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17 Managing a Complex Aircraft Systems Investigation
By Barry Holt, Western Region Senior Technical Investigator, Transportation Safety Board of Canada, and David Fisher, Manager, Air Safety Investigations, Commercial Aircraft, Bombardier Air Safety Investigation—
The authors discuss a complex investigation of two Bombardier Q400 main landing gear failures that required extensive testing of the aircraft gear mechanics and resulted in software updates for existing proximity switch electronic units and new PSEUs for newly manufactured aircraft worldwide. This paper won the award for the best presentation of the 2017 seminar.

21 Making a Difference in Aviation Safety: Colgan Flight 3407 Nine Years Later
By Roger Cox, U.S. National Transportation Safety Board (NTSB) Operational Factors Group Chairman During the Colgan Flight 3407 Investigation—
The author examines an investigation of Colgan Flight 3407, a Bombardier DHC-8-400 (Q400) that crashed near Buffalo, New York, on Feb.12, 2009. He notes that as a result of the accident, the U.S. Congress enacted a new aviation safety law in 2010, building on and adding to the NTSB’s recommendations from its investigation. Nine years after the accident, over half the NTSB’s recommendations are still open, and some of the actions mandated by the law remain incomplete.

FEATURES

11 ISASI Rudolf Kapustin Scholarship Essays: Investigations—Do They Really Make a Difference?
By Dylan Grymonpré, 2017 Kapustin Scholarship Recipient—
The author suggests that the manner in which air safety statistics are presented may not accurately show the importance of continued air safety improvements. He argues that investigators may need to ensure that their findings and recommendations result in actual changes.

14 ISASI Recognizes Chan, Wing Keong with the 2017 Jerome Lederer Award
By J. Gary DiNunno, Editor—ISASI’s highest honor for air safety achievement recognizes Chan, Wing Keong, former director of the Air Accident Investigation Board of Singapore, for his long-standing air safety efforts and for building the AAIB Singapore into a world-class investigative organization.

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ABOUT THE COVER

During the final event of ISASI’s 2017 seminar, Society President Frank Del Gandio presents Dr. Chan, Wing Keong with the 2017 Jerome F. Lederer Award for outstanding contributions to technical excellence in accident investigation.
ICAO AND WHY IT’S IMPORTANT

Most ISASI members know that International Civil Aviation Organization (ICAO) Annex 13 provides us with international standards and recommended practices (SARPs) for the conduct of aviation accident and incident investigations and the development of aviation safety improvements. In addition, ISASI’s official ICAO international observer organization status, granted in 2013, has provided a means to give our input to strengthen, update, and improve ICAO’s official policies and declarations. I do, however, still get occasional questions about what ICAO is and how it was created.

ICAO is a United Nations’ specialized agency. ICAO administers and governs the Convention on International Civil Aviation. Recognizing the growth potential and importance of civil aviation, representatives from 52 states met in Chicago, Ill., in 1944 to develop that cooperative international agreement, which is also known as the Chicago Convention. In 1947, a majority of member states ratified the agreement and ICAO became official. Through ICAO, 192 current state members, plus industry groups such as ISASI, work for consensus on international civil aviation SARPs and guidance materials to promote safety and security on a global scale.

Creating, maintaining, and updating SARPs and procedures for air navigation (PANS) are the basic function of ICAO’s mission. SARPs and PANS are vital for ICAO member states and other stakeholders to ensure harmonized global aviation safety and efficiency in the air and on the ground and global standardization for air navigation facilities.

New aviation technology and procedural innovations demand that ICAO continually updates many of the Chicago Convention’s 19 annexes and five PANS. The development and updating of SARPs and PANS follow a complex amendment process, involving a number of technical and nontechnical bodies within ICAO and official observer organizations, such as ISASI. An initial proposal for a new or improved standard, recommended practice, or procedure to be formally adopted or approved for inclusion in an annex or a PANS typically takes about two years.

