if available) what rules drove the presentation of the data?
• Were any distractors present during the event?
—Describe each distractor.
—Was the distractor presented in visual, audio, tactile (vibration), scent form?
—Were threats such as smoke, fire, extreme weather conditions present?
—Were any social influences (provided by other crewmembers, agencies, or culture) in play?
• Was a checklist available to manage this event?
• Did the cues presented by the displays accurately reflect the status of the aircraft?
• Did the cues presented by the displays support the correct decision/response path?
• Were ambiguous indications displayed during this event?

(2) Crew Response

• What cues did the crew need to resolve (detect/diagnose/respond to) this event?
—Can include digital display or other system interfaces, aircraft, and environmental cues.
• Were these cues available (generated by aircraft or in environment)?
—If not, why? (Can include parameter not monitored, system inoperative.)
• If available, was the cue detected?
—If not, why? (Can include cue was presented outside visual range, on MFD page not selected by crew, crew unaware information was available, alert had been inadvertently silenced or extinguished or was otherwise masked.)
• If detected, was the cue correctly interpreted?
—If not, why? (Can include presentation did not allow for normal reaction times, meaning of icon/phraseology was not easily recognized, icon was infrequently observed, several signals were combined into a single alert.)
• Did the crew select the appropriate response?
—If not, why?

(3) Previous Interactions

• What previous experiences had the crew had with the displays?
(Include social interactions such as false alarms.)
• What experience level/familiarity with the interface did crews have?
• Did crew have experience on more than one interface/aircraft?
—How current was crew with this interface?
• Did cues used during simulator training match those used on the aircraft?
• Did crews trust/distrust or accept/dismiss the information once it was detected?
• Was scenario something they had encountered before be it in an aircraft, in a simulator, or anecdotally?

(4) Concluding Questions

• Were there any other obstacles to effective communication between the crews and the displays?
• Did any elements of the display/interface contribute to effective communication? ◆

tem is degraded, and red indicates that a limit has been exceeded or a system is inoperative. The size of numerical and textual symbols is selected to allow them to be read in the normal operating environment; an increase in font size indicates an escalation of events.

Transient alerts, such as warnings, cautions, and advisories, are normally presented when pilot action is required, when a system is approaching a limit, or when the information is not normal for the current aircraft configuration. Designers may also elect to advise crews of a change in system status and when the automation is performing a corrective action to enable them to predict future system behavior. Alerts may be grouped by function, priority, or sequence of occurrence. These rules are communicated to users by the operating instructions and are reinforced over time as experience with the system increases.

Communication challenges

Despite the use of standardized presentations and symbology, challenges to effective communication between aircrew and automation exist. Before a decision can be made, the need for a decision must be recognized; but change is not always easy to detect. When a signal is closely aligned with the observer's field of vision, it is easy to see. But presenting a signal as little as 2 degrees from fixation reduces detection to as little as 20 to 40% of the time. Focusing on a task can affect the detection of unrelated cues. Research exploring the failure to detect a visible cue (inattentional blindness) showed that only 54% of participants were able to detect an unexpected event while performing a vigilance task. We also anticipate trends will continue; research into the phenomena of change blindness (the inability to detect changes to a display while attention is diverted) demonstrated that changes that occurred during eye movements (saccades) were detected correctly on the first try only 71% of the time. Attenuation, including pairing a visual signal with an audio cue, can increase the probability a signal will be detected.

Once change is detected, mental models are used to guide the response to an event. Research has shown complex problems are solved utilizing the conscious or subconscious matching of patterns. Thus when encountering an unusual situation, an individual attempts to match the current situation to one experienced before. If this is not possible, previous experiences are evaluated for their relevance to the current situation. If no clear matches can be found, a random search for solutions is used. Matching is driven by signals (stop cues) that trigger a known pattern. Events indicated by clearly defined alerts or that include cues that have been encountered previously can be quickly matched with existing mental models, increasing the opportunity for crews to use established checklists or procedures to resolve the situation.

When ambiguous cues are present, pattern matching becomes more difficult. Infrequently displayed cues or those without a clear message can delay comprehension of a message. Unexpected or ill-defined cues generate the search for patterns and can increase the likelihood that cognitive processes such as satisfacting (choosing the first option that meets minimum matching criteria) and confirmation bias (affirming prior interpretations by discounting or dismissing conflicting information) may delay or prevent the correct assessment of a situation. Previous "social" interactions may make otherwise clear indications ambiguous; less emphasis is placed on an alert known to have false indications, while a highly reliable alert reduces monitoring of the indicated parameter. Choices made early in an event impact the choices available as the event unfolds, and the longer it takes a crew to recognize that an error has been made, the more difficult it is to recover once the correct course of action is recognized.

Unusual inflight and on-ground events require operators to respond quickly with limited or partial information while in a dynamic environment. The quality of these responses is dependent upon the crew's ability to detect, assess, and appropriately respond to signals present in the environment. The consequences of making incorrect decisions can be dire: miscommunication regarding heading, altitude, or location could result in controlled flight into terrain, while misdiagnosis of a system malfunction could result in a delayed or incorrect response, causing damage to the aircraft or injury to personnel. It is important to recognize that selection of an improper course of action may not be the result of poor decision-making by the crew, but rather the result of the displays inaccurately communicating the current situation. Each accident, incident, and unusual event provides the opportunity to evaluate the transfer of information between the aircraft and the crew and the strengths and weaknesses of these interactions. My challenge to safety investigators is to use these opportunities to gather data that can then be used to improve cockpit interfaces.

