ISASI FORUM

"Air Safety Through Investigation"

JANUARY–MARCH 2012

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C. Donald Bateman receives the National Medal of Technology and Innovation from President Obama at White House ceremonies. The Medal is the nation's highest honor for technological achievement. Bateman, the 2008 ISASI Jerome F. Lederer Award recipient, is being recognized for developing and championing critical flight safety sensors now used on aircraft worldwide, including ground proximity warning systems and windshear detection systems. Photo: Ryan K Morris/National Science & Technology Medals Foundation

ISASI FORUM
"Air Safety Through Investigation"

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AIR SAFETY INVESTIGATORS
INCORPORATED AUGUST 31, 1964

Invest in ISASI's Future; Mentor a Student

By Frank Del Gandio, ISASI President

January is National Mentoring Month, so it is with a bit of serendipity that I write this column during the opening days of the New Year to announce ISASI's initiation of a hybrid student mentoring plan as a natural outgrowth of our highly successful memorial scholarship program.

The program has awarded 22 scholarships since 2002, the year of its inception. For the past two annual seminars, the awardees have presented their winning essays to the seminar assembly. And at last year's seminar, we recorded more than 20 students in attendance.

In the International Council meeting last September, we discussed the mentoring concept. We determined that a full-fledged program, such as one that may be found in a company or corporation, would be less attractive to potential mentors than one that merely brings together a student who seeks a mentor and an ISASI member who wishes to share knowledge and experiences with a student on an ongoing basis.

Still, even a minimized program requires organization, form, and direction. Anthony Brickhouse, a professor at Embry-Riddle Aeronautical University and an ISASI member, has volunteered to be the lead on this program. He will develop the workings of the program, which will include securing a roster of students seeking a mentor and maintaining a list of members who wish to mentor. The details of the mentoring plan will be announced in a future edition of *ISASI Forum.*

In the meantime, here are a few thoughts:

Benefits of mentoring—A mentor is a caring adult friend who devotes time to a student. Although mentors can fill any number of different roles, all mentors have the same goal in common: to help young people achieve their potential and discover their strengths. Mentors should understand that they are not meant to replace a parent, guardian, or teacher. A mentor is not a disciplinarian or decision-maker for the student. Instead, a mentor echoes the positive values and cultural heritage of our profession. A mentor is part of a team of caring adults.

Mentor's purposes—A mentor's main purpose is to help a student find ways to achieve individual goals. Since the expectations of each student varies, a mentor's aim is to encourage the development of a flexible relationship that responds to both the mentor's and the student's needs.

Why should you become a mentor?—Our industry, like others, is changing. Many of us are retired or are contemplating retiring in the near future. However, we all have one thing in common. We have a wealth of knowledge and experience in the aviation industry. This knowledge would be a valuable addition to any student's education and decision-making regarding a career path.

What is in it for me?—To begin with, you will probably provide this student with a vision of real-life experiences from your history. You will get a sense of accomplishment by providing information to these students. In a way, your legacy may go on through someone else. You will be a great asset to someone who will probably hold a position somewhere in the aviation industry that will maintain and improve the high standards we have established.

What would be expected of me? —A commitment to communicate with the student on an agreed-upon basis. This can be in person, by phone, or through e-mail. Be passionate about your profession and the aviation community. Be a good listener and communicate your experiences and knowledge.

Should you wish early involvement in this very worthy effort, contact Anthony at abrickhouse@cfl.rr.com. I promise that you will not regret it. ◆

Embry-Riddle Aeronautical University (Daytona Beach, Fla.) students attend ISASI 2011 in Salt Lake City, Utah. All are student members of ISASI.

Analyzing the Safety Data

By Paul Mayes, ISASI Vice President

There are several organizations that publish aviation safety statistics and analyze the safety trends. While the numbers and trends can be revealing, they do not reflect the actual impact of a serious accident or fatality. For every victim, there can be dozens of family and friends who are affected by the suffering. However, the best measure of the success of our air safety work is by these statistics.

The initial reviews are showing that the year 2011 was a very safe year for civil aviation. Last year was the second safest year by number of fatalities and the third safest year by number of accidents. Also, at the end of 2011 there was the *longest period* without a fatal airliner accident in modern aviation history.

There were a total of 28 fatal airliner accidents, resulting in 507 fatalities and 14 ground fatalities. The number of fatalities is lower than the 10-year average of 764 fatalities. When these numbers are quoted as rates, the results are even more encouraging due to the increases in passenger numbers and flights every year.

Seven out of 28 accident airplanes were operated by airlines on the European Union's (EU) "black list" as opposed to six out of 29 the year before. The EU added a total of nine airlines to the black list and removed three airlines based on improved safety records.

In 2011, Africa showed a continuing decline in accidents: 14 percent of all fatal airliner accidents happened in Africa. This is still a county that needs a great deal of help to get its safety in line with North America. The major accident rate in North America, for example, has remained flat at about one in 10 million flights, while in Africa the rate is roughly 40 times greater, according to the International Air Transport Association. Russia suffered a very bad year with six fatal accidents.

While the year's airline accident statistics are very welcome, all of us in safety know that we cannot rest on our laurels. One accident involving a widebody aircraft could reverse these trends. And there are worrisome factors that could impact these trends.

Airport and runway incursions are still high on the risk scale. For example, a B-777 and an Airbus A340 had a close call at JFK International Airport last year when the B-777 entered the active runway. The incident in June was the most dangerous near miss of the year at the New York City airport, according to a news report from the Federal Aviation Administration. The A340 carried 286 passengers bound for Munich while the B-777 carried 346 passengers headed to Cairo. If they had collided, it could have been the worst commercial air disaster in history.

There are various technological solutions to reduce the risk of runway incursions (for example, ground surveillance radar, conflict recognition, barrier systems, onboard taxi path displays, and conflict warnings), but as yet many of these are not mandated. Should we as an air safety organization be more active, and proactive, in lobbying for greater risk management and the implementation of technological solutions to this threat to aviation safety?

Similarly, the aviation safety analysts are highlighting loss of control as a major accident finding. Although there are many factors in this type of accident, it can be related to the standards of pilot training and lower levels of pilot experience as the so-called "baby boomers" retire. On the positive side, there was the example of an Airbus A380 that had an uncontained engine failure during the initial climb from Singapore. The skill and team work of the crew resulted in a safe landing after a very hazardous loss of systems.

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Therefore, even though the accident rate in North America, for example, is very low, we must not relax our safety efforts. ISASI can play an important part in ensuring the continuing safety of aviation. The majority of our members are based in North America, and many have influential positions in the government and as regulators. But ISASI is an international organization, and we can make a difference through ICAO and in our own countries.

As the current vice president and the only non-North American on the ISASI Executive, I feel I can add an extra dimension to the ISASI Executive and assist with the wider international role. We have members in most countries, although many countries are only represented by one or two ISASI members. The Executive is here to provide what support we can to all our members.

As individuals, we must conduct our business with the utmost integrity and do what we can to make aviation even safer. Perhaps that should be a part of our New Year goals. ◆

ISASI MEMBERS EARN
YEAR-END RECOGNITION

Presidential, royal, and agency honors are awarded to three ISASI members and one ISASI corporate member at year's end.

(This material was compiled from related news releases and a contribution from Nancy Wright.—Editor)

Honeywell engineer and 2008 ISASI Jerome F. Lederer Award honoree C. Donald Bateman is a recipient of the nation's highest honor for technological achievement, the National Medal of Technology and Innovation from the U.S. Department of Commerce Patent and TradeMark Office. President Barack Obama presented him the National Medal on Oct. 21, 2011, in a White House ceremony. Bateman was honored for developing and championing critical flight safety sensors now used on aircraft worldwide, including ground proximity warning systems and windshear detection systems. The FAA mandated the installation of these systems for all commercial aircraft.

The National Medal of Technology and Innovation was created by statute in 1980. It is administered for the White House by the U.S. Department of Commerce's Patent and Trademark Office. The Award recognizes those who have made lasting contributions to America's competitiveness and quality of life and helped strengthen the nation's technological workforce. Nominees are selected by a distinguished independent committee representing the private and public sectors.

Don was among 11 others who were recognized in the fields of science, engineering, and invention. Of these men, President Obama said: "Each of these extraordinary scientists, engineers, and inventors is guided by a passion for innovation, a fearlessness even as they explore the very frontiers of human knowledge, and a desire to make the world a better place. Their ingenuity inspires us all to reach higher and try harder, no matter how difficult the challenges we face."

RYAN K MORRIS/NATIONAL SCIENCE & TECHNOLOGY MEDALS FOUNDATION

President Obama prepares to present Don Bateman the National Medal of Technology and Innovation.

Don began his initial work on GPWS in the late 1960s. Additional innovations involve systems for heads-up display, speed control autothrottle, stall warning, angle of attack, automatic flight control, weight and balance, radar, and others. He continues to be actively involved improving aviation safety and is currently working on improving his runway aural awareness system, which reduces the risk of runway incursions and overruns.

Born in Canada, Don is a U.S. citizen educated at the University of Saskatchewan. He has been with Honeywell and its predecessors since 1960. He has been a strong supporter of ISASI for more than four decades, supporting the organization with his knowledge and by presenting papers and speaking at industry events.

Over the years, Don has been recognized for his achievements worldwide. He won the Admiral Luiz de Florez Award from Flight Safety Foundation twice. He's been an *Aviation Week* Laureate and received the New Zealand Air Safety Foundation Award in 1992. He was named a Pathfinder by the Museum of Flight in Seattle and was inducted into the National Inventors Hall of Fame in 2003. He won the Laura Taber Barbour Air Safety Award from the Flight Safety Foundation and is a Honeywell Corporate Fellow. He is also a Fellow of the Royal Aeronautic Society.

About his selection, Don said to *Forum*, "I have been fortunate to have a patient, encouraging wife and family. Also, I have had the privilege of working with some very special colleagues, the support of a few key friends from my upper management, from the airlines, the FAA, aircraft manufacturers such as Boeing, Airbus, Gulfstream, the Flight Safety Foundation, the International Russian Flight Safety Foundation, the Royal Aeronautical Society, and especially ISASI. Many of my accomplishments have been our accomplishments. All have been my friends making flying safer."

Kevin Darcy, president of the Pacific Northwest Regional ISASI Chapter in which Don holds membership, commented, "Those of us who have had the good fortune to watch Don in action over the years congratulate him for his remarkable achievements. He has been a key player in the success of our Chapter and has often arranged events at Honeywell."

ISASI President Frank Del Gandio added, "Don's recognition should come as no surprise to his peers and fellow members. Don is a giant in his field. I don't believe it is an overstatement to say that his work has probably saved more lives than any other single person who has ever worked in the field. His recognition is richly deserved." ◆

"Don is a giant in his field. I don't believe it is an overstatement to say that his work has probably saved more lives than any other single person who has ever worked in the field. His recognition is richly deserved."

Royal honors

ISASI's United Kingdom corporate member Cranfield University is being awarded a Queen's Anniversary Prize for Higher and Further Education for its "world-leading work in aviation safety through research and training in air accident investigation." The Safety and Accident Investigation Centre has a worldwide reputation for excellence. The UK's Department for Transport, the Civil Aviation Authority, and the Ministry of Defence (MOD) turn to Cranfield with its deep knowledge of the aviation sector to spearhead critical research and training across the UK's aviation fleet. The facilities give students the opportunity to experience practical "real life" situations. Students gain skills in evidence collection and witness interviewing and analysis through simulated accidents staged on the University's own airport.

Over the last 30 years, the University has trained more than 1,000 air accident investigators and safety managers for national investigation agencies, the military, airlines, regulators, and manufacturers. Past students have gone on to investigate some of the most serious aviation accidents in every continent including, most recently, the Qantas Airbus A380 engine failure of late 2010.

In all, 21 institutions are winners of the Queen's Prizes. A total of 130 institutions entered submissions to the Royal Anniversary Trust. The Prizes recognize and celebrate outstanding work within UK higher, further education institutions and the impact that they have.

The Queen's Anniversary Prizes
For Higher and Further Education
2011

Entries undergo a rigorous process of independent external assessment. This includes review by national and international experts and specialists covering the relevant disciplines, reference to government departments and UK devolved governments with a particular interest in the fields of work under consideration, and to professional and other bodies and sources. The final decisions on recommendations for the queen's approval are made by the Awards Council of the Trust.

The Prizes are a biennial award scheme within the UK's national honors system. As such, they are the UK's most prestigious form of national recognition open to a UK academic or vocational institution. The honor is distinctive in recognizing the institution rather than an individual or team. The scheme was established in 1993 with the approval of the queen and all-party support in Parliament.

Cranfield University will be presented with a medal and certificate by Her Majesty the Queen and His Royal Highness the Duke of Edinburgh at a ceremony to be held at Buckingham Palace in February and will be allowed to use the Queen's Anniversary Prize crest for four years.

Professor Graham Braithwaite, head of the University's Department of Air Transport and chair of ISASI's Investigator Training & Education Working Group, said: "We are absolutely delighted with this prestigious award in recognition of the role our work has played in ensuring the safety of travelers worldwide. The industry as a whole has benefited from the University's work in aviation safety, including passenger behavior and fire evacuation procedures.

"We are enormously proud of this achievement, which represents the hard work of many staff and visitors over at least 30 years. I hope that all of the past students and staff of Cranfield and those in industry who have either helped us or utilized our work will join us in celebrating this achievement."◆

Top Champion of Safety

Top safety champion Bob Matthews

Robert "Bob" Matthews snared "Top Champion of Safety" honors in the Federal Aviation Administration's 4th annual AVS National Awards ceremony in late October. FAA Associate Administrator Peggy Gilligan and the senior executive management team honored members of AVS for their contributions to aviation safety. Out of 62 nominations, seven individuals and three teams were recognized.

Tagged "The Top Champion of Safety," Bob is a senior aviation safety analyst and special assistant to the director in the Office of Accident Investigation and Prevention. An internationally renowned aviation safety expert, Bob is respected for his historical analysis of safety trends and his identification of emerging safety challenges.

He has had a hand in every critical FAA rule currently under consideration—providing effectiveness measures for pilot flight, rest, and duty requirements and safety management systems—just to name a few.

Over the course of his career, Bob earned a Ph.D. in public administration, taught as an assistant professor, helped develop national transportation legislation for the Federal Highway Administration, and served under the Secretary of Transportation as an aviation analyst.

His most recent work involved an instrumental role in helping establish the next generation of aviation safety enhancements by transitioning FAA's focus from analyzing accidents to monitoring national airspace system operations so that AVS can proactively identify and address emerging threats before they lead to serious incidents or accidents.

Bob has now retired from government service and, along with Frank Del Gandio, who has also retired from the FAA, is exercising his entrepreneurial spirit by operating the newly formed company Legend Aviation, doing safety and analytical work. ◆

International Recognition

Dr. William "Bill" Johnson

The International Federation of Airworthiness (IFA) has announced that the 2011 honoree of the Whittle Safety Award is ISASI member Dr. William B. Johnson, chief scientific and technical advisor for human factors in aviation maintenance for the Federal Aviation Administration.