Ron Schleede, ISASI vice president, serves as the Society’s ICAO Working Group chairman and leads the ISASI delegation to ICAO meetings. The Society’s delegation has also included Bob MacIntosh, ISASI treasurer, and Nick Stoss. ISASI representatives participated in ICAO’s biannual 2015 High Level Safety Conference and the organization’s subsequent Accident Investigation Panel (AIGP) meetings. ISASI’s team participates in several of the 11 AIGP working groups that use correspondence, conference calls, and occasionally face-to-face meetings to develop materials for discussion and resolution during the next full panel gathering. As Ron noted in an AIGP trip report posted in our website library, ISASI and ICAO both benefit from our direct participation—ICAO obtains our experience and expertise, and we strengthen our global reach as a truly international air safety society.

ISASI has continued to expand its global reach and networking through regional, national, and local meetings; training seminars and workshops; student chapters; and our flagship journal, ISASI Forum. We remain financially sound, and our active membership numbers are stable because we’re able to recruit new members to replace those who are no longer active. I urge each of you to encourage your colleagues who aren’t part of our organization to consider becoming members.

Please remember that details about the Kapustin scholarship fund are posted on our website and that student applications and essays are due in mid-April. The number of scholarships that ISASI can provide each year is based on your donations, which in the United States are tax deductible. I look forward to a productive and successful year for ISASI and hope to see many of you at our annual seminar held in Dubai, United Arab Emirates, this fall. A call for technical papers to be presented at this year’s annual gathering and guidelines for authors is now posted on the website and in this Forum. Abstracts for papers to be considered are also due in mid-April.

On a final note, I wish ISASI members and their families a happy and safe new year.◆

Frank Del Gandio
ISASI President
More than 360 delegates, guests, and companions from 38 countries participated in technical briefings, listened to pertinent keynote addresses, and attended tours and social gatherings during the Society’s 48th annual International Accident Investigation and Prevention Conference held Aug. 22–24, 2017, at the Sheraton San Diego Hotel and Marina in California.

Tutorial workshops, the eclipse, and a welcome reception

Preceding ISASI 2017, some 122 participants attended Monday’s tutorial sessions targeting civilian and military air accident investigators that were separate from the seminar. On the civilian side, ISASI Flight Recorder Working Group Chair Mike Poole, Plane Sciences, and ISASI members Frank Hilldrup, NTSB, and Steve Roberts, AIRINC, conducted a morning session entitled “Flight Recorders: Beyond ICAO Annex 13.” They discussed the design history of flight data recorders (FDRs), FDR survivability, the structure of digital data, and examined development of the third generation of solid-state recorders. The participants looked at the design of modern recorders, discussed the use of data maps, and examined a typical modern-day installation process.

In the afternoon, Martin Maurino, ICAO, and Jason Fedox, NTSB, covered cabin safety technology and improvements in the “Survival Factors” tutorial. They discussed ICAO’s Survivor Factor Accident and Incident Investigation Manual and outlined some cabin safety investigations, provided information about specific cabin safety improvements that have increased survivability, and discussed several different types of occurrences.

On the military side, James Roberts, Boeing, and David Harper, USAF, led an all-day discussion in the “Military Accident Investigation” session. John Karstens, Boeing, discussed adapting Safety Management Systems (SMSs) to military operations. José Casido, an Airbus accident investigator, discussed that manufacturer’s safety structure and experience. He provided an overview of military accident statistics and Airbus involvement as a technical advisor.

Tutorial participants interrupted their sessions for a few minutes to view (with proper precautions) a partial eclipse of the sun. After the tutorials ended, everyone gathered in the evening for a welcome reception held on the hotel grounds.

ISASI 2017 begins with noted speakers, introductions, and presentations

From the podium overlooking a packed ballroom, ISASI 2017 Committee Chair Barbara Dunn, president of the Canadian Society, on the morning of Tuesday, August 22, opened the seminar with a warm welcome to San Diego. Following her procedural announcements, Dunn introduced ISASI President Frank Del Gandio for his traditional opening address.