Each accident, incident, and unusual event provides the opportunity to evaluate the transfer of information between the aircraft and the crew and the strengths and weaknesses of these interactions.

"Exploring Communication" presents a series of questions for use when exploring the effectiveness of communication between an aircraft and the crew. These questions are organized into four sections. The first section looks at the cues available to the crew, when they were available, and the quality of the signals presented. The second investigates what cues the crew needed to successfully resolve the event and whether the crew detected, interpreted, and responded to these cues. The third is concerned with previous interactions between the crew and this and other display interfaces. The fourth presents concluding questions. This list is not intended to be all inclusive; it is offered as a guide to increase the understanding of communication between display interfaces and the crew. ◆

Council Meets in Spring Session

(Compiled from submitted reports and Council meeting minutes prepared by Barbara Dunn, as stand in for the ISASI secretary. The full minutes report is available on ISASI's website, www.isasi.org.—Editor)

The spring ISASI International Council meeting, held on May 1, set into motion plans for the formation of an Asian ISASI society, withdrew its support from the International Working Group on Human Factors, accepted a New Zealand Society bid to host ISASI 2012, received an update on ISASI 2010 to be held in Sapporo, Japan, and considered a "position" on the matter of criminalization of aircraft accidents, among other issues.

PHOTOS: E. MARTINEZ

Caj Frostell, David King, Barbara Dunn, Ron Schleede, Frank Del Gandio, Dick Stone, and Dan McCune prepare for the Council meeting.

President Frank Del Gandio called the meeting to order. Attendees included Dick Stone, executive advisor; Ron Schleede, vice-president; Peter Williams, New Zealand councillor; Barbara Dunn, Canadian councillor; Caj Frostell, international councillor; Lindsay Naylor, Australian councillor; David King, European National Society president; and Dan McCune, proxy for Jayme Nichols, chair of ISASI 2009. Mamoru Sugimura, chair of ISASI 2010; Marty Martinez, editor of *ISASI Forum*; and Ann Schull, ISASI office manager, attended as guests.

President Del Gandio put forward a petition in which the Singapore Ministry of Transport, acting as "Organizing secretary," requested the Council's approval to form the "Asian Society of Air Safety Investigators" (AsiaSASI). The Council was favorably impressed with the efforts to develop the new society and encouraged the effort to continue as the organizers cleared up some infrastructure questions that Council members put forth. The Council asked that clarifications be made early enough so that the topic could be voted on at the September meeting.

Dick Stone reported that the International Working Group on Human Factors, formed 2 years ago and on which he serves as chairman, is "not functioning as we had hoped." He recommended that ISASI withdraw its support and form its own working group using as its model the work done by the TSB of Canada. The ISASI goal would be to develop an HF manual designed for use by investigators. Permission to use TSB documentation has been awarded to ISASI. The Council unanimously approved a motion to adopt the recommendation. Stone will head up the new human factors effort. Stone also announced the recipients of the 2009 ISASI Kapustin Memorial Scholarship (see page 3).

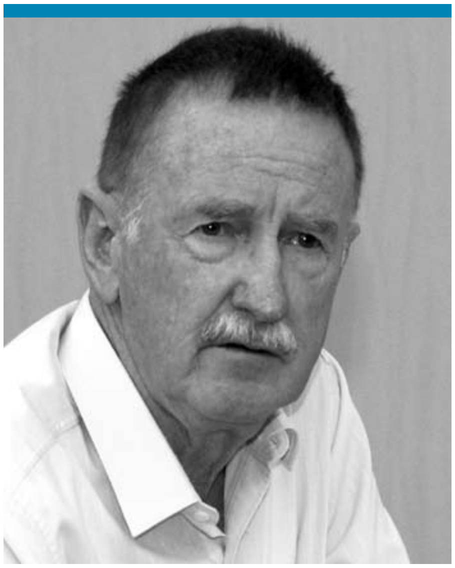
Ron Schleede discussed securing international seminar sponsorship and noted the need for each society to appoint one person to act as the local coordinator for international seminar sponsorship. This person would liaise with Ron prior to soliciting any sponsorship funds for the seminar in order to avoid confusion and possibly approaching sponsors twice.

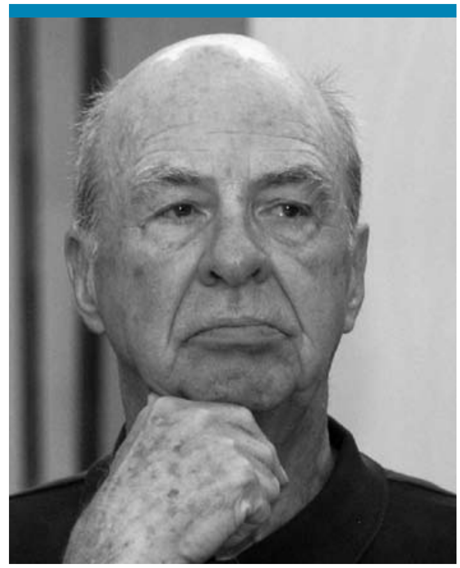
Williams announced a bid to host ISASI 2012 in New Zealand starting September 9 of that year. The Council unanimously accepted. This will be the third time that the ISASI seminar has been held in New Zealand. Williams also reported that the New Zealand Society has created a Ron Chippindale Memorial Presentation in memory of the ISASI Fellow who was a founding member of the New Zealand Society and became its first president. Ron was the victim of an automobile incident that took his life on Feb. 12, 2008 (see *Forum* April/June 2008, page 3). The award will be presented annually at the ANZSASI seminar to either a person specially invited to address the seminar or one whose submitted paper has been designated as worthy of the presentation.