The Award, which honors the co-inventor of the jet engine, Sir Frank Whittle, is the highest and most prestigious award the Federation can confer to recognize an advance in aviation safety. The citation reads, "In recognition of his dedication, research, leadership, and promotion of human factors in aviation maintenance and engineering and his many publications exemplified by the 'Maintenance Human Factors Presentation System' and the video production Grounded.

In making the Award, IFA said: "Safety specialists, worldwide, first observed that attention to human factors on the flight deck and on flight crew behavior had a positive impact on safety. The same attention and programs were initiated for maintenance/engineering personnel by the mid-1980s. From the early national plans for human aviation human factors to a 25-year legacy of international maintenance human factors symposia, Dr. Johnson has been a key planner and contributor. At the international level, in his corporate and government roles, Dr. Johnson has influenced attitude, procedures, tools, training systems, and policy regarding human factors in maintenance. Johnson has successfully evoked an applied scientific approach that combines the fundamentals of human performance, psychology, and learning to the daily requirements of operational aviation maintenance."

Upon notification of the Award, Johnson said, "Industry and government attention factors have impacted not only continuing flight and worker safety, but also operational effectiveness and efficiency. We are off to a very good start on maintenance human factors. Our collective activity shall evolve as it is integrated with other safety management systems. I accept this Award as it acknowledges the importance of maintenance human factors and the many maintenance human factors proponents in government and industry worldwide." ◆

Impact Dynamics Cases and Cautions

The authors look at the British Airways B-777 crash at London Heathrow Airport on Jan. 17, 2008, and report the resulting investigative computational impact dynamics work concerning the rupture induced by loads from the main landing gear.

By Robert Carter, Air Accidents Investigation Branch;
Anne Evans, Air Accidents Investigation Branch; and
Andrew Walton, Cranfield Impact Centre

(This article is adapted, with permission, from the authors' paper entitled Impact Dynamics—Cases and Cautions *presented at the ISASI 2011 seminar held in Salt Lake City, Utah, Sept. 13–15, 2011, which carried the theme "Investigation—A Shared Process." The full presentation, including cited references to support the points made, can be found on the ISASI website at www.isasi.org under the tag "ISASI 2011 Technical Papers."—Editor)*

When a British Airways B-777 crashed at London Heathrow Airport on Jan. 17, 2008, after a rapid loss of thrust on both engines, the safety investigation led by the United Kingdom Air Accidents Investigation Branch (AAIB) concentrated principally on the causal and contributory issues concerning the powerplants, fuel system, and icing in the fuel. [See *ISASI Forum* April-June 2011, page 5].

In parallel to the investigations into the root causes of the accident, the AAIB conducted a further investigation into the crashworthiness and survival aspects of the accident. There were, fortunately, only relatively minor injuries in the accident and no ground fire, despite a substantial rate of descent at impact and rupture of a major fuel tank. In this article, we will discuss the computational impact dynamics work concerning this rupture, which was induced by loads from the main landing gear. Also to be considered are the advantages and disadvantages of computational impact dynamics studies in accident investigations, including previous instances in which the AAIB has been involved.

The accident on Jan. 17, 2008

While on approach to London (Heathrow) from Beijing, China, at 720 feet AGL, the right engine of Boeing 777-236ER G-YMMM ceased responding to autothrottle commands for increased power and instead the power reduced to 1.03 Engine Pressure Ratio (EPR). Seven seconds later, the left engine power reduced to 1.02 EPR. This reduction in thrust led to a loss of airspeed, and the aircraft touching down some 330 meters [1,082 feet] short of the paved surface of Runway 27L at London Heathrow. The investigation identified that the reduction in thrust was due to restricted fuel flow to both engines. It was determined that this restriction occurred on the engines at the Fuel Oil Heat Exchanger (FOHE).

The investigation identified the causal factors that led to the fuel flow restrictions as being the release of accreted ice from within the fuel system, causing a restriction to the engine fuel flow at the face of the FOHE on both the engines. This ice had formed from water that occurred naturally in the fuel while the aircraft operated with low fuel flows over a long period and the localized fuel temperatures were in an area later described as the "sticky range." The FOHE, while compliant with the applicable certification requirements, was susceptible to restriction when presented with soft ice in a high concentration, with a fuel temperature below -10°C and a fuel flow above flight idle. The certification requirements did not take into account this phenomenon as the risk was unrecognized at that time.

Cabin crashworthiness/survivability

Despite a high rate of descent at impact, there were only 16 passengers identified with "minor injuries" and one serious injury in the accident. There were a number of crashworthiness and survivability issues identified in the cabin, and these are fully described and analyzed in the AAIB final accident report (AAIB AAR 1/2010, published February 2010), with detailed safety recommendations. These issues concerned cabin lighting, emergency lighting, and the seatback video monitors attached to the business-class seats; they were all dealt with by the AAIB investigation in a conventional investigation process.

Fuel tanks crashworthiness/survivability

The major crashworthiness work in this accident, however, concerned the impact-related damage to the aircraft fuel tanks, which had been compromised in the impact and ground slide sequence. The initial impact of the aircraft was approximately 120 meters [393 feet] inside the airfield's perimeter fence (see Figure 1). The first ground marks were made by the rearmost wheels, followed by all the main wheels as the trucks tilted forward, at which time the maximum vertical acceleration spike of 2.9g was recorded on the DFDR. The touchdown into soft soil produced impact gouges with a depth of up to 0.45 meters [1 foot] from the right main landing gear (MLG) and 0.36 meters [1 foot] from the left gear. There was contact with the rear fuselage as the aircraft continued forward.

The aircraft then rebounded and briefly became airborne again. On the second impact, approximately 53 meters [174 feet] from the first impact, the ground marks indicated that the right MLG had moved inboard. There was contact by the engine nacelles and the nose landing gear, which immediately collapsed. As the weight of the aircraft transferred onto the engine nacelles, the engine cowlings and engine accessories were damaged and the engines dug into the ground.

During the ground slide, both the engines scooped up soft soil, which increased the aircraft's retardation. Approximately 152 meters [498 feet] after its initial contact, the right engine struck the thick concrete cover of an inspection pit. This caused damage to the lower part of the engine and assisted the deviation of the aircraft's ground slide to the right, with the aircraft coming to rest on the tarmac area near the threshold of Runway 27L, approximately 372 meters [1,220 feet] from the first impact (see Figure 2).

The nose landing gear had separated from the aircraft; damage to its attachments was consistent with both a high vertical load and side load to the left. The left MLG had partially separated due to overload but remained attached to the fuselage by the drag and side braces. During the initial impact, the gear beam outboard end fuse pin had fractured, which allowed the gear beam to rotate upward. The trunnion housing fuse pins then also fractured, allowing the forward trunnion to move upward. The significant vertical load had also resulted in a piece of top wing skin being removed. There were witness marks on the aft trunnion outer bearing race, consistent with the aft trunnion then having been pulled out. The attachment of the inboard end of the gear beam was damaged but remained intact; the drag strut fuse pin had "crankshafted" in a direction indicating that a load had been applied in tension but this had also remained intact.

Of greater interest was the damage to the right MLG. During the initial impact, the fuse pins in the right MLG gear beam outboard end fractured, which allowed it to rotate upward in the same manner that had occurred on the left MLG. The lower housing ("H block") fuse pins had then also fractured, and witness marks on the lower housing support indicated that the H block, together with the forward trunnion, had been pulled aft and down. There was no evidence of any crankshafting or damage to the drag brace fuse pin. Witness marks on the upper surface of the truck beam indicated an over-travel in both the truck pitch-up and pitch-down directions.

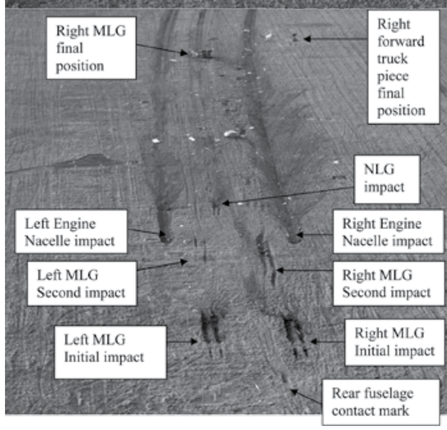
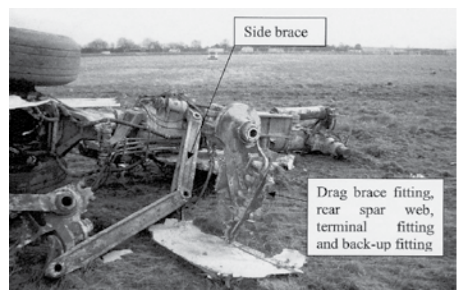


Figure 1 (above). G-YMMM, Runway 27L at London Heathrow. Figure 2 (left). G-YMMM ground impact marks. Figure 3 (below). Right main gear with rear spar web.



During the subsequent ground slide, the right MLG had separated from the aircraft, rupturing the rear wing spar web. The drag brace support fitting, together with portions of the rear spar web, rear terminal fitting, and the internal back-up fitting, remained attached to the right main landing gear (see Figure 3) around the drag brace fitting. Examination of the fracture surfaces indicated an overload in the aft direction.

During the separation, the remaining section of the right MLG had impacted the fuselage, damaging the wing-to-body fairing and penetrating the rear cargo hold. This impact had caused damage to and leakage from the passenger oxygen cylinders, which are located in the rear cargo hold. This section of MLG then became airborne and impacted the right horizontal stabilizer as the aircraft continued to slide. This was confirmed by the presence of an

■ ***Robert Carter*** *is a principal inspector and investigator-in-charge (IIC) with the Air Accidents Investigation Branch (AAIB). He is a graduate of Imperial College, London, and Cornell University, New York. He joined the AAIB in 1985. His civil and military accident field investigations include the Boeing 747 at Lockerbie (1988), the Boeing 737 at Kegworth, UK (1989), the Airbus A300B4 near Medan, Sumatra (1997,) and the Concorde at Gonesse, France (2000). In November 2008, he assumed IIC duties for the Boeing 777 G-YMMM investigation, having the responsibility for completing the investigation and preparing the final reports.*

■ ***Anne Evans*** *was a senior inspector (engineering) with the Air Accidents Investigation Branch in the UK. She joined the AAIB in 1987 and specialized in the analysis of FDR and CVR data. In 2000 she began work as an engineering investigator and has participated in a range of civil and military accident investigations, including the Boeing 747 at Lockerbie, UK (1988), the Boeing 737 at Kegworth, UK (1989), and the A320 in Ibiza (1998). She was responsible for investigation of crashworthiness aspects on the accident to the Boeing 777 G-YMMM at Heathrow in January 2008. Ann was graduated from Imperial College, London, and is the ISASI European Councillor.*

■ ***Dr. Andrew Walton*** *joined Cranfield Impact Centre in 1983, having graduated from Loughborough, Cambridge, and Cranfield Universities. His major interest is in analytical crash simulation methods, working in the aerospace and automotive sectors. He first worked with the AAIB in the simulation of the Boeing 737-400 accident at Kegworth, UK in 1989. Subsequently, he has worked with the AAIB and other authorities in some 20 or so accidents as part of formal accident investigations. The case reported in this presentation represents his most recent work with the AAIB involving the accident of Boeing 777 at Heathrow in 2008.*

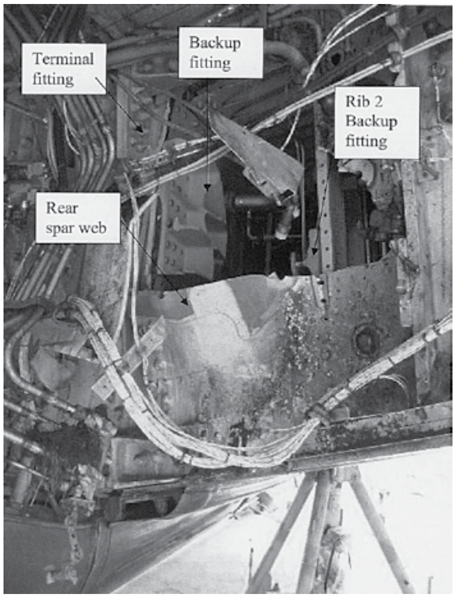


Figure 4. Right rear spar and center fuel tank structure.

embedded portion of horizontal stabilizer leading edge material (see Figure 4).

The two front wheels of the right MLG, together with the forward section of the truck beam ahead of the center axle, became detached and impacted the right side of the fuselage, resulting in the injury to the passenger seated in seat 30K.

For the investigation, Boeing generated a clear and useful graphical account of this MLG sequence, and it is reproduced in the AAIB accident report.

Previous impact modelling

Over the previous 20 years, the AAIB had been involved in a number of exercises where state-of-the-art computational impact dynamics has been used within an accident investigation. The scenarios had been varied, but in each case the fundamental purpose of the computational work had been to deepen the understanding of the conventional "field investigation" work and, in particular, to compare the impact, principally in terms of impact decelerations and loads, with values used in the aircraft design and certification processes. This is rather different from the use in industry of impact dynamics as a "predictive" tool in which the modelling takes the place of expensive and highly instrumented hardware impact tests. Instead, the use within the investigation takes place **after** the hardware exercise (the accident, which is always unplanned, uninstrumented, and uncontrolled!) but aims, for instance, to quantify seat deceleration signals to allow comparison with certification levels.

The classic AAIB case was the B-737 G-OBME accident at East Midlands in January 1989. For this exercise, relatively crude compared with recent work, airframe and ground modelling were used as a supplement to other investigation work in order to generate seat load and deceleration levels. This was followed by further work using these deceleration signals levels in modelling a typical passenger in a typical seat. The AAIB was involved in a similar exercise in support of the SAS MD-81 OY-KHO accident near Stockholm in December 1991 in which there was a particular interest in the strength of overhead bin attachments as well as passenger seats. In September 1999 the AAIB used impact modelling in investigating a Cessna 404 Titan G-ILGW accident in which the plane crashed shortly after takeoff from Glasgow Airport, with the emphasis again on airframe and seat strength.

Another interesting case was the BEA investigation of the Concorde accident in 2000. In this instance the impact of interest was between a large mass of detached tire and the lower skin of a main fuel tank, and the computational simulation ran alongside a series of tank impact tests. It was the experience gained from these cases that brought about the confidence to undertake impact modelling in this G-YMMM accident.

G-YMMM crashworthiness modelling

Regarding the accident to the BA B-777 G-YMMM, study was carried out by the Cranfield Impact Centre (CIC) to simulate the impact in order to investigate the failure of the right MLG and the consequent fuel tank rupture. A Finite Element (FE) model of the aircraft, based on data from the manufacturer, was combined with a FE model of the accident site. For this structural impact analysis, LS-DYNA software was used for its capability to predict the dynamic behavior of nonlinear materials under transient loads and varying boundary conditions.

The FE model for the right main landing gear and its attachment to the aircraft model was derived from engineering data supplied by the manufacturer and supplemented by additional data from other sources. The model of the accident site was created from a detailed site survey, which included soil properties measured at the impact area. The aircraft and ground models were combined to simulate the dynamic behavior of the aircraft during the impact, and the aircraft model was projected at the ground at the velocity and attitude derived from the recorded data. More detail on the analysis by the CIC, and the results, are contained in the AAIB accident report. Figures 5 and 6 show static images from the dynamic impact modelling.