“We are here at ISASI 2017 to share our views and information on air safety investigations, including investigative techniques, analytical approaches, and emerging issues in the field,” Del Gandio told delegates and officials seated in the filled meeting room. “Our theme this year is ’Investigations—Do They Really Make a Difference?’ The short answer is yes, they make a big difference.” He observed that investigations in most fields, “whether they are in aviation or in other areas, follow a similar intellectual model: Document what happened and did not happen, complete with technical and scientific testing, interviewing witnesses, survivors, support personnel, and others. That part of the process has been made a bit more definitive with the use of onboard data, ATC data, etc. The documentary phase is followed by analysis in an effort to make some coherent sense of the event and to put it into a larger context. Aviation investigations then take a third critical step: when appropriate, recommending how to fix an identified problem.”

Del Gandio said, “To some degree we are the victims of our own success. Yes, we have witnessed sensational aviation events in recent years, including military shoot-downs or political acts, plus at least one suicide (Germanwings) and the continued saga of MH370. Nonetheless, major ‘accidents’ have been amazingly rare in recent years. The continued rarity of major accidents may perhaps explain why the question about the continued value of investigations could even be posed.”

He asked, “Do investigations still matter and, if so, how?” He answered, “Our efforts provide the original documentation that leads to identifying the risks
that we track in operational data. We will continue to document and analyze how those or other risks actually play out when things go badly wrong. Our findings will continue to be a primary source of recommendations about how to alleviate identified risks. Investigations also will continue to document and analyze what happens in high-risk incidents or accidents that mercifully do not lead to fatalities.”

Del Gandio closed his opening remarks “with my usual suggestions to attendees. Please participate fully in this seminar. To those who have real expertise, please be open and share your knowledge. To any students or new members of our profession, I encourage you to take advantage of the knowledge that is in this room. If you have questions about virtually anything related to aviation, someone in this room can answer your question with authority or will be able to find someone who can. Finally, to everyone, enjoy the San Diego seminar.”

NTSB chairman delivers keynote address
Del Gandio then introduced longtime ISASI member and NTSB Chairman Robert Sumwalt to present the seminar’s first keynote address.

“Good morning and thank you for inviting me to address this gathering.”
Sumwalt began. “It’s great to be here with others who share a passion for air safety investigations.

“The theme for this year’s ISASI seminar is ‘Investigations—Do They Make a Difference?’ Well I certainly hope so, because I’ve been going to accident scenes since I was 17. On that day, I heard about a plane crash on my car radio and decided to try to find it. As I approached the crash site, I saw the coroner and decided to tuck in close to him. As the law enforcement officers on scene raised the yellow tape and cleared the way for him, I ducked in with him.

“Don’t ask me how this happened, but on the way home, I drove by the airport and stopped at a flight school and signed up for flying lessons. So yes, I sort of got into aviation by accident.”

“When I began flying for an airline in 1981, there was still some distrust of big brother and companies using flight data recorders and cockpit voice recorders [CVRs] to ‘spy’ on pilots. Look how far we’ve come. For years now, not only are CVRs in every airline cockpit, but now airlines and several business aviation operators routinely monitor hundreds of parameters from flights to look for exceedances or deviations. And to top it off, these operators actually share their data with government and industry to look for potential problems so the problems can be addressed before they lead to accidents. It’s a system that is built on trust. Honestly, I believe this is one of the big reasons our aviation safety record has gotten as good as it is in the U.S.

“I’ve been actively involved in the aviation safety business for more than 30 years. During that time, I’ve developed the belief that an effective, credible investigation needs three critical elements. First, the investigation needs to independent and objective. Quite simply, we need to ensure the investigation remains independent from outside influences. Independence is one of the NTSB’s core values, and I truly believe it is one of our greatest virtues.”