Sugimura, chairman of the ISASI 2010 seminar to be held in Sapporo, Japan, provided a PowerPoint presentation on the plans for the annual event. It will be held September 5-9 at the Royton Sapporo Hotel. The selected theme is "Investigation to Be ASIA in Mind—Accurate, Speedy, Independent, and Authentic; the subtheme is "Overcoming Cultural Difference and Language Barrier." Dan McCune provided a full report on the planning for ISASI 2009 to be held in Orlando, Fla. (see page 25).

The issue of criminal prosecution was again a topic of lengthy discussion. The

Ron Schleede briefs on the sponsorship program.





From left: Lindsay Naylor reports on Australia Society events; David King speaks about criminalization; Tom McCarthy listens.

Council reviewed cases of persons prosecuted or being charged and agreed on the threat such practices by some states pose to occurrence investigations. It also reviewed the Flight Safety Foundation 2006 resolution on the subject, which included a significant number of industry signatories. Council members were asked to thoroughly review the FSF document for possible adoption by ISASI. The matter will be voted on at the September meeting.

Tom McCarthy, in his role as treasurer and Membership chairman, reported that the Society is in "excellent condition" financially, enabling an early payoff of the office condominium of $51,542. The office was purchased in 2000 for $101,000. His report noted a comparison of the "net asset/fund balance" from 1990—$39,451 to year 2007—$220,250. Regarding membership, he reported 1,474 members and 195 delinquencies. Corporate membership totalled 144 with 27 delinquent in dues. Those members in dues arrears have all benefits suspended, including voting rights, and delivery of the *Forum* until dues payment is received.

National societies/councillors

In reports from national society councillors, Lindsay Naylor, ASASI, noted that membership was at 155; that a December 2008 Reachout workshop was highly successful; and that planning was under way for the ANZSASI 2010, which will be hosted by the Australian Society.

Mamoru Sugimura reports on ISASI 2010.

Barbara Dunn, CSASI, reported 117 members, 17 of which joined in Halifax at ISASI 2008, the attendance at which left the local Society in "good financial shape." She also noted that in elections held earlier this year she and Elaine Parker, vice-president, were returned to office. She also noted that in October CSASI will be hosting a Winter Operations Conference in partnership with the Air Canada Pilots Association. More information can be found at www.winterops.ca.

Dave King, ESASI, reported that the European regional seminars have been very successful, with more than 100 attending the April 20 seminar held in Hamburg (see page 26). Both turnout and sponsorship have been excellent, with many people attending who are not able to participate in the international seminars. He noted that Airbus and the BEA have both expressed a desire to be involved next year, with April 2010 being proposed as the next date.

Randall Mainquist, chairman of the General Aviation Working Group, and 12 members met during ISASI 2008 and will meet again at ISASI 2009. At the 2008 meeting, discussions were held on non-volatile memory (NVM) use and applications in general aviation, including the incorporation of NVM into small, inexpensive cockpit recorders. ◆

Mid-Atlantic Council Conducts Spring Meeting

The ISASI Mid-Atlantic Council (MARC) hosted 83 members and guests at its annual spring dinner 2009 meeting in May. William R. Voss, Flight Safety Foundation president, was the guest speaker for the event, which is held in conjunction with the spring ISASI International Council meeting. ISASI President Frank Del Gandio also addressed the group.

MARC President Ron Schleede called the meeting to order following a "get reacquainted" refreshment hour. He outlined the evening's program, thanked corporate members for the donation of the many door prizes that lined the gift table, and announced that among the prizes were two sets of roundtrip airline tickets for travel to any destination within the U.S. Tickets were donated by AirTran Airways and Globetrotter Travel Agency.

After the buffet dinner and raffle distribution of the prizes, Ron noted the status of the ISASI Kapustin Scholarship Fund challenge issued by the Dallas-Fort Worth Regional Chapter. He explained that a feature of the annual meeting is a report on the progress of the Fund. It is named for the past president of MARC, but was established in memory of all ISASI members who have "flown west."

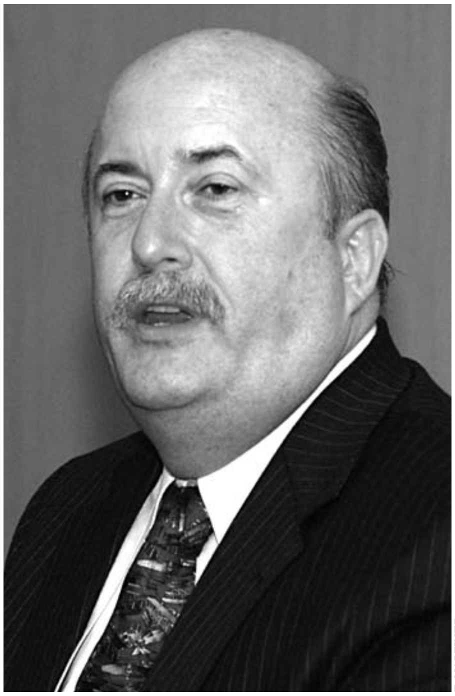
For this year's event, the DFW Chapter made a sizeable donation and challenged attendees to meet the $4,000 campaign goal. The response was "outstanding," said Ron in announcing a tally of $5,600. Contributors included Victoria Anderson, Chris Baum, Coug Cassaro, Edward M. Cullinane, Frank Del Gandio, Jerome Frechette, Cynthia Keegan, Gina T. Pellegrino, Tom and Ginger McCarthy, Charlie Pereira, John Purvis, Alissa Rojas, Ron and Kathie Schleede, Richard and Ruth Stone, the Alaska Regional Chapter, Curt Lewis and Associates LLC, the Canadian Society of Air Safety Investigators, the Dallas-Fort Worth Chapter, the European Society of Air Safety Investigators, the Mid-Atlantic Regional Chapter, and the Northwest Regional Chapter.