In addition to a simulation of the accident conditions, a number of test cases were also run to investigate the factors in the impact; these included the impact surface (soft soil and hard ground) and yaw/roll angle at impact. A "normal" landing case was also simulated using data supplied by the manufacturer to validate the model. The nature of the ground surface was found to have a significant effect on the outcome of the simulation.

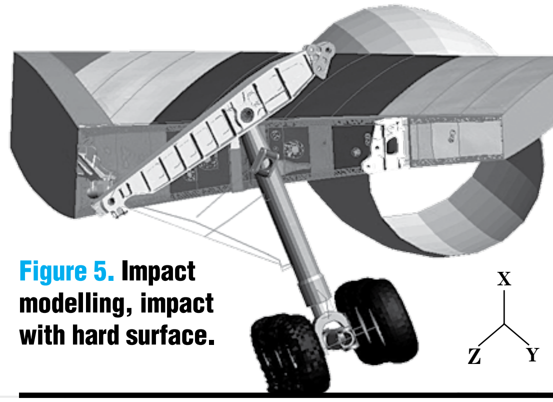


Figure 5. Impact modelling, impact with hard surface.

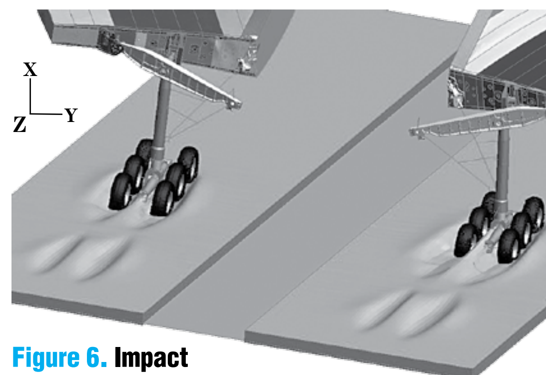


Figure 6. Impact modelling, soft ground deformation.

The fuel tank rupture

The AAIB analysis in the final report used both the conventional investigation examinations and the results of the Cranfield Impact Centre FE simulation work.

Both main landing gears had partially separated at the initial impact, which occurred with a vertical rate of descent of 25 ft/s immediately before impact. The ground marks showed that, at the second impact, the main landing gear legs were unable to sustain vertical load and that the aircraft contacted the ground on its engine nacelles and its nose landing gear, which immediately collapsed.

The separation of the left gear attachments followed the design breakaway sequence, leaving the fuel tanks intact except for a small gap between the upper wing skin and the rear spar. The gear remained with the aircraft as it continued to slide along the ground. Analysis of the sequence of failures indicated a very heavy vertical impact, with the fracture of all six fuse pins in the upper and lower housings of the forward trunnion. The drag brace fuse pin showed some evidence of crankshafting but did not fracture.

The right gear showed a similar initial breakaway sequence following the fracture of the outboard end of the gear beam attachment; however, only the four fuse pins in the lower housing for the forward trunnion failed, leaving the two upper housing pins intact. The forward trunnion was then forced down and aft. The ground marks at the second impact indicated that the right MLG had been displaced inboard during the initial impact.

As the aircraft continued the ground slide, the right MLG moved aft allowing the shock strut to contact the truck beam. This resulted in the separation of the forward portion of the truck beam together with two wheels. This piece then struck the right side of the fuselage causing damage within the cabin and leading to the passenger injury. As the remainder of the gear assembly continued to move aft, the inboard wheels contacted the fuselage behind the MLG bay. The rear spar web, together with the back-up fitting and terminal fittings, ruptured, which caused the right MLG to separate. This became airborne and struck the right horizontal stabilizer before coming to rest.

The possibility of the landing gear being displaced inboard had been considered in the certification of the B-777-200LR, as this variant has a fuel tank located aft of the main landing gear bay. As a result, the manufacturer introduced a rotational tab and reduced the cross-sectional area on the drag brace to protect the additional fuel tank in the event of an overload condition. On G-YMMM, this area contained the passenger oxygen bottles, which were disrupted by the MLG during the ground slide; this could have contributed to a post-impact fire. As the fuel tank rupture represents a significant hazard in a survivable accident, the following recommendation was made: "***Safety Recommendation 2009-094—****It is recommended that Boeing apply the modified design of the B-777-200LR main landing gear drag brace, or an equivalent measure, to prevent fuel tank rupture on future Boeing 777 models and continuing production of existing models of the type.*"

The rupture of the rear spar resulted in a breach in the center fuel tank. Based on the knowledge at the time, the design breakaway scenario was accepted when the aircraft was certificated and found to be in compliance with the requirements.

Use of computer-based impact tools can add real value to the accident investigation. This is as a supplement to other approaches, not as a substitute, and compared with other investigation costs, it can be expensive.

The current CS 25.721 (a) requirements stated that "*…The overloads must be assumed to act in the upward and aft directions in combination with side loads acting inboard and outboard. In the absence of a more rational analysis, the side loads must be assumed to be up to 20% of the vertical load or 20% of the drag load, whichever is greater…*"

Although, as part of the B-777-200 certification, this criteria was met as part of the EASA Certification Review Item (CRI), there is no such requirement in the FARs. This generated a safety recommendation: "***Safety Recommendation 2009-095—****It is recommended that the Federal Aviation Administration amend its requirements for landing gear emergency loading conditions to include combinations of side loads.*"

The analysis by the CIC also showed very different failures resulting from landing on soft ground as opposed to a hard runway surface. In the soft ground accident simulation, the results showed that only one of the fuse pins failed. A delayed build-up of shear forces in the pins (when compared to impact with hard ground) prevented most of them from reaching their failure loads. This delaying action allowed the fuse pins to continue transferring loads into the rear spars and resulted in distortion in the region of the drag brace attachment.

It was concluded that the difference in outcome in the simulation from that of the accident was due to the soil characteristics in the model being different to those of the soil at the accident site. Had the soil strength in the model been greater, it is probable that more fuse pins would have failed and the rear spar distortions would have been less. However, the analysis did indicate that landing gear interaction with soft ground can substantially modify the breakaway sequence.

Dynamic FE modelling is a novel and complex task. The analysis carried out by the CIC had a number of limitations and ultimately did not accurately reproduce the accident outcome. Further research is required in order to fully understand the effects of soft ground on the landing gear breakaway and the dynamics of the fuse pin loading.

The current requirements do not explicitly differentiate between landings on different types of surfaces and the resulting dynamics. Emergency landings may be performed on soft surfaces either outside the airfield boundary or beside the runway itself. To consider different types of surfaces in the landing gear design requirements, this safety recommendation was made "***Safety Recommendation 2009-096—****It is recommended that the Federal Aviation Administration, in conjunction with the European Aviation Safety Agency, review the requirements for landing gear failures to include the effects of landing on different types of surface.*"

Lesson learned

Within this accident investigation the impact dynamics work was limited in scope but was, overall, successful and helped to formulate a number of safety recom-

(continued on page 31)

ENSURING SAFETY IN AVIATION'S

By NTSB Chairman Deborah A.P. Hersman

Accident investigation's past and present, and how it must adapt in order to play an even more pivotal role in creating civil aviation's safer and stronger future.

(The following article is presented for the historical and future perspective it provides to the profession of air safety investigator. It is adapted from remarks delivered by National Transportation Safety Board Chairman Deborah A.P. Hersman at the 8th annual Assad Kotaite Lecture in Montreal, Quebec, on Dec. 8, 2011.—Editor)

It is my honor to be here with so many people who do so much for civil aviation and for aviation safety. And it is a privilege to be invited to give this talk and be here with Assad Kotaite, a giant in international aviation. Dr. Kotaite's leadership has advanced cooperation among ICAO, its contracting states, and the global aviation community, and dramatically fostered improvements in safety through standardization and technical leadership.

Deborah A.P. Hersman, chairman, NTSB

I have not had the privilege to know Dr. Kotaite for as long as many of you. But in speaking with my colleagues, they all credited him with the success of ICAO—its lack of politics and its focus on doing the technical work and being an efficient and effective organization. He excelled at leadership of an organization, of people, and of ideas. He dramatically fostered improvements in safety through standardization. And that is my theme—fostering improvements in aviation safety.

As I look out at the audience and see so many of you from all around the world, I am reminded that global diversity and international perspective are what make aviation so strong.

Growing up, I spent most of my childhood overseas. I lived in Spain, England, and Amman, Jordan. I got to see other countries—their challenges, their successes, and their diversity. I learned that one size does not fit all.

In Jordan, I saw goat and sheepherders, which brings me to a story I want to tell. It's a Lebanese tale in homage of Dr. Kotaite's heritage. Once upon a time, three goats—Siksik, Mikmik, and Jureybon—were grazing on a stony hill. Scenting them, a hyena lopes up. "Siksik," calls the hyena. "Yes, sir," says the goat. "What are those points on your head?" "These are my little horns, sir." "What is that patch on your back?" the hyena asks. "My hair, sir." "Why are you shivering?" roars the hyena. "Because I am afraid, sir." With that, the hyena gobbles him up.

The hyena turns to Mikmik, who answers just as his brother, with the same tragic result.

Next, the hyena approaches Jureybon.

As the hyena draws near, Jureybon bellows, "May a plague be on you!" The hyena asks, "What are those points on your head?" "Why, those are my trusty sabers!" "And the patch on your back, what is that?" "My sturdy shield!" Jureybon replies. To the hyena's last question, "Why are you shivering?" Jureybon snarls, "Shivering? I'm shaking with rage to throttle you!"

Jureybon advances on the hyena, who runs for his life. Jureybon springs after him, slits open his belly, and frees his brothers.

You could say that Jureybon was the world's first accident investigator. He saw what happened, learned from it, and adapted to prevent it from happening again.

And, that's what I will talk about: accident investigation—its past and present, and how it must adapt in order to play an even more pivotal role in creating civil aviation›s safer and stronger future.

Jureybon did exactly what the 185 delegates from 52 states intended two-thirds of a century ago at the 1944 Chicago Convention that created ICAO. Investigating, learning, and adapting from accidents so that the deadly past would not be repeated. And that's what all of us and all of you are doing every day.

Thanks to the vision in 1944—and to the efforts of so many more—today's global airline accident rate is at its lowest ever. The Air Transport Association reports that last year the global rate was one accident for every 1.6 million flights.

That's a 42 percent improvement since 2000. How did we get to this low rate? What did we see? What did we learn? And, how did we adapt?

Here are three key areas that helped get us to that low rate: data, technology, and design. Those Chicago pioneers recognized the importance of data. Their plan: ICAO was to be a center for the collection, study, and distribution of information on all significant aircraft accidents.

They did early work to define common terms and develop a standard method to present accident statistics. And they laid important groundwork to develop an accident investigation manual.

This focus was essential. For one, between 1946 and 1950, on average, U.S. carriers had a major aviation accident every 16 days. Think about that: Every 16 days.

Here's another way our forebears recognized the importance of data. A report from the 1947 meeting of the Accident Investigation Section noted that flight recorders had proven valuable. The report recommended, "These instruments should ideally record indicated air speed and acceleration as well as altitude." Those early foil flight recorders, followed by their

SECOND CENTURY

second- and third-generation descendants, contributed significantly to today's outstanding global safety record.

Solved accidents

I could fill an entire book with examples of accidents solved—and countless accidents prevented—thanks to information obtained from data recorders. Much of that information led directly to technological improvements.

In fact, just last month, Honeywell's Don Bateman was recognized by President Obama with the National Medal of Technology and Innovation for his breakthrough work developing ground-proximity warning and windshear detection systems. [Mr. Bateman is ISASI's 2008 Jerome F. Lederer Award winner.]

Bateman's EGPWS has all but solved CFIT accidents. And with Doppler radar and so much more, aircraft now fly more safely in all kinds of weather conditions. Traffic Alert and Collision Avoidance Systems, or TCAS, have helped eliminate mid-air collisions. Those are just the tip of the technology iceberg.

Through aviation's first century, the community learned a tremendous amount—the hard way—about aircraft design issues from a number of accidents, including the DC-10 with its poorly designed cargo door latches and the Boeing 737 and metal fatigue.

As we ended that first century, we saw further design improvements on the workhorses of the airline industry—remedies for the rudder design issues in the 737 and the inflammability of the 747 center fuel tank. Today, we find fewer and fewer equipment and design failures.

Why?

We investigated. We learned. And we adapted.

Second century challenges

So, what are we seeing in aviation's second century? Today, there is greater safety. Yet, at the same time, there are greater challenges in investigating accidents and ensuring safety. This is because while modern technology has made aircraft more efficient, they are also far more complex.

No one knows that better than you do.

Look at the changes. Old "steam gauges" have been replaced by electronic displays. Hand flying has been supplanted by increasing automation. Many flight controls now rely on electronic actuators compared with control cables. And, of course, there are more and more composite structures.

While these all provide advantages, they require adjusting how accident investigators acquire evidence and information. The evidence and failure signatures we relied upon in yesterday's investigations are not always available today.

For example, in 2001, when we pulled the vertical fin of the Airbus A300 out of the waters in the New York area, it took us a long time to figure out where the failure began and why—and what the forces operating on it were because we didn't have typical overstress signatures that we used to see with metal.

Or, before glass cockpits, investigators could determine an airplane's airspeed at impact because they could see the slap of a needle on the face of the gauge. These concrete physical traces are no longer there.

The good news is that investigators have access to more data sources. Today's flight recorders collect thousands of parameters. And investigators are able to retrieve information from nonvolatile memory sources, which can be recovered from electronic components, including digital engine controls, flight control and maintenance computers, and much more.

Even when these devices are severely damaged, we've had successes with chip-level data extraction. There's also data transmitted from onboard reporting systems, such as ACARS, which can provide investigators with critical real-time information.

And, we're seeing an immense amount of video data from surveillance cameras and personal cameras, as well as information from GPS devices and electronic flight bags. In fact, over the last seven years, there has been a 200 percent increase in the number of recording devices that come into our lab. All of this comes together to provide key pieces of the investigative puzzle.

Yet, even with all the data sources, we continue to deal with the most complicated piece of equipment in aviation for which there is no data recorder—the human.

For example, in the August 2006 accident in Lexington, Ky., the pilots tried to take off from the wrong runway—one intended for GA aircraft. This investigation highlighted issues of communication, runway signage, and the importance of cockpit discipline.

Likewise, it was not a mechanical issue that caused the February 2009 crash near Buffalo, N.Y. This investigation shed further light on pilot professionalism, fatigue, and pilot training.

Unlike the early accidents in which investigators identified a structural or component failure, human factors accidents are even harder to investigate. We can figure out why a component failed, we can't always figure out—especially in a fatal accident — why humans made the decisions they made.

It's important to identify the decision-making process that got them there so we can prevent it from happening again. Yet, unlike airplanes that come off the assembly line, that are intended to be exactly the same every time, and perform to predictable and repeatable specifications, human beings are not always predictable. As the mother of three boys, I can tell you that humans are not predictable.

And there's only so much data on the CVR, often the most scrutinized piece of equipment on an accident airplane. Inves-

No matter how proud we are of the safety re achieved, we cannot—we must not—be co

tigators listen for inflections in the pilots' voices—yawns, straining on the controls, and many other subtle changes in speech to determine why pilots responded the way they did...or did not.