Sumwalt observed that according to a U.S. Senate Commerce Committee report, “The most single aspect of the NTSB must be its total independence from those governmental agencies it oversees in regard to their transportation regulatory functions. If the board is under pressure from any administration to pull its punches or to tone down its reports or to gloss over government errors in transportation safety, then its watchdog function has been fatally compromised.” The U.S. Congress separated the NTSB from the U.S. Transportation Department in 1974. “So,” Sumwalt declared, “my charge to you is to ensure your investigations are free from external pressures. The traveling public deserves independent and objective investigations.

“The second critical element of effective investigations, in my opinion, is to keep your eye on the goal—prevention. Remember that according to ICAO Annex 13, ‘the sole objective of the investigation of an accident or an incident shall be the prevention of accidents and incidents. It’s not the purpose of this activity to apportion blame or liability.’

“As soon as the investigation starts seeking to apportion blame or liability, the focus on true safety improvements can get derailed. Granted, there are those who are in the business of litigation—but not the purpose of this activity. It’s not the purpose of this activity. It’s the prevention of future mishaps.

“Prevention of future accidents is the core component of an investigator’s mission; a thorough investigation that determines the cause of an accident is of little value to the public if the knowledge does not prevent future accidents. Successful adoption of safety recommendations is...
the forward-looking fulfillment of the work we all do.

“The third critical element of effective investigation is that we must not be satisfied at superficial findings. We must look for the underlying issues. If we focus only on the obvious error, we may miss valuable accident prevention opportunities because systemic flaws may remain undetected and thus uncorrected. It’s one thing to say a person committed an error. It’s quite another to try to understand all of the factors that may have influenced that error. Where was the rest of the system that should have prevented a simple error from being catastrophic? If we are really interested in improving safety, then we must look at the entire system, not just focus solely on the frontline personnel.

“In my office, I have the framed cover of an ISASI Forum. On the cover, it states: ‘The discovery of the human error should be considered as the starting point of the investigation, not the ending point.’ I placed this magazine in my office to serve as a reminder of the importance of going beyond simply stating that someone committed an error. We need to answer why the error was made. “As I head toward the ending of this discussion, allow me to put a different twist to the theme of this conference. Instead of asking if investigations make a difference, I’d like to put the focus on the dedicated men and women who actually conduct air safety investigations. The question now becomes: ‘Investigators—do they make a difference?’ “Like many of you, I have been doing safety work for a long time. I know there can be trials and tribulations. I know there can be trials and tribulations. I know there can be disappointments, setbacks, frustrations. Perhaps sometimes you feel your work is all for nothing. And why do I suspect you may sometimes feel that way? Because as one safety professional to another, I know from experience that when we care about something as much as we all do, it can be frustrating when we feel our input is ignored; when we know there is more that can be done; when we see things that should be changed, but aren’t; when we feel others really don’t care. You may occasionally ask yourself: ‘Is it all worth it? It is really worth all of the time I have spent on these safety initiatives?’ “Well, to answer that and keep it all in perspective, one of my favorite inspirational sayings is ‘And whoever saves a life, it is considered as if he saved an entire world.’ You only need to keep one person from getting into trouble in an aircraft. If you have done that, it’s as if you have saved an entire world. Let me assure you, the work you are doing—it does matter. It does make a difference. It is important. And yes, it does keep people from dying. So as one professional air safety investigator to another, thank you for your tireless efforts. I guarantee your work is saving an entire world.”

More introductions were in order

Before the formal presentations began, Del Gandio introduced the other top Society officers—Vice President Ron Schleede, Treasurer Bob MacIntosh, Secretary Chad Balentine, and Executive Advisor Dick Stone. As chairman of the ISASI Randolph Kapustin Memorial Scholarship Committee, Balentine then introduced the four recipients of the Society’s 2017 scholarship awards: Maria Gregson, University of Nottingham, UK; Dylan Grymonpré, Carleton University, Canada; Mahmood Masood, University of Central Missouri, USA; and Ross Rozanski, University of Southern California, USA. During the course of the three-day seminar, more than $1,500 in donations for the 2018 scholarship fund were collected from participants and state and local ISASI organizations.