President Del Gandio overviewed ISASI's finances. He said they are in "good shape," attributing the condition to well attended and sponsored seminars and to the savings of $60,000 in rent costs resulting from the purchase of the office condominium in 2000. He reminded the group of the "mortgage burning" ceremony conducted before them last year. Membership has reached 1,474 individuals and 144 corporate members. This reflects the representation of 59 countries in the Society. In this regard, Del Gandio noted that the Singapore Ministry of Transport, acting as "Organizing secretary," requested the Council's approval to form the "Asian Society of Air Safety Investigators" (AsiaSASI). Showing ISASI's outreach, he reported that recent ISASI website statistics showed 1,490 hits from 88 countries and that the Reachout Workshop program has delivered 34 sessions in 21 different countries with an attendance that exceeds 1,300.

A surprise event caught Ron Schleede unaware as President Del Gandio called him to the front and presented the coveted ISASI Fellow member status to him. Ron's pleasure was evident in the large

PHOTOS: E. MARTINEZ

ABOVE: From left, Robert Sumwalt, NTSB, William Voss, and Frank Del Gandio share a conversation. RIGHT: Ron Schleede, left, enjoys accepting the ISASI Fellow pin from President Del Gandio.



E. MARTINEZ

William Voss speaks to the assembled group.

smile he wore as the Fellow symbol was pinned to his lapel. Del Gandio also presented a corporate membership plaque to David Gleave, representing Aviation Safety Investigation, West Sussex, UK.

Guest speaker Voss opened with the admission that the group was a difficult one to speak before because, "a lot of you taught me a lot of what I know." He was referring to his 23-year climb up the ranks at the Federal Aviation Administration to become director of air traffic systems development. After that he did a stint with ICAO's air navigation bureau and moved to FSF in October 2006.

He talked about the future of safety management—what does it mean to us and where is it going and criminalization of aviation accidents. In discussing the worldwide accidents of the past 9 months, he said the most prominent question received was "Is the downturn to the economy doing this to us?" He doesn't think so, as there is no common economic-related thread among the accidents. Rhetorically, he asked "What will inoculate us from the idea that the downturn means less safety?" In response, he pointed to the spate of bankruptcies air carriers experienced in the opening years of 2000 and noted how high the levels of safety remained.

Voss believes it is proactive safety systems that will maintain the high level of safety in difficult economic times. Chief among these are competent and independent regulators. They must have the ability to do risk-based surveillance, strong carrier oversight, maintain a close but appropriate relationship with the industry, and have non-political interference. The next big problem he sees is a "competent, qualified workforce." Many skills have been lost in the downturn, signaling a skill shortage for the next 2 to 5 years when continued growth will place heavy demands on air travel. This means that regulators won't have the people needed to do the work.

He said that the pressure is on to deal with Safety Management Systems with a strong focus on process and not so many rules, meaning more performance-based standards as opposed to prescriptive checklists. Voss gave examples of what an industry without Safety Management Systems would be like.

In closing, he challenged the investigators in the audience to "find a way to help the regulator who is bouncing out left and right, battered by political opposition. Find a way to keep the regulators moving forward toward a more systematic-based approach."

FSF has long been concerned with the growing trend to criminalize acts and omissions of parties involved in aviation accidents and incidents. Criminalization of aircraft accidents, he said, is all about what the public perceives and that tends to drive governmental belief. The decay of trust that encircles the world is bringing about a real crisis and is driving some of the highly regulated environment that exists, he noted. He provided examples of accidents that ended in criminal charges, à la Brazil, and in which investigators lost control of the accident site or the "black boxes."

Voss concluded the topic discussion by asking the investigators to think about

- how the regulator revolution is going.
- how do we approach the issue of investigators?
- how do we deal with a pubic that is just angry no matter what?
- how do we keep the public from doing something that we know is wrong: losing safety data that protect them?
- How do we get the message across? ◆

Register Now for ISASI 2009

Jayme Nichols, ISASI 2009 chairperson, reminds members that all registration fees to attend the 40th annual seminar to be held in Orlando, Fla., September 14-18 increase effective August 11 and that registration cancellation made before July 10 will incur a $10 fee. Cancellations between July 27 and August 10 will incur a $75 fee. There will be no refund of fees for cancellations after August 10.

Seminar planners have established a detailed and easy-to-manage website accessible through the ISASI website, www.isasi.org. All areas of delegate interest are easily identified and accessed on the site. A seminar registration form found on the website can be submitted electronically. The seminar will be held at the Coronado Springs Resort, which is offering a delegate room rate of US$144 for either a single or double and is subject to taxes. The special rate is available until August 24 for reservations from September 11-21 to allow early arrival or late departure. No provisions exist for special rates on upgrade rooms. Delegates should deal directly with the Coronado Springs Resort regarding their accommodations. The hotel registration form is available through a link on the ISASI 2009 seminar website.