One of the most frustrating things our investigators encounter is listening to a CVR and hearing a pilot say, "Look at that!" It can take years of painstaking effort to finally determine what "that" was and its relevance to the accident.

Unfortunately, there are no FDRs in pilots' heads.

Adding to the complexity of accident investigation in aviation's second century is the increasing globalization of aviation. No longer is there a clear distinction between domestic and international accidents. Accidents involving U.S. operators and U.S. equipment can and do occur anywhere in the world. Likewise, accidents may happen in the United States but involve a foreign-operated or foreign-manufactured aircraft.

And, truly, what does "foreign-manufactured" mean today? Look at the Boeing 787 supply chain, which stretches from Japan to Italy. The Airbus A380 has 100-plus suppliers in more than 20 countries.

This is why the accident investigation framework provided by Annex 13 is so crucial. Annex 13 provides the foundation—the protocols, the rights, and responsibilities—for the states to work together.

One of the challenges is when the accident investigation protocols defined in Annex 13 collide with the local political and judicial systems. This is where data and cooperation are so essential. The data, most often on the recorder, are needed first since for safety investigations the data lay the foundation for all the activities to follow. Those activities enable us to investigate, to learn, and to adapt. Today, as we work together across boundaries to learn what caused an accident, we are doing even more to help those whose lives are affected by them.

Many states have instituted family assistance programs. Most recently, the European Union passed family assistance legislation for its member states. We applaud ICAO for its family assistance leadership. At the NTSB, we were honored, at ICAO's request, to participate in a task force to revise ICAO Circular 285, first published 10 years ago.

As I mentioned in the beginning of my speech, we recognize that one size will not fit all cultures. In March [2011], the NTSB held a family assistance conference attended by representatives from more than 30 countries—from North and South America, from Africa, and from Asia. Clearly, there is a widespread need for consistent principles for governments and air carriers. We are hopeful the Council and Assembly will embrace this issue. Because in the aftermath of an accident, we have seen what happens, we've learned about what needs to be done, and, now we need to adapt.

With air travel's dynamic worldwide growth, projected to be some 3.6 billion passengers by 2014, we know that as we plan we must be very intentional in how we work together, which is why the ICAO structure and Annex 13 are so important.

How are we going to investigate, learn, and adapt in order to prevent accidents in aviation's second century?

It's clear that accident investigation will depend far more on data and cooperation than in the past. While time-honored tin-kicking will never go away, it is increasingly being joined by sophisticated data analysis.

And the amount of data is growing every day.

New Investigation model

Let me tell a story that illustrates the new model of accident investigation...and the importance of data and cooperation.

On Jan. 17, 2008, a British Airways Boeing 777 crash landed at London Heathrow. The plane, on a flight that had originated in Beijing 10-and-a-half hours earlier, was on short-final approach at 720 feet AGL when the right engine and then the left engine stopped responding to autothrottle. Through outstanding airmanship, over busy roadways and dense population, the pilots brought the plane to land just beyond the perimeter fence at Heathrow. The UK's AAIB led the investigation, which the NTSB joined as an accredited representative.

The FDR, CVR, and quick access recorder were recovered, and there were some 1,400 parameters on the data recorders. The pilots gave extensive interviews. None of this told the team precisely why both engines failed. Nor did tests of the fuel, of water content, examining where the airplane was last serviced, and more. Everything came up blank.

Yet, with a rich store of data, the team reviewed thousands of similar flights. One key finding was that the accident plane flew longer at a low fuel flow in cold temperatures than other flights. Temperatures on the accident flight's routing reached as cold as minus 74º C.

This, in turn, led to scrutiny of fuel delivery to the engines. Lab tests looked at the effect of extreme cold temperatures and long idle times. Of particular interest was the fuel oil heat exchanger, which uses cold fuel to take heat away from the oil and leads to the engine running cooler, especially the bearings.

The investigative team performed tests running a fuel system mockup for hours with cold fuel. They saw ice crystals collect on the face of the fuel oil heat exchanger. If the engine throttle was applied, the newly formed ice broke up. But, with no throttle applied, the ice continued to form. [See "Investigative Data Mining: Challenges and Innovative Outcomes," page 5, *ISASI Forum,* April-June 2011.]

It turned out that this perfect flight—with minimal throttle usage to conserve fuel—led to slushy ice forming within the fuel system. When throttle was applied

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during the later stages of approach, the accumulated ice traveled to the fuel oil heat exchanger and restricted the fuel flow.

Corrections included interim procedures that were followed by a redesign of the fuel oil heat exchanger. We investigated, learned, and adapted. Safety was served through data and cooperation.

Here's another story about the importance of data to accident investigation. In late 2008, a Continental Airlines 737 crashed on takeoff at Denver International Airport. It was a windy day, as it is so often on Colorado's high plains. In Continental's operation, the 737 has a crosswind limit of 33 knots. A Denver tower controller told the flight crew that the winds on the runway were from their left at 27 knots.

The crew, assessing they were well within Continental's limits for operating in crosswinds, prepared for takeoff. Yet, when they rolled down the runway they were hit by 90-degree crosswinds that exceeded 45 knots. This resulted in the plane, full of holiday travelers, departing the side of the runway at about 90 knots. The airplane sustained substantial damage during the roll over uneven ground and post-crash fire. Fortunately, no one was killed or seriously injured.

Just as with the BA flight, the investigative team downloaded recorders, examined equipment, and interviewed the crew, dispatchers, meteorologists, Boeing aircraft performance engineers, and controllers. From this information, the team could not tell what was so unusual about this day, this flight, or this flight crew.

The data revealed that frequently Denver's major airport experiences much stronger crosswinds than expected on takeoff. That led to the first key finding: the method ATC used for reporting winds to flight crews did not provide the best possible information to flight crews. Then, questions about crew training took investigators to Continental's simulator training facility to see how it trained its 737 pilots on crosswinds. The simulator could provide up to 30 knots of crosswinds but was unable to replicate gusts while on the runway.

Sometimes it can be difficult to reach a simple finding. That was the case with this accident. Our investigation revealed that the pilots were being trained on a constant wind and no gusting. Yet, pilots are more likely to see crosswinds gusting to 40 knots than engine failure on takeoff. They are trained in engine-out procedures and not gusts.

Just like with the British Airways Heathrow crash landing, the aviation community investigated, learned, and adapted to improve safety. None of which would have been possible without data.

Yes, data are key. And, in this era of dynamic growth and greater complexity, data are more important than ever. As Alan Mulally famously, and frequently, said when he was with Boeing: "The data will set you free."

In our work, the data do much more than that.

Data save lives.

In aviation's second century, accident investigators need all the data available to put together the big picture of what happened. Some of that data—as we saw at Heathrow and at Denver—are from routine flights that can be compared with the accident flights.

I applaud the agreement reached last year at the 37th Assembly to foster data sharing through the creation of the Global Safety Information Exchange. This information can be vital to learning what really happened and determining what can be done to improve safety.

Data and cooperation. These are how we will continue to investigate, learn, and adapt.

And, these are how aviation will maintain—and enhance—its strong safety record into the second century of powered flight.

The recent General Assembly initiated this dialogue about data sources. This is essential in setting standards of protection for the use of data in accident investigations. The NTSB looks forward to continuing the conversation on cooperation next year when we host an international conference to share experiences, address the challenges with conducting Annex 13 investigations, and identify best practices. We will also address training needs for investigators on new and advanced equipment as well as follow up on the work underway on international family assistance.

I began my remarks with a Lebanese story. Let me close with another tale. It's one of my favorites: Cinderella.

You know the story about the maiden outfitted in fine clothes by her fairy godmother who captivates the prince at the ball. Yet, when she races to leave before the stroke of midnight—as she was instructed—she loses one glass slipper. That lone slipper is how the prince —himself a clever investigator like Jureybon—finds the girl of his dreams.

Today, with sophisticated data analysis, the prince would not have to try the glass slipper on every female in the kingdom. He could run a software program, compare all the shoe sizes, avoid the wicked stepsisters, and quickly find his princess. And live happily ever after.

How will we in aviation fly more safely ever after?

No matter how proud we are of the safety record we have achieved, we cannot—we must not—be complacent. We must make a constant commitment to further improve aviation safety—by observing, learning, and adapting. And by using the data and increased international cooperation through ICAO.

But when the inevitable accident occurs, we must also recognize our responsibilities to those who are left behind. Because life is not always a fairytale ending. There are accidents and there are families and friends who are left behind.

Like Jureybon, we are our brothers' and our sisters' keepers. ◆

U.S. AIR FORCE

Building Partnerships in Unmanned Aircraft Systems

As UAS use propagates, the established, mutually supporting investigative and regulatory processes for manned aircraft that have evolved and exist today must be given the opportunity to perform those functions for UAS operations.

By Thomas A. Farrier, Chair, ISASI Unmanned Aircraft Systems Working Group

(This article is adapted, with permission, from the author's paper entitled Building Partnerships in Unmanned Aircraft Systems *presented at the* ISASI *2011 seminar held in Salt Lake City, Utah, Sept. 12–15, 2011, which carried the theme "Investigation—A Shared Process." The full presentation, including cited references to support the points made, can be found on the ISASI website at www.isasi.org under the tag "ISASI 2011 Technical Papers."—Editor)*

Unmanned aircraft systems (UAS) increasingly are finding their way into shared airspace, flying side by side with manned aircraft throughout the United States. In some instances, this is being orchestrated on a case-by-case basis. In others, it is due to increased latitude granted to military and other public-use UAS operators by the Federal Aviation Administration (FAA) under pressure from UAS users, interest groups, and in some cases the U.S. Congress.

For a variety of reasons, advocacy of unmanned aircraft systems is outpacing a knowledge-based approach to bringing them into the current aviation system. A near-universal perspective exists regarding data related to UAS operations and safety that is completely at odds with how similar data on manned aircraft have come to be regarded.

By their nature, unmanned aircraft systems have the potential to be extremely destabilizing in an operational environment that evolved from the basic principle of seeing and avoiding other aircraft in accordance with standardized right-of-way rules. In a 2008 report (GAO-08-511) to the U.S. Congress, the Government Accountability Office (GAO) made the following observation: "Routine UAS access to the national airspace system poses a variety of technological, regulatory, workload, and coordination challenges. Technological challenges include developing a capability for UASs [sic] to detect, sense, and avoid other aircraft; addressing communications and physical security vulnerabilities; improving UAS reliability; and improving human factors considerations in UAS design."

In other words, UAS "integration"—the preferred term for the desired end state advocated by most current public-use UAS operators—has to address not only the lack of an onboard pilot to perform see-and-avoid duties, but also issues arising from the remote location of the pilot, different certification strategies, and a lack of broad-based expertise in UAS-oriented human systems integration.

The only way to systematically address the needs of regulators trying to chart the future directions of unmanned aircraft systems in shared airspace is for today's UAS users to allow them far greater access to the practical operational and safety knowledge they have built and continue to build. At the same time, the amount and quality of data available to accident investigators trying to foster a UAS regulatory structure are sorely lacking, and the findings of investigations being conducted by various UAS operators and manufacturers are not being leveraged effectively to support the broad objectives of UAS safety as a sector. As UAS use propagates, the established, mutually supporting investigative and regulatory processes must be given the opportunity to perform the functions for which they evolved and exist today.

Today's UAS community

The principal UAS stakeholders—and thus the main holders of or gatekeepers to useful information about the operation and safety of the broad constellation of unmanned aircraft systems—fall into a few major categories.

- ***Operators***—Current operators of UAS in the U.S. national airspace system (NAS) include traditionally aviation-oriented components of the military that are adding

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UAS to their fleets. Also, public agencies with defined missions that are taking advantage of the economic efficiencies associated with UAS to expand their capabilities in the aviation environment, and a handful of new entrants into the community of flight pursuing entrepreneurial ideas for using the UAS platform commercially.

In the U.S., the umbrella term "public use" UAS operators includes military organizations, federal agencies performing a variety of missions, state and local law enforcement entities, and state-owned universities. Regardless of size, capabilities, or missions, however, under public law all of these organizations have the right to certify the airworthiness of their own unmanned aircraft systems and, to a large extent, the pilots who fly them as well.

In contrast to the public-use sector, since there are no regulations currently in place establishing UAS aircraft, ground control system, or pilot certification standards for civil operators, there is no provision for UAS to be flown as general aviation aircraft with typical airworthiness certificates. This has served as a brake on some—but not all—UAS flying aimed at developing capabilities and markets. So, for now, just about the only "civil" operators of UAS are manufacturers of UAS, as discussed below.

• ***Manufacturers***—As with the operators, the UAS manufacturers' sector is an interesting blend of the old and the new, including long-standing aerospace corporations, existing companies diversifying into aviation to support other lines of business, and purely UAS-oriented start-ups. If one scans recently published lists of current (announced) unmanned aircraft manufacturers, familiar names appear, like Boeing, EADS, Northrop Grumman, Thales, and IAI. For those with at least a nodding familiarity with unmanned aircraft systems, you're likely to recognize names like General Atomics, AAI, AeroVironment, and InSitu as well. However, for every established aerospace company engaged in UAS development or production, there are at least a dozen or more small businesses or individual entrepreneurs in search of part of the burgeoning UAS market. The presence of such enterprises complicates addressing two fundamental challenges: identifying current and emerging UAS manufacturers and encouraging them to document progress (and setbacks) encountered in their development efforts, especially where the setbacks have been marked by aircraft losses.

• ***Interest groups***—There are at least three major trade associations supporting UAS interests: the Association of Unmanned Vehicle Systems International (AUVSI); UVS International; and the British-based Unmanned Aerial Vehicle Systems Association (UAVS). To varying degrees, these and other nationally oriented UAS associations, such as UVS Canada, the Russian Unmanned Vehicles Association, and the Japan UAV Association (JUAV), all serve as advocates for the UAS manufacturing sector while engaging in varying degrees of interaction with their national airspace regulators.

Facing page: MQ-9 Reaper control link deliberately severed due to ground emergency; does not follow its preprogrammed "lost link" profile. U.S. Air Force declines to investigate as a safety event.
Above: July 27, 2011, Lockheed Martin HALE-D airship launches from Akron, Ohio; fails to achieve planned altitude, forced to make uncontrolled descent. U.S. Army, which sponsored the test as the HALE-D's operator for the purposes of its COA, declined to investigate, citing it as "not an Army aviation accident."

Current FAA data collection

Given the limitations of unmanned aircraft in terms of both see-and-avoid and the undesirability of control link loss in some locations and classes of airspace, the gap between UAS capability and the needs of the NAS as a whole is bridged in the U.S. by two separate processes: the "Certificate of Waiver or Authorization" (COA) process, managed by the FAA Air Traffic Organization (ATO) in cooperation with the FAA's Unmanned Aircraft Program Office (UAPO), and the "Special Airworthiness Certificate–Experimental Category" (SAC-Exp) process, managed by the UAPO with the participation of the ATO.

Beyond imposing operational controls to mitigate various recognized hazards associated with UAS operations, a key component of both approval processes is a requirement for operational and safety reports documenting authorized flights in the NAS. Monthly reports include basic data regarding flight hours and operations to aid in normalizing reported data. Individual occurrences are reported as they happen. In addition, a new template for COAs is about to be released, which will significantly expand the types of nonhull loss events of interest to regulators in developing system and pilot certification criteria for eventual civil use.