After the technical presentations for Tuesday, national societies conducted business meetings and then seminar participants and their guests traveled to the San Diego Air & Space Museum for a buffet dinner and a chance to wander through the museum’s exhibits, which include historic military and commercial aircraft and vintage automobiles.

Wednesday presentations began

at 9:00

Panel presentations on human performance investigation techniques and
helicopter accident trends dominated the early hours of the seminar. Following the lunch break, ISASI held a short membership meeting and then technical presentations continued throughout the day. After the final audience questions at the end of the day, ISASI working groups held meetings to discuss with interested members ongoing projects and efforts.

Thursday began at 8:30 with the second keynote speech
Moderator James Roberts, chair of the ISASI Military Air Safety Investigators Working Group, introduced James Viola, FAA, Office of General Aviation Safety Assurance, for the final keynote address.

Viola looked toward the seminar participants and said, “The quest to improve aviation safety has taken us down many paths, but few have paid dividends like good accident investigations and also public collaboration. By building strong relationships with operators, manufacturers, trade associations, and academia, we have collectively made most every form of aviation safer.

“In this presentation, I will briefly highlight the history and successes of three of our most important safety teams—the Commercial Aviation Safety Team, the General Aviation Joint Steering Committee, and the U.S. Helicopter Safety Team.

“The Commercial Aviation Safety Team was founded in 1998 with a goal to reduce the commercial aviation fatality rate in the United States by 80% by 2008.

“Think about the significance of this for a moment. In the decade that preceded the formation of CAST, not a single year went by without a fatal accident involving a U.S. air carrier—and in several of those years, there was more than one fatal accident. We are now on nearly an eight-year run in which there have been no fatal accidents involving a scheduled U.S. certificated airline. That is why by 2008, CAST was able to report that by implementing the most promising safety enhancements [SEs], the fatality rate of commercial air travel in the United States was reduced by 83%. As impressive as that achievement was, the entire industry recognized there was still work to be done.

“CAST has evolved, and the group is moving beyond the ‘historic’ approach of examining past accident data to a proactive approach that focuses on detecting risk and implementing mitigation strategies before accidents or serious incidents occur. The goal over the next decade is to transition to prognostic safety analysis.

“CAST aims to reduce the U.S. commercial fatality risk by another 50% from 2010 to 2025. CAST has developed an integrated, data-driven strategy to reduce the commercial aviation fatality risk in the United States. The CAST plan currently comprises 96 SEs aimed at improving safety across a wide variety of operations. CAST identifies precursors and contributing factors to ensure resources address the most prevalent categories of risk that pose the greatest threat to loss of life.

“To get a better feel for the CAST methodology, let’s take a look at one of the SEs aimed at reducing runway excursions. All of us understand that these excursions can lead to a loss of life; and like most accidents, they are well within our power to prevent. Excursions are often the result of unstabilized approaches, incorrect performance planning, and/or poor runway surface conditions.

“SE 222, which began in 2014, tasked the aviation community with performing research to enable development, implementation, and certification of onboard aircraft system technologies to assess airplane braking action and provide the data in real time to the pilot, other aircraft crews, air traffic controllers, and the airport operators.

“In a CAST study of runway excursions, the team determined that qualitative reports of runway friction based on pilot perception could be augmented, improved, and ultimately replaced by quantitative calculations of runway friction derived by onboard measurement and data-processing systems. This builds upon the work being done by the Takeoff and Landing Performance Assessment, or TALPA, group.

“Just as a reminder, the TALPA initiative aims to reduce the risk of runway overrun by providing airport operators with a method to accurately and consistently determine the runway condition when a paved runway is contaminated.

“This highlights another virtue of the CAST methodology, which is to leverage the work of other expert groups and to share data with other groups that seek to achieve common goals. And speaking of common goals, our efforts to improve general aviation safety are no less ambitious than those directed at our airline community.