The ISASI 2009 seminar will kick off with a golf scramble that will benefit the ISASI Rudolf Kapustin Memorial Scholarship fund-raising campaign. One hundred percent of the funds raised by the 1st Annual Kapustin Memorial Golf

In Memoriam

C.H. Whitburn (LM0787), Sutherland NSW, Australia, March 2009
Arthur E. Pearsall (LC0115), Oceanside, Calif., USA, Oct. 31, 2008
John W. Carlson (MO3537), Boca Ratun, Fla., USA

Scramble benefit the Scholarship Fund. The scramble will begin at 8:00 a.m. on Sunday, September 13. The cost to play will be $100 per person. Prizes will be awarded for the longest drive and the closest ball to the pin (holes to be announced). Golf clubs are available for rent at the Disney Magnolia Golf Course for a fee. All food and beverages will be at the player's own expense.

The full seminar program, along with registration forms, is available on the seminar website. The information may also be found in the April/June *Forum*, page 25. ◆

Reachout Report Shows Continued Program Interest

John Guselli, chairman of the Reachout Workshop program, reports that the Reachout program continues its consolidation process. Although impacted by current economic issues, communication continues between stakeholders at all levels with the objective of being ready when the situation improves.

Good support from the UK AAIB enabled European Society delegates to be canvassed during the Hamburg seminar in April. Many positive responses to the call for capable instructors to assist the program were received.

During May, the Reachout program received significant input and response from geographically diverse ATM managers in developing states. This activity followed the ATS Safety Management and Investigation Course, conducted at Changi by the Singapore Aviation Academy. Active participation by the Singapore AAIB reinforced this process and encouraged an enthusiastic response.

In addition, the June NZSASI regional seminar in Rotorua, New Zealand; provided another forum for discussion of the Reachout concept for South Pacific states. A number of capable and competent delegates provided initial indications of tangible support for the program. All expressions of interest are being vigorously pursued. ◆

Correction

In President's View, published in the April-June 2009 issue of *ISASI Forum*, the second of the two cited Kalitta Air accidents was incorrectly described, as noted by Capt. Scott Schwarz (MO5275), Kalitta Air Safety Committee chairman, who wrote:

The second accident, in Bogota, was not the result of an aircraft stall. I was a party to this investigation and am quite familiar with the facts. That crash was the result of a deliberate off-airport landing. Our aircraft was fully loaded with flowers bound for Miami. The aircraft lost one engine 7 seconds after rotation. While executing the engine-out escape maneuver to return to El Dorado International, a second engine failed 36 seconds after rotation, at which point the aircraft was no longer capable of climbing. The captain elected to proceed to a nearby Columbian Air Force base, which was now closer than El Dorado International. As the crew was turning toward the base, at approximately 60 seconds after rotation, a third engine began a series of long-period compressor stalls. At this point, the captain (Bryant Beebe, who has since been recognized by the IBT Airline Division for superior airmanship) realized that there was no possibility of making an on-airport landing. He was familiar with the local area from years of flying in South America and knew of an open field that, while situated between two towers, appeared long enough to attempt a landing. He was fully under control at touchdown. By the time the aircraft was landing, the third engine had ceased producing usable thrust. Unfortunately, there was a home hidden by the trees at the approach end of the field. That home was struck by the aircraft, killing two persons inside. This accident occurred at night, in very hazardous terrain, in a fully loaded B-747 with only one operating engine. All on board survived. I am proud to count Capt. Beebe among my personal friends and heartily concur with the IBT's opinion of his airmanship. ◆

ESASI Hosts Second Regional Air Safety Seminar

Following the success of its inaugural seminar last year, the European Society of Air Safety Investigators held its second seminar in Hamburg on April 20-21. The event was hosted in the historic Patriotosche Gesellschaft in the city center, which provided an excellent venue for the presentations. Approximately 74 attendees travelled from all over the world. The emphasis of the technical program was on current European issues and the technical challenge of accident investigations.

There were presentations from the EASA and the European Union on the legal framework, and Ulf Kramer from the German BFU spoke about the proposed changes to ICAO Annex 13 following the recent AIG meeting. Paul-Louis Arslanian from the French Bureau d'Enquêtes et d'Analyses (BEA) spoke about the particular challenges of international accidents and the intense news media involvement. There were also a number of presentations on the British Airways B-777 accident at Heathrow in January 2008. The contributions from the UK and the U.S. illustrated the complex technical challenges presented by this accident and the broad range of scientific approaches, both in terms of testing and research that have been applied to determine the cause of the power loss on both engines.

A civic reception was held at the City

Some of the 74 attendees are shown preparing for the start of the EASI workshop held in Hamburg, Germany.

Hall in Hamburg, hosted by Carsten Frigge, a state senator, and the DEKRA organization, which provides specialist inspection service to many areas, including aviation. The reception was followed by a tour of the beautifully ornate rooms within the City Hall, which are not normally open to the public and included a visit to the Parliament Chamber.

Following the seminar, on April 22, a technical visit was made to the Airbus A320 family production line at Finkelwerder. The group enjoyed superb Airbus hospitality and an interesting tour of the state-of the-art production line.

The feedback from attendees was very positive in terms of the length and extent of the technical program. ESASI expressed its gratitude for all the superb local arrangements, particularly the assistance of Klaus Ardey in making the seminar such a success. ESASI is planning to hold next year's seminar in Toulouse, France. ◆

ISASI Member Honored For ANZ DC-10 Antarctica Crash Work

ISASI member Steven Lund, director of air safety investigations for the McDonnell-Douglas Heritage Boeing Commercial Aircraft Group, was presented the New Zealand Special Service Medal (Erebus) on May 12 in a private ceremony from His Excellency Roy Ferguson, New Zealand ambassador to the U.S. Other ISASI New Zealanders had received their medals in 2007, including the late Ron Chippendale, who headed the New Zealand government's investigation.