The needs of UAS investigators

Given that little current hard data are available to regulators regarding UAS accidents, incidents, and malfunction trends, air safety investigators face a host of new challenges as unmanned aircraft systems become more widespread, especially in nongovernmental use. The three most critical are likely to be 1) Knowing how to investigate an unmanned aircraft accident, 2) Knowing what can go wrong (to understand what the investigation uncovers), and 3)Having a common language with which to describe findings and make recommendations.

• ***The mechanics of investigation***—To break down the investigator's problem to a manageable level, one must recognize that unmanned aircraft systems consist of multiple, noncollocated components—some exactly the same as manned aircraft, some similar to those used in manned aircraft but employed differently, and some unique to remotely piloted aircraft. Equally important is the need to understand that different manufacturers choose to solve the various technical challenges associated with unmanned aircraft in very different ways.

Special Committee 203 of RTCA ("Unmanned Aircraft Systems") has conceptualized unmanned aircraft systems as consisting of three basic, interconnected components: the "control segment" (the pilot and associated hardware and software needed to effect control), the "aircraft segment" (the unmanned aircraft proper), and the national airspace system (which incorporates the communications, navigation and surveillance capabilities that support flight operations).

A typical NTSB investigation may involve nine or more groups working on in-

STANDARDS DEVELOPMENT INITIATIVES

RTCA Special Committee 203

• Developing UAS minimum aviation system performance standards, minimum operational performance standards, etc.

EUROCAE WG-73

• Established to create six key products, including
—Framework for civil UAS to operate safely within shared airspace based on existing ATM regulations, infrastructure, and procedures
—Catalog of UAS normal and abnormal operations requiring special air traffic management consideration

ASTM International Committee F38

• Minimum safety, performance, flight proficiency, and quality assurance requirements
• Production acceptance tests/procedures, continuing airworthiness requirements

dividual aspects of the accident, including

- Air traffic control,
- Airplane Performance,
- Human Performance,
- Maintenance,
- Meteorology,
- Operations,
- Powerplant,
- Structures, and
- Systems.

Mapping the NTSB areas of concentration against the "segments" described above, most of the basic areas of inquiry readily suggest themselves. The investigator's path seems straightforward at this point; however, in the absence of specific knowledge about the exact system involved in the accident, or historical knowledge to draw upon, the picture quickly becomes much murkier.

• ***Developing theories of the sequence of events***—The RTCA architecture is a brilliant simplification of the raw components that must be in place to make an unmanned aircraft system work. However, for investigators, its utility fades rapidly once basic investigative requirements are figured out and a broad sense has been developed of the segment or segments most likely to have played a part in a given accident's sequence of events.

The investigator's task is greatly complicated when you walk onto an accident scene with no perspective on the safety record of the type of aircraft involved. It becomes that much more so when you realize that, for example, you may not have any idea as to the precise way that the UAS pilot's control inputs reach the unmanned aircraft's control surfaces.

In other words, for every new accident, investigators have to become experts not only on the accident at hand but on the precise operation of and relationships among all of the notional "segments" embodied in the accident UAS. Even having done so, the most difficult challenge is yet to come: describing what happened in such a way as to support an actionable judgment on the observed failure or failures leading to the accident.

• ***Existing taxonomies and unmanned aircraft system accidents***—Finally, making a worthwhile preventive recommendation depends upon being able to answer such questions as: Has this failure been observed before? If so, how frequently? Is a similar failure possible in other unmanned aircraft systems? And is the outcome of a similar failure in similar systems comparable to this accident?

Regulators and investigators alike need a much greater level of insight into what is normal and abnormal for unmanned aircraft systems in general and individual types of UAS in particular to be able to do their jobs effectively.

Cross-communication is lacking

Public-use UAS operators represent the single-best source of the kinds of operational and safety data needed to support the safe growth of commercial UAS activity, since they are far ahead of virtually all other users in the development of certification criteria (especially with respect to system reliability), safe operating protocols, and UAS-specific accident investigation procedures. However, the challenges associated with obtaining and leveraging such information are different based on the entities involved, because each has a different set of core concerns associated with its release and exploitation.

• ***Military UAS operators***—In the U.S., the uniformed military services have the option of asserting what is familiarly known as the "safety privilege" in controlling the release of information developed through aircraft loss investigations. The availability of this privilege in turn led to the evolution of two distinct processes to document each such loss: 1) The "mishap investigation," governed by individual service safety directives, and 2) The "accident investigation" (sometimes called the "collateral investigation"), which is conducted in accordance with service legal directives that conform to certain requirements of U.S. public law as well as the Uniform Code of Military Justice.

To oversimplify the differences between these two processes, the first does not make use of sworn testimony, may offer witnesses a promise of statement confidentiality, and results in a report created solely for preventing the recurrence of similar losses in the future.

The second process uses the body of factual information gathered by the mishap investigators as a starting point. It obtains sworn testimony from either the same set of witnesses or others identified as needed, and generates a report, including a legally protected "statement of opinion" by the lead investigator regarding the cause or causes of the accident, that may be used for any purpose (prosecution, civil litigation, etc.).

The fruits of accident investigations generally are available to the FAA, but only on the same basis that any member of the public can obtain them. Mishap investigation results based on candid testimony and expert interpretation of the factual data by those best qualified to render it are never made available to the FAA. Absent explicit legislation aimed at compelling their release, they never will be. Why? Because all mishap investigation reports for both manned and unmanned aircraft accidents must be protected uniformly to preserve their privileged nature.

• ***Law enforcement agencies***—Similar sensitivities arise in law enforcement organizations operating unmanned aircraft systems. For example, the largest nonmilitary user of the Predator family of UAS is the U.S. Customs and Border Protection (CBP) Office of Air and Marine. Although the CBP was the operator of the Predator whose 2006 crash marked the NTSB's first UAS investigation, it has matured into a responsible and effective user of both the resource and the airspace. The CBP has established a well-earned reputation for clear communications with the FAA on all UAS-related matters, including the occasional operational anomaly.

The main constraint on the use of the CBP's incident information is that, in many cases, the only way the agency can describe a sequence of events is by referring to a specific mission profile or route. This information frequently tends to be "security sensitive information" (SSI), which is defined as "information obtained or developed in the conduct of security activities, including research and development, the disclosure of which would

"(1) Constitute an unwarranted invasion of privacy (including, but not limited to, information contained in any personnel, medical, or similar file),

"(2) Reveal trade secrets or privileged or confidential information obtained from any person, or

"(3) Be detrimental to the security of transportation."

A related type of information—like SSI, also considered "sensitive but unclassified"—is "law enforcement sensitive." While not presenting identical obstacles posed by the military's "safety privilege," SSI and law enforcement sensitive information often are difficult-to-separate components of UAS incident reporting because they tend to provide essential context for understanding how a given event took place. However, the underlying issue is the same: all incident information is kept close because some of that information must be protected.

Unmanned aircraft have come a long way.

• ***Manufacturers and developers***—Interestingly, although UAS experimental certificates are intended to meet the needs of marketing and testing, not one currently valid certificate of this type has been issued for a small UAS. The most likely reason for this is that the regulatory gray area associated with model aircraft is being used to test small UAS concepts. Hence, no established structure exists that requires anomalous events to be reported to the FAA.

This doesn't mean that the manufacturers are unaware of the types of occurrences that could be highly undesirable if encountered in controlled airspace. It means that nothing obliges them to talk about such occurrences. UAS market competitiveness makes it is most unlikely that any manufacturer is likely to do so in a public forum where the advantages and defects of different systems could be more easily compared.

Several efforts aimed at developing standards for UAS manufacture and operations are in progress (see sidebar, page 18). However, it is not at all certain such standards will account for the entire range of considerations known to be challenges to the safe operation of UAS, especially when "innovation" is the watchword in UAS development.

The way forward

There really is no option: more and better data regarding UAS in general, and safety-related data in particular, are essential if UAS users want greater access to shared airspace than they have today. John Allen, director of the FAA's Flight Standards Service, observed, "What level of trust do we give this technology? We just don't yet have the data.… We are moving cautiously to keep the national airspace system safe for all civil operations. It's the FAA's responsibility to make sure no one is harmed by [an unmanned aircraft system] in the air or on the ground."

Clearly, then, it is the stakeholders who will have to develop a framework within which they are comfortable sharing data of varying degrees of value to different users. Given the unfortunate and ongoing willingness of many legal systems to favor prosecution over protection, any data exchange architecture intended to advance the safety of unmanned aircraft systems almost certainly would have to be explicitly protected by law to be attractive to submitters. This is a worthwhile goal, and one that the air safety investigator

(continued on page 30)

MAJOR INVESTIGATIONS, 'NEXTGEN' THINKING AHEAD

New and revised thinking is the challenge for the air safety investigators of tomorrow.

By Robert M. MacIntosh, Jr., National Transportation Safety Board, Retired

(This article is adapted, with permission, from the author's paper entitled Major Investigations, NextGen Thinking Ahead *presented at the ISASI 2011 seminar held in Salt Lake City, Utah, Sept. 12–15, 2011, that carried the theme "Investigation—A Shared Process." The full presentation, including cited references to support the points made, can be found on the ISASI website at www.isasi.org under the tag "ISASI 2011 Technical Papers."—Editor)*

Success in any business endeavor calls for constant review and revision of processes and technology. There is no exception to this premise in the global aviation environment. To remain current and relevant, the time-honored practices of aircraft accident investigation need constant revision. Today's journeymen air accident investigators can quickly find themselves rendered noncurrent by the technical, organizational, and political advances of tomorrow.

As the reliability of our airframes, powerplants, and infrastructure has improved, the perspective of our accident investigation focus has certainly shifted. In past decades, operators could expect an engine failure about every 1,000 hours of operation. Avionics components had even shorter time between failures. Thankfully, those times are past, and today's challenges result in a more proactive approach aligned with safety management concepts and a much more broad and effective approach toward risk identification and reduction. So where will the wings of change take formal investigations and practicing air safety investigators in the future?

Data—the insatiable quest

One place to look at "NextGen" ideas and new thinking is in the area of recorded data. With the preponderance of data available from the multiple parameters on aircraft flight recorders and the data further available within the nonvolatile memory (NVM) of various components and subsystems, how much time and effort do the investigators really need to exert on scene? How much on-site documentation is enough? Can we expect to effectively investigate major accidents with the recorded data alone?

I would offer that the answer to that premise is a very qualified perhaps—maybe—sometimes! We can cite some past cases where the wreckage is still up on the mountain or down on the seabed. Events in the 1990s, such as the Thai Airways A310 near Kathmandu, Nepal, or the Berginair B-757 off the north coast of the Dominican Republic, are examples of the ability of the air investigation team to proceed toward reliable conclusions and recommendations without (lacking) the on-scene documentation.

However, let's look at a situation where existing data alone did not allow the investigation team to arrive at substantive conclusions: the Jan. 17, 2008, B-777-200ER, British Airways accident at London-Heathrow Airport, United Kingdom. The UK Air Accidents Investigation Branch (AAIB) did a tremendous job providing details of the ongoing investigation through interim reports and a superb final report published in January 2010.

Many of the details of the AAIB investigation were presented at the ISASI 2010 annual seminar in Sapporo, Japan, in papers by Senior Inspector Brian McDermid, Heathrow 777, regarding the extensive fuel system testing, and by Senior Inspector Mark Ford, Investigative Data Mining, regarding the challenges presented by that evidence. It is that preponderance of evidence that should be notable to all of us involved in the investigation of accidents and incidents in large transport aircraft.

The B-777 was certificated in April 1995. It is equipped, per ICAO Annex 6, with an extensive list of flight recorder parameters derived from fly-by-wire mediated flight and engine controls. Since its entry into commercial service, the B-777 fleet accumulated more than 17 million accident-free flight hours over

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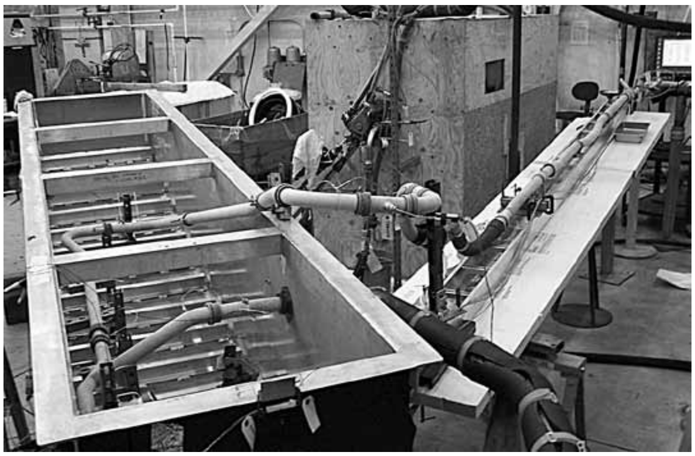
LEFT—Figure 1: Fuel tube and FOHE ice.
BELOW—Figure 2: Iron bird test rig.



more than 12 years prior to this hull loss. Also, regarding data available in the Heathrow event, recall that the aircraft remained relatively intact at the end of Runway 27L. All the crew and passengers survived, there were many credible witnesses, and data were available from both of the required onboard flight recorder systems, from a QAR quick access recorder, and from the air traffic and ground servicing organizations.

The UK AAIB final accident report provides clearly worded probable cause factors of the event—when the engines ceased responding to commands for increased power—including that accreted ice released in the fuel delivery pipes caused a restriction at the engine fuel oil heat exchangers (FOHE) during the critical landing stage of the flight. But did the data alone lead the AAIB to these probable cause factors?

I would suggest that many more resources and expertise went into that investigation: the field investigation, the component examinations, the interim actions for airline operators, the engineering testing and analysis, and, of course, the final report and safety recommendations. Most will agree this extensive and detailed work was necessary to make the whole investigation process and results credible to the professional aviation community and the public.

Further, we should ask ourselves, as state investigation authorities and industry investigation professionals, how we can best be prepared for any similar undertaking in the future. For this accident, though, the vast amount of data that was available both from the accident airplane and from thousands of other flights led investigators to develop a hypothesis about what occurred in this accident.

Within the UK AAIB, the air safety investigators recognized a need for some very specific expertise. It fell to a group of statisticians with the support of the air safety investigators to determine what may have been unique about this accident flight from those millions of accident-free flights that took place over the prior 12 years.

AAIB Senior Inspector Mark Ford tells us in the [April-June 2011] *ISASI Forum* article "Investigative Data Mining: Challenges and Innovative Outcomes" that their group got an early start with immediate access to the operator's flight data monitoring (FDM) of 13,500 flights. The data mining team eventually incorporated minimum fuel temperature snapshots from 191,000 flights from the northern hemisphere, the tropics, and the southern hemisphere based on many operators' data.

The point here is not to review the details of data mining provided in the AAIB's investigation, but rather to recognize the initiative taken by the AAIB to rally together the wide-ranging sources of FDM data in order to analyze and share that data in a meaningful way. There is industry consensus that this data mining initiative provided an important catalyst leading to the full understanding of the event. Further, similar data mining strategies may very well be the NextGen thinking required for future serious and complicated investigations.