“One of the most effective strategies on which we have embarked is the implementation of the General Aviation Joint Steering Committee, or GAJSC. The GAJSC was launched in 1997 as part of the industry-government Safer Skies Initiative to improve aviation safety. Revitalized in 2011, the GAJSC works to improve GA [general aviation] safety through data-driven risk-reduction efforts focused on education, training, and enabling new equipment in GA aircraft. This public-private partnership works to improve safety by using a consensus-based approach to analyze aviation safety data and develop risk-reduction efforts.

“The GAJSC’s goal is to reduce the GA fatal accident rate per 100,000 flight
ISASI 2017 TECHNICAL PROGRAM

Monday, August 21, 2017
Tutorials
8:30–12:30 “Flight Recorders: Beyond ICAO Annex 13,” Mike Poole, Plane Sciences, and Frank Hilldrup, NTSB
12:30 Lunch
1:30–5:30 “Survival Factors,” Martin Maurino, ICAO, and Jason Fedox, NTSB
8:30–5:30 “Military Accident Investigation,” James Roberts, Boeing, and David Harper USAF
6:30 Reception

Tuesday, August 22, 2017
9:00 Barbara Dunn, seminar chair
9:15 Welcome—Frank Del Gandio, ISASI president
9:30 Keynote—Robert Sumwalt, NTSB chairman
10:00 Scholarships–Chad Balentine, ISASI secretary
10:15 Scholarship essay—Maria Gregson, The University of Nottingham
10:30 Break
Moderator—Tom Farrier, UAS Working Group
11:00 “Airbus Support to Accident Investigation,” Nicolas Bardou, Airbus
11:30 “The Role of Investigations in Creating and Implementing Safety Nets,” Jim Burin, FSF
12:00 Lunch
Moderator—Alastair Buckingham, NZSASI president
1:00 “Preexisting Fracture in a Helicopter Composite Rotor Blade System,” Torstens Skujins and Joseph Rakow, Exponent
1:30 “EASA’s Annual Review of Safety Recommendations,” Mario Colavita, EASA
2:00 “Colgan 3407: Eight Years Later—Making a Difference in Aviation Safety,” Roger Cox, NTSB (Ret.)
2:30 Break
3:00 “Video Velocity Analysis,” Adam Cybanski, CAFDFS
3:30 “The Passenger Brace Position in Aircraft Accident Investigations,” J. M. Davis, University of Calgary; M. Maurino, ICAO, and J. Yoo, Korea Aviation & Railway Accident Investigation Board
4:00 “AF447 and Germanwings Investigations—What Difference Did They Make?” Arnaud Desjardin, BEA, and Philippe Plantin de Hugues, ICAO
4:30 Scholarship essay—Dylan Grymonpré, Carleton University
4:45 National society meetings
5:45 Bus pickup—Dinner San Diego Air & Space Museum

Wednesday, August 23, 2017
Moderator—Dr. Steve Sparks, General Aviation Working Group
9:00 Panel “Analysis Techniques for Investigating Human Performance,” Dr. Randy Murrow, NASA Ames Research Center; Bill Bramble, NTSB; Fanny Rame, BEA; and Joel Morley, Canada TSB.
10:30 Break
11:00 “Investigations, Recommendations, and Safety Management Systems,” Thomas Farrier, JMA
11:30 “Investigations into ATC Matter,” Curt Fischer, NATCA
12:00 Lunch
Moderator—Ron Schleede, ISASI vice president
1:00 ISASI membership meeting
1:30 “The Effect of ICAO Type Aerodrome Weather Forecasts on Aircraft Operations,” David Wilson, Australian Transport Safety Board
2:00 “Why It Makes a Difference to Report and Investigate UAS Incidents,” Jeff Guzzetti, FAA
2:30 Break
3:00 “Managing a Complex Aircraft Systems Investigation,” Barry Holt, TSB, and David Fisher Bombardier
3:30 “Hazards of Excessive Pilot Flight Control Forces,” Robert Joslin, FAA, ERAU
4:00 “How Data from Internal Safety Investigations and Processes Can Be Used to Assess Performance of Safety Management,” Nektarios Karanikas, Amsterdam University
4:30 Working Group Meetings
Dinner on your own