The Medal was instituted in November 2002 to recognize the service of those New Zealanders, and citizens of the United States and other countries, who were involved with the extremely difficult and very unpleasant, hazardous, and extreme circumstances associated with the body recovery, crash investigation, and victim identification phases of Operation Overdue.

Operation Overdue was mounted by the New Zealand police following the crash of Air New Zealand (a McDonnell-Douglas DC-10-30 ZK-NZP) Flight TE901 on the north slope of Mount Erebus, Ross Island, Antarctica, on Nov. 28, 1979, with the loss of all 257 passengers and crew.

The Medal was struck pursuant to a royal warrant from the Queen of England, Elizabeth the Second. The Medal was to be awarded for those special services under regulations that the governor-general of New Zealand, acting on the advice of the prime minister or a minister of the crown acting for the prime minister, may determine. ◆

Steve Lund, center, receives his medal from the New Zealand ambassador to the U.S., His Excellency Roy Ferguson. Looking on, right, is the New Zealand police liaison officer at the embassy, Superintendent Sandra Manderson. As former head of the police department in Christchurch, New Zealand, she supported Lund's investigation team while enroute to Antarctica.

NZSASI Safety Seminar Inaugurates Chippindale Memorial

The New Zealand Society (NZSASI) hosted a joint Australian, New Zealand regional air safety seminar in Rotorua, New Zealand, June 5-7. Approximately 95 people registered, along with 20 partners, an excellent number given the economic situation. A highlight was the inaugural Ron Chippindale Memorial Presentation, in honor of the ISASI Fellow and New Zealand ISASI councillor who was killed in a motor vehicle accident in 2008. Peter Williams, New Zealand Society president, said that the memorial is in the form of a presentation by an invited speaker that "touches on the aims and ethics and inspires us to be better investigators."

Councillor Chippindale's long-time friend and current president of the Australian Society, Lindsay Naylor, was asked to give the first such address. He gave a summary of Ron's illustrious and safety-devoted career before outlining the known circumstances of a runway excursion accident currently under investigation.

The CAA of New Zealand, Air Nelson, Mount Cook Airlines, and Airclaims New Zealand, Ltd., helped sponsor the seminar. The Royal New Zealand Air Force and the Australian Defence Force safety office, both corporate members of ISASI, supported large contingents. Attendees also came from Japan, Tahiti, and the U.S.

Distinguished attendees were the

Lindsay Naylor, right, accepts a memento from New Zealand President Peter Williams inscribed: "To commemorate the Ron Chippindale Memorial Presentation made by Lindsay Naylor, NZSASI 2009."

chief of the Air Force and the director of the CAA. On behalf of the ISASI president, Williams presented Ashley Smout, the chief executive of Airways New Zealand, with a certificate of ISASI corporate membership. Smout then gave the opening address.

The 18-paper program began with presentations that clarified practical and legal aspects of major investigations conducted in accordance with Annex 13, and the CAA's approach to investigation and enforcement and explained why the police might treat an air accident scene as a potential crime scene.

Papers on current investigations described a serious B-744 depressurization incident and some A330 pitch events. Papers were also given on investigations into large turbine engine surges and the unexpected result of degraded dampers in piston engines. A very interesting paper was given on how to evaluate the merits of computer graphics animations of accidents.

An enlightening presentation was made by an airline on some human factors issues encountered with RNAV operations. A further paper showed the potential for fuller investigation of bird-strike incidents. Other papers discussed the challenges involved in implementing Safety Management Systems; some lessons learned in the deep-water recovery of a helicopter; the use of a panoramic camera for recording an accident scene; and the influences of organizational, situational, and social pressures on pilot decision-making.

During the seminar, the New Zealand and Australian Societies held general meetings and received five applications for ISASI membership.

The joint annual seminar is a long-standing event on the accident investigation and air safety calendar. Next year's seminar will be hosted by ASASI in Canberra. ◆

PNWR Chapter Meets at Boeing Facility

The Pacific Northwest Regional (PNWR) Chapter held a technical seminar on June 18 at the Boeing Longacres training facility in Renton, Wash.

Richard Anderson made a presentation to the PNWR Chapter summarizing the accidents and major incidents that have occurred to Boeing aircraft during the past year. This "Year in Review" presentation has become a favorite among the Chapter members in the Northwest because it gives an overview of the year's accidents and how the overall accident trends are developing.

This year was no exception since Richard provided both insights into recent accidents and highlighted some safety issues that were applicable to investigators.

All ISASI members are encouraged to attend the technical sessions offered by PNWR. A current schedule of events can be obtained by e-mailing the Chapter president, Kevin Darcy, at KDarcy@safeserv.com. ◆

DFWRC Co-sponsors Human Factors Seminar

In March, the Dallas-Ft. Worth Regional Chapter co-sponsored the "Aviation Human Factors and SMS Conference: Real World Flight Operations and Research Progress." The seminar, held at the Frontiers of Flight Museum in Dallas, Tex., was well attended, with more than 200 attendees. The Conference focused on research issues, academic challenges, and system advances for human factors in the real-world of operations for FAR Part 121, 135, 141, and 91, fixed-wing and rotorcraft.

During the seminar, Chapter President Tim Logan informed the attendees about ISASI and the benefits of membership. Following the presentation, several interested attendees requested applications for membership.

Following the seminar, the Chapter held its first meeting for 2009. Time was taken to recognize and thank Curt Lewis for 8 years of service as the Chapter's president. Also discussed at the meeting were plans for a Chapter safety day to be held later this year. ◆

Curt Lewis (left) accepts his Leadership Award for past service from the new Chapter president, Tim Logan.