Are you ready to "data mine"? Can you (or your investigation agency) arrange for access to very privately held FDM data? Can you analyze it for your specific purposes and at the same time protect it from unauthorized users, such as overzealous or misguided judicial advocates? To clarify, the subject is raw data, not summarized or aggregate information derived from raw data. And the question posed is, Can your investigation get timely access to all the data that may sometimes be needed in a complicated investigation, similar to the data analyzed by the AAIB. An investigator's need for such raw data may very well be the "NextGen challenge" for the air safety investigators of tomorrow.

Testing—collaborative efforts

Another investigative vignette from the Heathrow event that deserves special recognition within our investigation community is the fuel rig testing. How did the investigation replicate the conditions of the accident to confirm the hypothesis that there were some unique factors of the flight that contributed to the formation of ice in the fuel pipes and then contribute to the subsequent release of a quantity of ice (slush) in the fuel delivery stream? As many of our ISASI members have seen, just like the carburetor ice conditions of the general aviation fleet, the suspect ice obstruction/restriction usually seems to have melted before the inspector arrives to see the evidence.

That lack of physical evidence provides an opportunity to review the details of the trail toward a final decision to test a major portion of the airplane fuel system. We know now that the B-777 has more than 110 feet of fuel tubes and lots of turns and twists valves, filter units, and a fuel-oil heat exchanger unit

(FOHE) that makes up the complete system in the tank to engine setup. There was hardly an investigator on the planet who did not suspect fuel system icing from some source as he or she read the initial details of the BA accident, but where to look?

AAIB senior Inspector Brian McDermid in his [April-June 2011] *ISASI Forum* article "Heathrow 777: Investigation Challenges and Problems" presents a fascinating story of starting out thinking that small-scale laboratory testing would be sufficient. Then there was a consideration for the possibility of flight testing and further consideration for the use of a full-scale climatic hangar with either a single pass of fuel or with a reticulating source of fuel. Finally, a decision was made to assemble a full-sized test rig with components of the crashed airplane at the North Boeing Field facility in the U.S. The UK AAIB and participating agencies came to this highly engineered and costly conclusion that an "iron bird" test rig was needed to accurately replicate the mechanical and environmental conditions and to ensure that credible results would be fully available for all aviation industry stakeholders.

Broad-based aviation industry cooperation and communication were necessary to make this endeavor fully representative of the flight conditions. Recall that the Boeing 777 has an option for engine installations offered by all three large engine manufacturers: Rolls-Royce, Pratt & Whitney, and GEAE. The Rolls-Royce Trent engine involved in the Heathrow event is also installed on both Boeing and Airbus transport airplanes. Within the strict interpretation of Annex 13, hence, any similar event affecting an engine type common to different airframes remains a challenge to the airframe manufacturers. Therefore, a broad scope of early industry interest in the details of this investigation existed. Further, state investigative agencies probably should conclude that with limited agency resources they cannot conduct such complex investigations alone.

ICAO Annex 13 standards and recommended practices place the state of occurrence in the leadership position and in full control and responsible for air accident investigations. But without the collaborative knowledge and collective resources of other investigative agencies and industry, an investigation of this magnitude cannot move forward. To do less creates a credibility gap that would do a disservice to all involved. Further, any muted effort could stop well short of the desired goals of identifying the causal factors and mitigating the safety risks.

The Heathrow investigation results are well known. Following an in-depth analysis of the occurrence by the participating agencies, with major participation from the engine and airframe manufacturer, the FAA issued an airworthiness directive (AD) applicable to B-777/Trent 800 airplanes effective Sept. 29, 2008, for interim mitigating actions to prevent recurrence. It introduced on-ground fuel circulation procedures along with inflight high-thrust fuel circulation procedures prior to descent. This AD was superseded in March 2009 with some limited modifications, and, concurrently, the Trent FOHE received a subsequent engineering design improvement. The AAIB final report also contained safety recommendations to FAA and EASA authorities to undertake joint research to identify the root causes of fuel system icing that should encompass the airframe, the engine, and the environment to address future aircraft design and certification requirements.

What is the takeaway from these unique experiences of the Heathrow B-777 investigation? Ask yourself, does your agency (and state) have the capability to investigate a complex accident event? Are you prepared to offer sufficient elements of trust to those outside your close sphere of control? Will the independence of the investigation allow you to reach out for similar additional expertise? Are you able to recognize the parallel air safety interests of those other concerned participants? Can a sufficient level of trust be cultivated between government and industry representatives to go forward in a productive arrangement to share FDM data? Are you prepared and functionally able to put mechanisms in place to meld these common interests? To repeat—These are the NextGen challenges for the air safety investigators of tomorrow.

Civil/military issues

In keeping with the ISASI 2011 theme, "Investigation—A Shared Process," let's look at a recent example of civil/military cooperation in the field of investigation. This accident occurred on April 10, 2010, to a Tu-154M Polish Air Force (PAF) flight providing transportation for the president of the Republic of Poland and a party of distinguished visitors.

The military mission was to deliver a group of military and civilian dignitaries and their wives, politicians, businesspersons, and clergy to a ceremony in the Russian Federation at a memorial complex intended to heal some of the wounds of World War II. The destination was Smolensk "Severny" Airfield, a military facility slightly more than 1 hour from Warsaw. The mission ended in a very tragic controlled flight into terrain (CFIT) scenario just 600 meters short of the destination runway. All 88 passengers, 3 cabin crew and 4 flight crew, and 1 security officer were fatally injured.

As might be expected, old political wounds resurfaced along with the turmoil from the death of the president of the Republic of Poland and many of the leading cabinet members, military hierarchy, and social and political leaders.

Of interest to ISASI members is what happened next. What agency would investigate the crash of a Polish Air Force VIP transport aircraft within the territory of the Russian Federation? This was a "state aircraft," clearly outside the ICAO convention

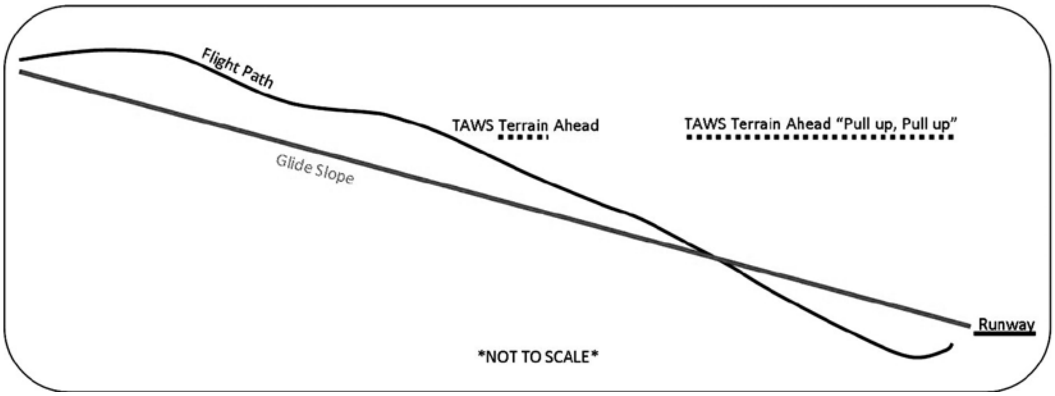


Figure 3: Tu-154M glide slope versus flight path.

definition of civil air transport activity. The bilateral diplomatic agreement authorizing this international nonscheduled flight to carry passengers did not address the eventuality of accident or incident, and there was no provision for insurance coverage of the passengers.

Upon notification of the crisis, the president of the Russian Federation provided an initial response at the accident site supervised by the head of the flight safety agency of the Russian Armed Forces. However, from the onset, it was obvious to all concerned that, in this very highly charged atmosphere, the traditional military leaders should not be in a position to investigate themselves.

With some astute diplomacy on both sides, three days following the accident, the governments of the Russian Federation and the Republic of Poland concluded a bilateral agreement that the regional international independent safety investigation organization, the Interstate Aviation Committee (IAC), would conduct the investigation in accord with the existing ICAO Annex 13 standards and recommended practices. Acting as the state of occurrence, the IAC appointed an investigator-in-charge, and the Polish government appointed an accredited representative within the protocols of the state of the operator and state of registration. The Polish Air Force participated as an advisor to the accredited representative of Poland.

The various participants formed the traditional investigation groups and set about to investigate the accident at the crash site and at the Warsaw dispatch point and crew base. Early readout of the CVR indicated conversations related to the setup of a flight management system (FMS), and several audible warnings could be heard from a terrain alert warning system (TAWS) prior to the crash. The FDR readout indicated that, for most of the flight, the autopilot was engaged and coupled in lateral navigation mode with the FMS. Evidence from the accident site identified the FMS and TAWS components as manufactured by Universal Avionics Systems Corporation of Redmond, Wash., in the U.S. A maintenance records examination confirmed that these units had been installed as an upgrade of the PAF Tu-154 fleet.

The investigator-in-charge notified the U.S. National Transportation Safety Board (NTSB) of the U.S.-manufactured and certificated navigational equipment and requested U.S. participation in the investigation. Ultimately, despite significant mechanical damage, with the assistance of the design and manufacturing engineers, much of the nonvolatile memory data was retrieved at the manufacturing facility. The examination and analysis of the FMS and TAWS and conventional flight recorders revealed several important crew actions and led to the following general conclusions:

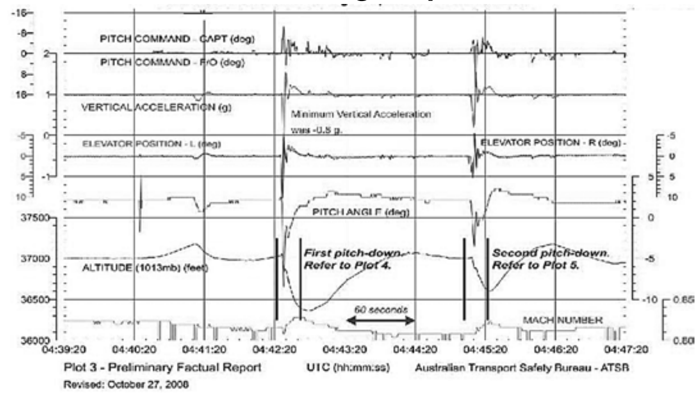
• The FMS terrain database did not contain data for the Smolensk "Severny" military Airfield. The crew constructed an approach in the FMS using waypoints superimposed on the physical location of the published 2 RBN approach procedure.
• The weather was below minimums upon arrival. The crew requested and was granted approval to conduct a "trial" approach to the published minimum of 100 meters.
• The crew flew the approach with the autothrottle and autopilot engaged in lateral nav mode and used the autopilot climb/descend wheel for the glide path.
• The crew continued descent below the published minimums and took no action in regard to the TAWS terrain alerts and warning, ultimately colliding with trees and terrain in a valley before the runway threshold. The aircraft was destroyed. All aboard were fatally injured as a result of deceleration, blunt force trauma, and destruction of structure.
• Further, the presence and discussions in the cockpit during the approach of the commander-in-chief of the Polish Air Force and the protocol director of the Polish government influenced the crew to continue the approach in conditions of unjustified risk.

The investigation was completed in January 2011 (nine months after the occurrence), and the final report and supporting documents are available to the public and posted on the IAC website.

This brief accident résumé illustrates the necessity of the IAC investigation group to gather much more information than was available on the flight recorders. This action is not always prudent or appropriate in every case due to the labor-intensive process requirements. However, in order to fully understand this accident scenario, it was necessary to proceed in much more expanded detail to determine the navigation performance of the FMS and the warning capabilities of the TAWS. This effort required what we should call "the physical presence test." That is, the investigators traveling directly to the component manufacturing facility, jointly developing an investigation protocol, and proceeding to examine each subcomponent and circuit board to extract the bits of data necessary to understand the overall component function and performance.

What does this action say to you and your fellow investigators? Are you prepared, when necessary, to identify equipment with nonvolatile memory sources and seek out methods to extract raw data? Are you willing to invest the time and resources for forensic component examination? And on the other hand, are you capable and willing to determine when it may be sufficient for practical purposes to terminate searches that may appear to waste resources and delay timely conclusions? To repeat—these are the NextGen challenges for the air safety investigators of tomorrow.

VH-QPA A300-303 Inflight Upset Oct. 7, 2008



RIGHT—Figure 4: Flight data recorder information. BELOW— Figure 5: Travel distance and time zone differences between participants.

The sharing process

Again recognizing the "Investigation—A Shared Process," theme, let's address the issues of sharing proprietary data and the obstacles that investigators meet in attempting to accomplish that end. As an example, a multifaceted case involving different nation states can best illustrate the difficulties presented to an investigator-in-charge.

On Oct. 7, 2008, an Airbus A330-300 operated by Qantas Airways departed Singapore en route to Perth, Australia. On board were 303 passengers, 9 cabin crew, and 3 flight crew. While in cruse flight at Flight Level 370, the autopilot disconnected. At about the same time, there were various aircraft system failure indications; and, while the crew was evaluating the situation, the airplane abruptly pitched nose down. The airplane reached a maximum pitch angle of about 8.4 degrees nose down and descended 650 feet during the event. The passenger cabin experienced minus 0.8 to minus 1.3g.

After returning the airplane to the assigned flight level, the crew began to deal with multiple failure messages and cabin injuries. About three minutes later, the airplane began a second pitch-down event, reaching a maximum pitch angle of about 3.5 degrees nose down, 0g and descending about 400 feet. One flight attendant and 11 passengers were injured during the two upset events. The Australian Air Transportation Safety Board (ATSB) initiated an investigation and quickly identified two significant safety factors related to the pitch-down movements. First, immediately prior to the autopilot disconnect, air data inertial reference unit (ADIRU) No. 1 started to provide erroneous data (spikes) on many parameters fed to the aircraft systems. The other two onboard ADIRUs continued to function correctly. Second, some of the spikes in angle-of-attack data were not filtered by the airplane's flight control computers, and those flight management computers subsequently produced the pitch-down movements.

The ADIRUs were subject to detailed examination and testing at the Northrop-Grumman Corporation facilities in the U.S. The download, examination, and testing were attended by representatives of the ATSB, the French Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA), the U.S. NTSB, the U.S. Federal Aviation Administration (FAA), the airplane manufacturer, and the operator.

Following a preliminary analysis of the occurrence, Airbus published interim operational procedures in the form of an operator information telex to Airbus operators. They were asked to distribute it to all A330/A340/A340-500/A340-600 flight crews immediately. The telex provided brief details known about the occurrence and provided operational recommendations applicable for A330/A340 aircraft fitted with Northrop Grumman ADIRUs. An operations engineering bulletin (OEB) followed, and subsequently the European Aviation Safety Agency (EASA) issued an emergency AD, effective Nov. 19, 2008, to mitigate the potential hazard of a pitch excursion. Similar OEBs were issued by Airbus for A340 airplanes, and an EASA AD followed for the A340. The results of the ATSB investigation, the interim reports, and the final report are available on the ATSB website.

What is different about this flight path upset event from those of the past? Simply put, the past days of a flight control cable hang up or a stuck hydraulic servo or iced elevator tab have given way to new technology.