Thursday, August 24, 2017
Moderator—James Roberts, MASI Working Group
9:00 Keynote—James Viola, FAA, Manager, Office of General Aviation Safety Assurance
9:30 “Understanding Maintenance Caused Accidents,” Pete Kelley, FAA
10:00 Scholarship Essay—Mahmood Masood, University of Central Missouri
10:15 Scholarship Essay—Ross Rozanski, University of Southern California
10:30 Break
11:00 “Crash Scene Hazard Management: An Updated Approach,” Tyler Brooks, CAF, Claire Maxwell, CAF, and Gary Lacoursiere, CAF
11:30 “Learning from Accidents that Are a Consequence of Complex Systems,” Shem Malmquist and John Thomas, MIT
12:00 Lunch
Moderator—Joann Sheehan, Cabin Safety Working Group
1:00 “Lost Opportunities and Thinking Illusions,” Andrew McGregor, Prosalive Ltd.; Capt. Simon Tapp, Air China; and Barry Hughes, Ringaringa Research Lab
1:30 “Lessons Learned from Aviation Accidents, Minor Errors, Major Effects Accidents that Have Helped Shape Aviation Safety,” Daniel Cheney, FAA
2:00 “Integrated Pilots’ Visual Parameters into Flight Data Recorder for Accident Investigation and Prevention,” Thomas Wang Aviation Safety Council, Taiwan; Wen-Chin Li, Cranfield University; and J.H. Lin, National Central University, Taiwan
2:30 Break
3:00 “Fiction Versus Reality: The Impact of Hollywood on Accident Investigations,” Katherine Wilson, NTSB
4:00 “Use of Data Science to Make the Difference in Investigation Analysis Process,” Marion Choudet, ATR, and S. David, BEA
4:30 Seminar conclusion—Barbara Dunn
6:00 Reception and banquet
hours by 10% from Jan. 1, 2009, to Dec. 31, 2018, with no more than one fatal accident per 100,000 flight hours by 2018.

To give you an idea of what the GAJSC has accomplished to date:

- 38 SEs.
- 29 loss of control and four system component failure power plant.
- 20 SEs complete and another 18 SEs are under way.
- LOC—approach and landing—first test and demonstration of the CAST process to the GA community.
- LOC—all other phases of flight—the first test of the CAST process was successful, and a second working group was formed that looked at all LOC in all of the remaining phases of flight.
- System component failure power plant—third working group.
- CFIT was next on the list, but since it had been trending in a downward direction and system component failure-power plant had remained mostly static, the GAJSC decided to work on system component failure power plant next.

“You’ll notice the focus on loss of control accidents. That is because the FAA developed an overview of the 2001–2010 fatal GA accidents (again, thanks to all those in this room who have contributed data) and determined that 40.2% involved a loss of control. As a result, the GAJSC’s Loss of Control Working Group conducted analysis of 90 fatal GA aviation accidents that occurred during approach or landing. The group then proposed a series of SEs that targeted factors such as the need for angle-of-attack systems, improvements in aeronautical decision-making, reliance on automation, the utilization of type clubs to improve training, increased emphasis on stabilized approach and landings, and impairment caused by some medications.

“Finally, our industry partners are an invaluable distribution network for information on a variety of safety topics such as strategies for the avoidance of severe weather or how certain prescription medications can impact pilot performance.

“So as we continue to make improvements in fixed-wing aviation, we must not forget another very important sector of the aviation community—helicopters. Helicopters perform a number of critical missions that among other things save countless lives each year. Still, the missions they perform and the challenging environment in which they operate pose unique challenges to operators and regulators alike.