New Members

CORPORATE

Aviation Safety Investigations, UK
David P. Gleave, chief investigator
Air Astana (Kazakhstan)
Gerhard Coetzee, vice-president corporate and quality
Iger Darilor, acting as manager safety investigations
Administration des Enquêtes Techniques (Luxembourg)
Jean-Claude Medernach, director
Marc Determ, investigator
Allianz Aviation Managers, LLC, USA
Brian R. Hogan, vice-president aviation
Michael L. Carlucci, claims adjuster/aviation claims

INDIVIDUAL

Abdulkarim, A., N., Kaduna, Nigeria
Black, Joshua, M., Venice, FL, USA
Cassaro, Douglas, J., Alexandria, VA, USA
Faryniuk, Glaucia, R., Abu Dhabi, United Arab Emirates
Hatchell, David, B., Irmo, SC, USA
Jeyalingam, Gerard, Abu Dhabi, United Arab Emirates
Little, Stephen, R., Abu Dhabi, United Arab Emirates
Lucbernet, Dominique, L., Abu Dhabi, United Arab Emirates
Maranhao Neto, Pericles de Andrade, Melbourne, FL, USA
McCarthy, Neil, S., Cow Bay, NS, Canada
Mulligan, Brian, M., Coventry, RI, USA
Osman, Wail, Abu Dhabi, United Arab Emirates
Papouis, Constantinos, Athienou, 7600, Cyprus
Plets, John, E., FPO, AP, USA
Price, Michael, F., Pompano Beach, FL, USA
Ramos, Elaine, Y., Abu Dhabi, United Arab Emirates
Saindon, Karl, Belleville, ON, Canada
Schmid, Carl, P., Mossman, QLD, Australia
Sciarra, Daniela, Abu Dhabi, United Arab Emirates
Silcock, Aaron, J., Morrinsville, New Zealand
Smith, Everett, W., Albuquerque, NM, USA
Storey, Alicia, G., Enterprise, AL, USA
Subramaniam, Vijay, P., Abu Dhabi, United Arab Emirates
Watkins, Justin, T., Prescott, AZ, USA ◆

President Del Gandio, left, presents a certificate of corporate membership to David Gleave, representing Aviation Safety Investigation, West Sussex, UK.

Unmanned Aircraft System WG Issues Year One Report

In September 2008, ISASI President Frank Del Gandio approved the formation of an ISASI working group focusing on new investigative challenges arising from the growth of the unmanned aircraft system (UAS) sector of aviation. He named Tom Farrier (MO3763) chair of the Unmanned Aircraft Systems Working Group. Following is his first contribution to the membership through the *Forum.*

"In accepting the chairmanship of this Group, I thought we could hit the ground running. Unfortunately, that has not turned out to be the case. Still, the issues that need to be tackled are beginning to take shape.

"Our first and greatest challenge is a lack of Working Group (WG) members with UAS-specific knowledge. There's a gratifying amount of interest within ISASI in the subject of UAS in general. However, the WG itself is hampered by having a wealth of avenues deserving inquiry, but lacking the expertise or rolled-up sleeves willingness needed to do them justice. The WG needs fewer observers and more doers.

"A secondary challenge, possibly related to the first, is that most of the government and government-industry groups taking on various aspects of UAS development, deployment, and integration are holding their members to remarkably strict levels of confidentiality about their activities. This is counterproductive, but a fact of life. Given the growing number of potential arguments that could be raised against different aspects of current and proposed UAS operations and regulations, limiting professional discourse on them may inhibit the cause of safety but it's smart politics.

"So, where do we fall short today in being able to proceed? The easy—and frustrating—answer is that there's almost no hard data to work from. The reasons for this vary from user to user and system to system, but a few general themes keep cropping up: any loss of the bigger ones is considered militarily sensitive, nobody is centrally tracking how many hours the smaller ones are flown, materials and propulsion technologies are considered proprietary, etc. Further, perhaps the two most critical issues associated with UAS operations are (1) The necessity of reliable control and datalinks between the pilot and the aircraft; and (2) Feasible means of ensuring that 'see and avoid' remains a viable strategy for manned aircraft through some functionally equivalent analogue to it for unmanned aircraft systems.

"Although a failure in either of these areas can easily be foreseen as an underlying cause of an accident, it's unlikely that either will be publicly debated—with solid information gained from operational experience—for some time to come, since these are also the most controversial aspects of UAS operations in mixed manned/unmanned airspace.

"In short, the path that ISASI's exploration of the UAS arena will follow in the months and years to come is slowly evolving, and is guaranteed to be twisty and bumpy. However, the growth of the UAS sector is proceeding, and we'll need to keep moving forward with it. To the extent that the emerging constellation of unmanned aircraft systems will be different from today's fleet of manned aircraft, we as investigators will need to be ready to deal with those differences. The general course we'll need to chart to get from today to tomorrow seems clear enough.

- We need to encourage dialogue and consciously address the baseline obligation to investigate UAS accidents to prevent their recurrence, without taking any position on the merits of UAS themselves.
- We should not enter into any debates regarding the wisdom of any particular regulatory approaches or design solutions.
- We need to approach unmanned aircraft systems from the highest concep-

tual level possible (aircraft one place, pilot another), and then work from that starting point in developing investigative strategies that account for all of the resulting accident possibilities.

• We need to move forward on the assumption that just about any current aircraft may someday be capable of being flown remotely (so-called 'optionally piloted aircraft'), and that there also will be a growing diversity of purpose-built aircraft optimized for carrying out the 'dull, dirty, or dangerous' activities at which unmanned aircraft systems excel.