Today's modern fly-by-wire, computer-assisted flight control systems are highly sophisticated and unique to the manufacturer. Control laws, design concepts, and aerodynamic performance data are generally regarded as trade secrets of a proprietary nature. Each airframe manufacturer's fly-by-wire concept, failure mode analysis, and flight control logic are not something to be readily shared outside the confidence of the manufacturer and the certification authority. Therefore, during an independent investigation intended to improve flight safety, in-depth negotiation among participants is required to share and protect data that is specific and relevant to the investigation.

The investigation of the A330 pitch excursion of Qantas Airways was defined as an ICAO Annex 13 "accident" by virtue of the occupant serious injuries. The investigation presented some unique challenges in coordination due to a number of multinational participants. The Australian ATSB had the responsibility to conduct an investigation representing the state of occurrence, operator, and registration. As expected, the Airbus A330 brought into the investigation the organizations of Europe, including the Airbus factory team in Toulouse, the BEA, and the EASA, the aircraft certification authority in Cologne, Germany. Further, the ADIRUs installed on this A330 were Northrop Grumman Corporation products, manufactured in the U.S. and certificated to standards set by the FAA. Therefore, U.S. participation included an NTSB accredited representative and advisors from the FAA and Northrop Grumman. Importantly, the ATSB was able to negotiate the issues of limited access with the manufacturers and other participants to fully accomplish its safety goals.

Also, in some countries there may be additional constraints and legal restrictions that limit technology transfer of safety relevant data on a national level. For example, in the U.S. there are a broad set of regulations that control the import and export of defense articles, commercial items, technical data, and defense or commercial services.

These regulations sometimes extend to the participation of foreign entities or the import/export of parts. Further, the regulations may extend to target commercial items that can be termed "dual use," those items having both commercial and military applications. Also, most countries in the international community maintain foreign policy and national security goals and technology exchange rules that apply to specifically designated countries, regimes, terrorist organizations, illegal traffickers, and other nefarious groups. Although exceptions can be made for certain air safety initiatives, the accident investigation community must operate within the confines of the respective governmental policies.

The intent of discussing the details of the specific A330 upset event and the causes and safety actions to mitigate risk is to recognize the international coordination necessary to effect the investigation and to alert our colleagues of the varying organizational needs that may be present in similar future investigations.

Setting up foreign travel arrangements or even telephone conferences in this multinational environment presents global management challenges and unique demands on resources. Turning again to the A330 example, in addition to the number of participating agencies already mentioned, it is also appropriate to note the travel distance and time zone differences involved among the participants.

Once again we should ask ourselves to consider how best to meld an investigation group to function in the global environment. Do you have an infrastructure in place and ready to address the challenges of distance among participating agencies? Are you prepared to recognize the rationale and impediments of technology transfer concerns? Have you cultivated channels of communications with your foreign relations ministry and diplomatic service departments to be aware of the political issues that may be an obstacle to the investigation? The Qantas upset event serves as an excellent illustration of the added aspects of distance and proprietary data that present the NextGen challenge in multinational investigation management.

Takeaway conclusions

There are 190 ICAO member states, and per the ICAO convention and the standards and recommended practices of Annex 13, each member state is obligated to either investigate accident and serious incident occurrences or to delegate the investigation responsibilities to another state.

From the preceding examples, the B-777 of British Airways, the Tu-154 of the Polish Air Force, and the A330 of Qantas Airways, we can observe some exemplar agency accomplishments by the UK AAIB, the IAC of Russia, and the Australian ATSB in the area of investigation and the associated safety recommendations to identify and reduce risks for future flights. As members of the investigative community, are you and your state prepared with the experience and resources to manage or participate in accident/incident investigations similar to the scope and complexity outlined above? If your state does not have the capability to do a complete and credible investigation, do you know where to reach out for necessary guidance and support? Hopefully investigators will recognize the wake-up call for greater cooperation necessary to work toward identifying and reducing risk in a timely and efficient manner.

Due to the increasing engineering complexity of the aircraft, the availability of additional data sources, the changing human factors operational environment, the global nature of the aviation industry, and the advances of air traffic and airport interface, our future successes in investigation will be measured by how well we can adjust and accept the emerging challenges of mutual trust and support among all participants.

Whether the accident/incident event is a four-seat glass cockpit airplane such as the Cirrus model; a new corporate business jet; the new regional entrants from China (Comac), Japan (Mitsubishi), or Russia (Sukhoi); or a large commercial transport airplane from Airbus, Boeing, Bombardier, or Embraer, investigators must be motivated to accept a shift to new realities for data sources and cooperative analysis to facilitate a timely and efficient investigation and risk mitigation process.

The same can be said for a data search of a hand-held GPS, an EFB, or notepad. This updated approach will require a revised level of trust and professional respect among all participants and an increased reliance on the manufacturing state accredited representative team and the manufacturers' investigative advisors. Such new and revised thinking is the NextGen challenge for the air safety investigators of tomorrow. ◆

ISASI 2012 Opens Registration

The ISASI 43rd annual international conference on air accident investigation is now open for hotel and seminar registration. The event is being held in Baltimore, Md., USA, Aug. 27–31, 2012.

"Evolution of Aviation Safety—From Reactive to Predictive," the theme of the seminar, is designed to address several areas of interest: 1) The historical evolution from reactive to predictive; 2) the interaction between accident or incident investigation and accident prevention or analysis; 3) Analytical processes that identify, monitor, or assess emerging risks; and 4) the practical application of those processes to minimize the risk of accidents.

The four-day program consists of a day of tutorial workshops and a three-day technical program. The annual event will be held at the Baltimore Marriott Waterfront, which is only eight miles from Baltimore Washington International (BWI) Airport and only one mile from Baltimore Penn Station (Amtrak). Located in the heart of Baltimore, the hotel sits on the water's edge in Baltimore's East Harbor. The hotel is hailed as the most sophisticated and upscale destination in Baltimore, only steps away from the city's finest dining, shopping, and entertaining attractions.

The guest rooms feature many high-tech and luxurious amenities offered at the special seminar room rate of US$159.00 (plus taxes) based on single or double occupancy. This rate includes daily room Internet access and use of the hotels fitness facilities. This rate is available for three days pre- and post-seminar (Aug. 24 to Sept. 3, 2012). The cutoff for reservations is Aug. 4, 2012. To make your hotel reservations, please go to the link posted on the seminar's website, which may be accessed via the ISASI site, www.isasi.org.

Also available on that site is the seminar registration application. The seminar program registration fee (in U.S. dollars) by midnight August 5 is member, $660; non-member, $710; student member, $220; and companion $360. If registration is made after August 5, the fees are $720, $780, $250, and $400, respectively. Day pass fee for any of the three days is $200, and $225 after August 5. The member fee for the one-day tutorial by August 5 is $175, and student $125. After August 5, member tutorial fee is $200, and student $150. Fee for a single event: Tuesday night dinner $120, awards banquet $125.

Two tutorials are planned for seminar day one. Anna Cushman of the FAA will present "When Animation Doesn't Tell the Real Story…Flight Data Recorders for Accident Investigation and Beyond." Cushman is a flight data analyst and program manager of the FAA's Flight Data Lab. She provides flight data technical support to the FAA accident investigation team during NTSB accident investigations and data analysis and policy guidance in support of the FAA's aviation safety responsibilities. Anna is an instrument-rated private pilot. She holds a BS degree in mechanical engineering and an MS degree in mechanical engineering, with a concentration in aero-fluid dynamics.

Her tutorial will explain how data products can help in the evaluation of an event and what the real story is on FDR data quality and decoding. Topics of discussion include sources of flight data on board an aircraft, FDR decoding—document control quality issues, data limitations—the effect of sampling and other issues, and how flight data regulations affect you as an investigator, operator, and regulatory inspector.

Andy McMinn will present "Basic Failure Analyses: Failure Mode Identification at the Accident Site." He is an air safety investigator/instructor who has worked at the Department of Transportation's Transportation Safety Institute for 12 years. Andy is a graduate of the University of Oklahoma with a degree in metallurgical and materials engineering, specializing in forensic metallurgy, failure analysis, and aircraft investigation. His career began in 1983 as a materials engineer with the U.S. Air Force's Oklahoma City Air Logistics Center in the Materials Engineering Laboratory. There he conducted forensic metallurgy, failure analysis, and aircraft accident investigation of Air Force aircraft, aircraft components, and aircraft engines.

McMinn says of his tutorial, "Basic failure analysis/failure mode identification of fractured aircraft components at the accident site is a skill needed by all air safety investigators and is considered by many to be 'black magic' when it needn't be. The black magic of failure mode identification is based on scientific principles that are easily learned when condensed down to basic structure and metallurgy, i.e., what the component was made of, how it was made, how it was treated, and what its normal service conditions are? All of these determine how a component fails whether in flight due to abnormal service conditions or in an accident due to impact forces with the ground/water."

Seminar program technical details and the companion's program are now in the reconciliation stages and will be posted in the next issue of *ISASI Forum*, as well as on the seminar website.

Reminder

ISASI annual dues were due in January. For those members who may not yet made the payment, please contact Ann Schull at isasi@erols.com or call 703-430-9688 to make payment arrangements. If payment is not received, the affected member will be placed in an inactive status. ◆

NEW MEMBERS

INDIVIDUAL

Ralph L. Wilson, Dallas, GA
Jeffrey P. Weiherer, Moorpark, CA
Sam J. Watson, Canberra, ACT
Stephen W. Tignor, Daytona Beach, FL
Bret W. Tesson, Hazelwood, MO
Carol L. Stone, North East, MD
Chad M. Sneve, Senoia, GA
Taylor S. Smith, Dayton, OH
Mark A. Shelly, Bel Aire, KS
Jonathan M. Schwartz, Prescott, AZ
Christoph Schlueter, Lorgues, France
Shivani A. Rudradat, Daytona Beach, FL
Joe D. Rucker, Tucson, AZ
Mike S. Richards, Washington, DC
Jason A. Ragogna, Atlanta, GA
John P. Quinlan, Burraneer, NSW
Stephen P. Quigg, Perquea, PA
Joy Premraj, Daytona Beach, FL
Raymond J. Pearson, Fadden, ACT
Rizwan S. Nasir, Perth, WA
Kelvin (Kel) L. Morton, Cotton Tree, QLD
Mitchell A. Morrison, Sacramento, CA
James M. Morrison, Ogden, UT
Beshoy A. Mishriky, Tampa, FL
Jason S. Minns, Kevalla Beach, QLD
Michael A. Miles, Brooklyn, NY
James D. Mercereau, Haslet, TX
Brannon D. Mayer, Hermantwon, MN
Travis R. Matthews, Annapolis, MD
Shannon M. Masters, Atlanta, GA
George Mashababe, Harare, Zimbabwe
Lloyd G. Mais, Cairns, QLD
Amber M. Macchia, Daytona Beach, FL
Jeffrey Luong, Daytona Beach, FL
Christopher O. Lowenstein, Monroe, CT
Katrina E. Lewis, Archefield, QLD
Evan, C. Lee, Auckland, New Zealand
Eric C. Launer, Sanford, FL
Kristina R. Larson, Prescott Valley, AZ
Betty S. Koschig, Fredericksburg, VA
Robert A. Kopko, Pensacola, FL
Robert B. Kelly, Ormond Beach, FL
Edwin F. Kelly, Oranjestad, Aruba
Ryan T. Joseph, Daytona Beach, FL
Justin A. Jaussi, Chesterfield, MO
Gary A. Janelli, Anchorage, AK
Marc J. Hookerman, Lake Saint Louis, MO
Matthew R. Harris, Wellington, New Zealand
David T. Hamblin, Knoxville, TN
David K., Hall Big Rock, IL
Zachary J. Gualardo, Ormond Beach, FL
Robert G. Grubb, Waxhaw, NC
Fred B. Grantham, San Tan Valley, AZ
David J. Goddard, Northgate, QLD
Robert J. Gallagher, Meridian, MS
Frank W. Fischer, Lueterkofen, Switzerland
Crystal L. Ferguson, Palm Coast, FL
Sam I. Drummond, Corinda, QLD
Paul G., DanDan, Daytona Beach, FL
Yailet Cruz Galardy, Daytona Beach, FL
Tammy L. Crowell, San Jose, CA
John B. Carey, Sandwich, IL
Paul B. Breuilly, Lower Hutt, New Zealand
Carlos E. Bravo Guarello, Vina Del Mar, Chile
Richard T. Blackwell, Ormeau, OLD
Hugh H. Belle, Port Orange, FL
Daniel J. Bartlett, Alexandria, VA
Thomas R. Anthony, Palos Verdes Peninsula, CA ◆

Committee members for the seminar are Frank Del Gandio, Seminar chair; Barbara Dunn, Registration chair; Robert Matthews, Technical Committee chair; Ron Schleede, Sponsorship chair; and Candy Del Gandio, Companion Program chair. ◆

Jerome F. Lederer Award Nominations Sought

Nominations for the prestigious ISASI annual Jerome F. Lederer Award are now open. Awards Committee Chairman Gale Braden urges ISASI members to look for deserving candidates in the various fields of aircraft accident investigation and nominate those meeting the criteria. For consideration, the Committee chair must receive the nomination letter by May 31, 2012.

Braden said, "Each year, at our annual seminar, we recognize positive advancements in the art and science of air safety investigation through the Jerome F. Lederer Award. The criteria for the Award are quite simple. The Lederer award recognizes outstanding contributions to technical excellence in accident investigation.

"Any member of the Society may submit a nomination, and the nominee may be anyone in the world. The Award may be given to a group of people, an organization, or an individual, and the nominee does not have to be a Society member. The Award may recognize a single event, a series of events, or a lifetime of achievement."

The ISASI Awards Committee considers such traits as duration and persistence, standing among peers, manner, and techniques of operating, and of course achievements.

Each nominee competes for three years unless selected. If not selected during that time, the nominee can be nominated after an intervening year for another three-year period. This is a prestigious award that usual results in good publicity for the recipient and one that might be beneficial in advancing a recipient's career or standing in the community.

Nomination letters for the Lederer Award must be limited to a single page. Nominations should be mailed, or e-mailed, to the ISASI office or directly to the Awards Committee chairman, Gale Braden, 13805 Edmond Gardens Drive, Edmond, OK 73013, USA; e-mail: galebraden@cox.net. ◆

SERC Sets Spring Meeting In New Orleans, La.

ISASI's Southeast Regional Chapter will hold its spring meeting at the Maison Dupuy Hotel in New Orleans, La., on March 17, 2012.

The full-day program will include presentations by 1) Dr. Bill Johnson, FAA, "Are We Really Asking the Right Investigative Questions about Fatigue," 2) Dr. Paul Schuda, NTSB, "Volunteer Pilot Accident Briefs," 3) Major Hunter Larimore, Turobmcca, "Engine and Powertrain Examination," and 5) Blake Kelly, Embry-Riddle Aeronautical University, "ADS-B and Flight Data Monitoring in the Accident/Incident Investigation Program."

The registration fee is $75, and $35 for students. To register for the event, contact Alicia Storey at 334-598-8893 or e-mail astorey@srca.net. Hotel reservations are made directly with the hotel at 1-800-535-9177. Callers should ask for the ISASI group.