"With the above precepts firmly in mind, the investigator community also needs to remind both regulators and UAS manufacturers that where aircraft fly, they also crash. Any UAS accident that is incompletely or ineffectively investigated will lead to another. As such, recommendations aimed at preventing the recurrence of each UAS accident will need to be made, but the only way they will be *useful* will be if they are made *knowledgeably*.

The bottom line: there's only spotty data publicly available on numbers of losses, very little on failure modes or causes, and nothing reliable that would allow any of the losses to be normalized for comparison purposes. Several of the most likely vectors of loss aren't part of the public discourse because of their political sensitivity. And, many of the best minds in our business are in one way or another constrained from working cooperatively on any outside activity like that of the ISASI UAS Working Group.

"Sound like fun? You bet! If you think you can help move the ball forward, please drop me a note at uas@earthlink.net. Here's hoping the upcoming year will bring greater transparency and more willingness to openly address the things that we all need to know to help make future UAS operations as safe as possible." ◆

MOVING?
Please Let Us Know

Member Number___________________

Fax this form to 1-703-430-4970 or mail to
ISASI, Park Center
107 E. Holly Avenue, Suite 11
Sterling, VA USA 20164-5405

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Name ___________________

Address ___________________

City ___________________

State/Prov. ___________________

Zip ___________________

Country ___________________

New Address*

Name ___________________

Address ___________________

City ___________________

State/Prov. ___________________

Zip ___________________

Country ___________________

E-mail ___________________

*Do not forget to change employment and e-mail address.

Revised Membership Cards Now Available

On Sept. 7, 2008, the International Council decreed to update the membership cards from a laminated paper card to a plastic PVC .30 mil card, similar to credit-card size and type. The membership card is now available. Each card is designed with a different color strip designating the membership status: Fellow-black, Full-olive, Associate-sea green, Affiliate-maroon, and Student-slate blue. Because Life Membership cards are already plastic embossed cards, they are not included in the revision.

If you would like a new membership card please send an e-mail or note to Ann Schull, international office manager; isasi@erols.com or 107 E. Holly Avenue, Sterling, VA 20164. Include your membership number in the request. ◆

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Accident Investigation Board/Norway
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Administration des Enquêtes Techniques (Luxembourg)
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BAINES SIMMONS | AMERICAS
Human Factors and Safety Solutions

(Who's Who is a brief profile of, and prepared by, the represented ISASI corporate member organization to enable a more thorough understanding of the organization's role and functions.—Editor)

Baines Simmons Americas is an aviation safety consulting company based in Atlanta, Ga., specializing in integrated human factors and error/risk reduction services for aviation organizations of all sizes, including airlines, OEMs, maintenance repair and overhaul organizations (MROs), aviation ground handling companies, and other high-risk aviation operations

The Baines Simmons group of companies has worked with more than 250 aviation companies worldwide, including advising national aviation authorities in 40 countries. The managing directors of Baines Simmons Americas and Baines Simmons, Ltd., have been recognized with three international awards for aviation human factors and safety work. This partnership allows for knowledge sharing and capability development that is industry leading in the areas of safety culture assessment; Safety Management Systems (SMS) assessment, development, and change-management implementation support; human factors/error management program development; and human factors training—instructor-led and computer-based training (CBT) available in English and Spanish

The Baines Simmons group of companies utilizes a Safety Management and Risk Reduction Toolkit (SMARRT) approach to assessing large organizations safety processes. The SMARRT diagnostic approach is designed to address the challenge of improving safety performance from the perspective of individual and organizational performance to reduce business risk.

Additional capabilities

• *Safety Culture Surveys*—The surveys for both ground-handling and maintenance organizations are unique in the industry. The surveys can be rapidly customized to meet the needs of the client. The surveys help to quickly identify the risks or "hotspots" in an organization and allow immediate focus on intervention strategies. The following is a "snapshot" of the survey process:
1. The surveys consist of between 65 and 92 questions and are conducted in focus groups ranging in size from 3 to 32 people.
2. The surveys are conducted on site and during the regular work hours of the population being surveyed. An agreed-upon percentage of the total population is surveyed to obtain a valid data sampling.
3. Data are gathered in a way that allows the participants to remain anonymous and helps ensure candid, honest feedback.
4. Executive and summary reports are produced for the organizations management team detailed down to location, workgroup, or shift. The surveys are currently available in English, Spanish, and Portuguese.

• *Integrated Error Management Systems (IEMS)*—While surveys and training are important first steps in the error management and cultural change process, they are just the beginning. BSA also specializes in fully integrated error management system development.

• *"Just Culture"* post-event process construction and implementation support—Customized human factors and just culture training for managers, including the findings of the safety culture surveys within the clients organization.

• *Organizational investigation* processes to support a client's error/risk reduction efforts including *human-centered event investigation* training for organizations.

Sample of offered training courses

Implementing Effective Safety Management Systems
1. Implementing an Effective SMS (3 days)—Intended audience: safety managers, quality managers, internal evaluation program (IEP) managers, accountable managers, training managers, human factors managers, regulatory inspecting staff and managers.
2. SMS Implementation for Leaders (1 day)—Intended audience: senior leaders, directors, senior managers.
3. SMS Implementation for Front-Line employees (1 day) (maintenance-specific focus)—Intended audience: front-line managers, supervisors, lead technicians, technicians, support shop staff, materiel services, etc.

Effective Event Investigation (3 days)—Intended audience: ground and flight safety staff, quality assurance staff, MEDA/REDA coordinators, any other staff tasked with conducting investigations. ◆

AIR SAFETY INVESTIGATORS
INCORPORATED AUGUST 31, 1964

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