Online registration for the meeting is also available through the ISASI website, www.isasi.org. Click onto the SERC 2012 spring meeting flyer. ◆

SF Chapter Reactivates; Holds 'Kickoff' Meeting

After many years of inactivity, ISASI's San Francisco Chapter held a kick-off meeting October 28 that was well attended and featured three ISASI leaders. U.S. Society President Toby Carroll and Lederer Award winners Ron Schleede and John Purvis conducted a two-hour roundtable discussion titled "Investigating Major Aviation Accidents." In addition to the Chapter members, the presentation was well attended

In Memoriam

A.G. William Harvey (LM0294), Silver Spring, Md., USA, January 2010
Robert F. Hunt (LM2193), Annapolis, Md., USA, August 2010
James E. Dougherty (LM0518), McLean, Va., USA, September 2011 ◆

by a number of aviation enthusiasts from the area.

The program introduced the audience to the investigation process from the viewpoint of the NTSB, the manufacturer, and the operator. For most attendees, it was their first broad look at a process that for them has been cloaked in mystery. Even those familiar with the process benefitted from hearing the viewpoints other party members.

"We were delighted by the number of attendees and the degree of group participation for this kickoff meeting," Kevin Darcy, newly designated Chapter president, said.

The seminar, which also entitled attendees to FAA Wings program credit, was held in the Oakland Aviation Museum located at Oakland International Airport. The Museum proved an excellent venue for the meeting. "It was great being in the Museum's hangar surrounded by vintage and home-built airplanes, with a Rutan VariEze suspended overhead while hearing from these three incredibly experienced investigators," Darcy said. The meeting also allowed the attendees to tour the Museum.

The Chapter plans to begin regularly scheduled quarterly meetings reaching out to current and future ISASI members. ◆

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

Old Address (or attach label)

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.

Amsterdam Is Site of ESASI Regional Seminar

The European Society of Air Safety Investigators announces that its 5th air safety seminar will be held in Amsterdam, the Netherlands, April 19–20. "With emphasis on current European issues in the investigation and prevention of accidents and incidents, the two-day seminar is aimed at accident investigation professionals and will provide an opportunity to update professional knowledge and skills, as well as to meet other active air safety investigators," said ESASI Councillor Anne Evans.

Under the seminar theme "Air Accident Investigation in the European Environment," presentations will address current issues in the European environment and the challenges of modern air safety investigations. The two-day program will take place at the Dutch National Aerospace Laboratory (NLR), which is the center of expertise for aerospace technology in the Netherlands. Hotel accommodation will be arranged near the city center and transportation provided to the NLR. Event activity includes a dinner cruise reception that companions may attend.

For details, please check the Society website, www.esasi.eu. For bookings, contact ESASI Councillor Anne Evans—Tel: +44 (0) 7860516763 or e-mail: anne_e_evans@hotmail.com; or ESASI Secretary John Dunne—Tel: +44 (0) 7860 222266 or e-mail: j.dunne@btinternet.com. ◆

Luke Schiada Named NERC President

Luke Schiada has been appointed president of the Northeast Regional Chapter (NERC). He is a senior air safety investigator with the National Transportation Safety Board and has been involved in numerous domestic and foreign accident investigations as the investigator-in-charge (IIC) or United States accredited representative during his more than 14-year career.


Schiada

Luke is a graduate of Farmingdale State University of New York with degrees in aerospace technology and aviation administration, holds FAA commercial pilot and airframe and powerplant mechanic certificates, and has been an active ISASI member for more than 10 years.

He believes the objective of the reactivated regional chapter is to promote air safety via the exchange of aircraft accident investigations and aviation safety information on a local level with the additional benefit of providing networking opportunities to members in or aspiring to join the aviation safety field. Chapter meetings will be held biannually featuring interesting and informative speakers. Interested members are encouraged to contact Luke directly with thoughts, suggestions, and advice at LSchiada@aol.com. ◆

Canadian Society Issues Remembrance

Jim Stewart, on behalf of the Canadian Society, reports the "flying west" of Rayne "Joe" Dennis Schultz at age

89. He served as the director of Flight Safety for the Canadian Forces, which is an ISASI corporate member.

Jim, in his remembrance writes, "Joe was an amazing leader who developed and led the Canadian military aviation safety and accident investigation programs into the modern age. I was always amazed at how far ahead of his time Joe really was in terms of the safety business. The ideas and programs he introduced have been so absorbed into our safety work that I doubt we really remember that much of what we do came from the mind of one very talented man. He will be greatly missed."

Joe's obituary noted, "After a fighter pilot's struggle, Joe slipped the surly bonds of earth.... His love of flying carried over a distinguished 37-year career with the RCAF and beyond. A well-documented WWII Mosquito night fighter pilot with 410 Squadron, he went on to fly over 40 different aircraft including the CF-18 twice in his later years. Over many years in cooperation with the military and the civilian agencies associated with aviation, his vision, dedication and pursuit of excellence resulted in significant advancement in air operations generally and flight safety accident prevention programs in particular." ◆

ANZSASI Sets Seminar; Issues Call for Papers

The 2012 Australian/New Zealand Societies Australasian seminar will be held in Sydney at the Mercure Hotel, George Street, June 1–3, 2012. Registration details will be released shortly, but in the meantime the hosting Societies are issuing their "Call for Papers."

A representative for the event noted, "We would like offers of papers addressing contemporary air safety investigation and air safety issues. Please submit an abstract and short bio by March 1, 2012, to Paul Mayes at ropadofelix@hotmail.com. Paul may also be contacted for further seminar information.

The seminar hotel, the Mercure, is adjacent to Sydney's Central Station and easily accessed by train from the airport or by public transport. For partners, the Mercure is very central, close to Darling Harbour and to the Sydney attractions.

The seminar will follow its usual format with a welcome reception on Friday evening, two full days of presentations on Saturday and Sunday, and a dinner on the Saturday night. ◆

Correction

Forum incorrectly reported in its October-December 2011 issue that Michael Lemay was the creator of the ISASI 2011 logo. Credit for the superb work should go to Marjorie Chartier. Our apologies. ◆

LA Chapter Renamed; Reactivated as SoCal Chapter

The ISASI Los Angeles Regional Chapter has been in an inactive status for some time. Recently, Thomas Anthony, the director of the USC Aviation Safety and Security Program, volunteered and was appointed president of the re-established SoCal Regional Chapter by ISASI President Frank Del Gandio.

Thomas reports that a meeting was held in Los Angeles, Calif., in November 2011 to re-establish ISASI in the southern California area. Previously, due to the high level of aerospace activity in the area, there had been two ISASI chapters in southern California, eventually reduced to one. Now, however, it was decided to re-establish the Chapter to cover all of southern California. Support for the re-establishment was strong among all participants.


Anthony

The meeting was well attended by representatives from all areas of aviation accident investigation from general aviation to suborbital space travel. The keynote speaker was Jon Turnipseed, the chief of safety for Virgin Galactic. Jon detailed the development of the Virgin Galactic space program, the Spaceport America in New Mexico, and construction of the Virgin Galactic Spaceship and the White Knight delivery vehicle. Jon detailed the mission profile and prototype testing that is ongoing. The presentation was greeted with great interest.

Plans for the future include dinner meetings with presentations from manufacturers detailing the specific technical considerations that would be involved in investigations that concerned their products and reports from members about recent investigative developments. ◆

Reachout Program Remains Ready

"The ISASI Reachout program remains prepared to deliver the services of expert volunteers in diverse areas of the aviation world," says John Guselli, chair of the program. He adds, "We have recently fielded inquiries from New Zealand, Hungary, and Pakistan; however, these are all at the preliminary stage."

The process relies upon "host" organization(s) specifying the particular areas of expertise that are sought for their location. This enables the Reachout Committee to then match the necessary skills with the available volunteers.

Additionally, the "host" rganization(s) are expected to provide a training venue that permits interactive learning for the attendees. "This is not unlike any airline or government agency training facility," notes Guselli. ◆

Sumwalt Gains Second Term as NTSB Board Member


Sumwalt

Robert L. Sumwalt has been sworn in for his second five-year term as a Board member of the National Transportation Safety Board. Nominated by President Obama, his term of office will run until Dec. 31, 2016.

"Public service is truly one of the highest callings in the land. I have been honored to serve on the NTSB for the past five years, and I am humbled and appreciative that President Obama has asked me to serve for an additional term," said Sumwalt. "I am grateful to the Senate for their positive action on this nomination. I look forward to continuing to work with my colleagues on the Board, as well as the NTSB staff."

Member Sumwalt was first designated as Board member on Aug. 21, 2006, by President Bush and served as vice chairman of the Board for a two-year term. His ISASI membership precedes his NTSB service. ◆

Russia Interstate Aviation Committee Celebrates 20-Year Anniversary

The Interstate Aviation Committee of Russia, an ISASI corporate member, was sent a letter of congratulations on its recently celebrated 20th anniversary.

ISASI President Frank Del Gandio, writing to Dr. Tatyana Anodina on behalf of the Society, said, "We send our best wishes and heartfelt congratulations upon this noteworthy occasion. The Committee has been a long-time supporter of ISASI activities and programs and for that, we are truly grateful. I personally appreciate your participation in the Society and your long-time dedication to our mutual goals of enhancing aviation accident investigation and prevention. The professionalism of your organization is widely recognized, and I know that will continue in the future. Congratulations once again and know that ISASI is proud to have you as a member of our organization." ◆

US Safety Chiefs Outline Ambitious 2025 Strategy

Ken Hylander, responsible for safety at Delta Air Lines, and Peggy Gilligan, the Federal Aviation Administration's top safety official, spoke recently about a new goal to halve the current low accident risk by 2025, as reported by *Air Traffic Management* magazine.

The article noted that attaining that goal would mean approximately one fatality for every 22 million flights, which equates to one death roughly every two-and-a-half years, a period in which more than 1.4 billion passengers will have boarded scheduled flights operated by U.S. airlines. ◆

Building Partnerships in Unmanned Aircraft Systems

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community can and should pursue.

The quality and availability of relevant data are likely to be the most difficult issue to overcome. Many UAS operators, especially in the military, do not as readily acknowledge UAS as being aircraft so much as high-end equipment. If detailed information regarding *operational* issues is not being collected systematically, the problem of access to existing records may be overshadowed by the far greater problem of there being no relevant records in the first place.

Overcoming that hurdle, and obliging UAS operators to think about their unmanned aircraft as *aircraft* instead of simply as equipment providing aerial vantage points, may be the biggest challenge of them all.

Final word

The need for effective "sharing" of knowledge and resources is a critical prerequisite to figuring out how to safely operate manned and unmanned aircraft in shared airspace. The information available in the many scattered, proprietary, or otherwise protected UAS investigations that have taken place over the past decade ***must*** be gathered, analyzed, and exploited to improve both the safety of UAS and their operations and the quality and effectiveness of future UAS-related safety investigations.

Attorney Timothy Ravich, writing in the North Dakota Law Review in 2009, offered this succinct summary of the broad issues surrounding successful UAS integration:

"While the path for [UAS] development in the military, civil, and commercial sectors domestically and internationally seems clear, the saying that 'the sky's the limit' may literally be true as [UAS] increasingly become part of the national airspace system (NAS). After all, the national airspace is already occupied by aircraft manned by general, commercial, and military interests, and it is not entirely clear whether, when, how, or if [UAS] of every type can or should be incorporated into the busy NAS environment. Whether [UAS] can be integrated into the national airspace without also posing a safety or national security issue is an open question."

Safety professionals of all stripes will play a defining role in answering the

ISASI Information

questions posed by Mr. Ravich. It seems inevitable that accidents involving UAS will form part of the backdrop against which they will be considered. Only honest data describing both the context within which such accidents take place and the factors surrounding their root causes will lead to the safe integration of unmanned aircraft systems throughout the world's airspace systems, and to the development of regulatory controls consistent with the risks that UAS pose to the other users of those systems. ◆

(The views expressed in this paper are the author's, and do not reflect official positions of the Federal Aviation Administration, ClancyJG International, or its clients.)

Impact Dynamics Cases and Cautions

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mendations. The exercise was undertaken with the experience of previous cases and, indeed, the G-YMMM experience underlined the lessons that over 20 years have been remarkably consistent in applying computational impact dynamics:

1) Use of computer-based impact tools can add real value to the accident investigation. This is as a supplement to other approaches, not as a substitute, and compared with other investigation costs, it can be expensive.

2) The modelling process must fit into the timescale of the accident investigation, so it is important to start early and to make clear decisions on technical alternatives.

3) There is no substitute for the helpful cooperation of the aircraft manufacturer—it is pretty much essential. (If there are injuries involved, a cooperative medical investigator is essential, too).

4) The accident investigator must work closely and frequently with the specialist impact analyst throughout the investigation.

5) Accidents lending themselves to computational impact approach are infrequent, but the lessons are widely applicable and add substance to safety recommendations. ◆

ISASI

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WHO'S WHO

Airbus

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

Airbus is a leading aircraft manufacturer whose customer focus, commercial know-how, technological leadership, and manufacturing efficiency have propelled it to the forefront of the industry. With revenues of more than 29 billion euros in 2010, Airbus today consistently captures about half of all commercial airliner orders. The company also continues to broaden its scope and product range by applying its expertise to the military market.

Headquartered in Toulouse, France, Airbus is owned by EADS. It is a truly global enterprise of some 52,000 employees, with fully owned subsidiaries in the United States, China, Japan, and the Middle East; spare parts centers in Hamburg, Frankfurt, Washington, Beijing, and Singapore; training centers in Toulouse, Miami, Hamburg, and Beijing; and more than 150 field service offices around the world. Airbus also relies on industrial cooperation and partnerships with major companies all over the world and a network of some 1,500 suppliers in 30 countries.

Airbus draws together the skills and expertise of 15 sites in France, Germany, Spain, and the UK. Each site produces a complete section of the aircraft, which is then transported to the Airbus final assembly lines in Toulouse, Hamburg, or Tianjin. Airbus's industrial network has been expanded to include a regional design office in North America, a joint venture engineering center in Russia, and further engineering centers in the People's Republic of China and India.

Airbus's modern and comprehensive product line comprises highly successful families of aircraft ranging from 107 to 525 seats: the single-aisle A320 family (A318/A319/A320/A321), the widebody, long-range A330/A340, the all-new next-generation A350 XWB family, and the ultra-long-range, double-decker A380 family. Across all its fly-by-wire aircraft families, Airbus's unique approach ensures that aircraft share the highest possible degree of commonality in airframes, onboard systems, cockpits, and handling characteristics, which significantly reduces operating costs for airlines.

Furthermore, in anticipation of market growth, Airbus is extending its portfolio of freighter aircraft, which will set new standards in the general and express freight market sectors. Airbus's latest addition to its family of freighter aircraft is the A330-200F, a mid-sized, long-haul cargo aircraft that benefits from the excellent economics and fly-by-wire technology of the popular A330-200 airliner.

Airbus has sold more than 10,000 aircraft to more than 400 customers/operators and has delivered more than 6,500 aircraft since it first entered service in 1974. Sensitive to its position as an industry leader, Airbus strives to be a truly eco-efficient enterprise. To that end, Airbus is the first aeronautics company in the world to have earned the ISO 14001 environmental certification for all production sites and products for the entire lifecycle. Airbus seeks to ensure that air transport continues to be an eco-efficient means of transport, delivering economic value while minimizing its environmental impact. ◆