“The United States Helicopter Safety Team (USHST), formed in 2013 as a regional part of the International Helicopter Safety Team (IHST), completed a comprehensive analysis of U.S. fatal accidents that occurred from 2009 to 2013. The data are now being used to develop specific intervention recommendations to support further accident reductions. From 2016 through 2019, the USHST is focusing its attention on reducing fatal accidents within the U.S. civil helicopter industry. The IHST’s goal set in 2016 is to reduce the fatal accident rate to 0.61 per 100,000 flight hours by 2019 or 20% by 2020. That organization’s fatal accident rate goal for this year is 0.69 accidents per 100,000 flight hours or lower.

“Thanks in no small part to the actions of USHST participants, accident rates for U.S. helicopters declined in 2016 for the third consecutive year. There were 106 accidents in 2016, with an overall accident rate of 3.19 per 100,000 flight hours, compared to 121 accidents and an accident rate of 3.67 per 100,000 accidents in 2015. Seventeen fatal accidents were recorded both years, with a fatal accident rate of 0.51 per 100,000
flight hours in 2016, compared to 0.52 per 100,000 in 2015.

“Looking in terms of percentage, the 2016 overall helicopter accident rate represented a decline of 13% from 2015 and a decline of 27% since 2013, when the USHST was formed. The fatal helicopter accidents also declined 43% in the same period. This continues a downward trend the industry has seen over the last decade. In fact, during that period, the U.S. helicopter accident rate has been cut by over half. So that’s the good news.

“The bad news is that the accident rate for the U.S. civil helicopter industry rose 6.6 in the first six months of 2017 to 3.37 accidents per 100,000 flight hours from a rate of 3.16 for the full year 2016. The fatal accident rate for the first half of 2017 rose more sharply to 0.58 fatal accidents per 100,000 flight hours from a rate of 0.51 for the full year 2016.

“So how do we drive this trend back downward in order to meet our safety goals? The USHST has a number of initiatives under way, many targeting the occurrence categories I previously mentioned. A great deal of effort has been focused on providing training and educational resources for operators.

“This concludes the substantive portion of my presentation; but before I finish, I want to take a moment to thank the many organizations and dedicated professionals outside of the FAA who have contributed so greatly to our collective success. Ours is a difficult business, and we never have the luxury of resting on our laurels. Our partners in safety recognize this, and without their continued commitment, the success stories I referenced here would be far fewer. We all recognize the statistics I presented here represent more than numbers. They are lives saved and tragedies averted. So never for one moment doubt that you in this room are making a difference,” Viola concluded.

The remainder of the day included technical presentations and Kapustin scholars’ essays. Seminar Chair Barbara Dunn finished the day’s session noting that ISASI 2018 will be in Dubai, United Arab Emirates, with the Middle East North Africa Society serving as the host organization.

Awards banquet recognizes exemplary air safety efforts

ISASI’s annual seminar always ends with a celebration and recognition of exemplary efforts on behalf of air safety investigation. The Jerome F. Lederer Award, ISASI’s highest honor, is presented to an individual (or individuals or groups) who has shown lifetime efforts to improve or advance air safety investigation and achieving ISASI objectives.

The International Society of Air Safety Investigators was proud to distinguish Chan, Wing Keong, former chairman of the Air Accident Investigation Board of Singapore with the 2017 Jerome F. Lederer Award (see page 14).

Representatives of new ISASI corporate members were welcomed into the society and received a traditional wall plaque acknowledging their participation. New corporate members included Discovery Air Defense, Delft University of Technology, Faculty of Aerospace Engineering, Virgin Galactic, Korea Air, Abakan Air, Hawaiian Airlines, and INSITU.

Optional programs

On Tuesday, August 22, companions and guests of seminar participants were provided a tour of San Diego’s military history on an amphibious SEAL vehicle that traveled along the San Diego Bay shoreline and then into the water to view the North Island Naval Station. The group then went to Old Town to walk among the historic buildings and enjoy lunch.

On Wednesday, August 23, the companions and guests traveled to the village of La Jolla, just north of downtown San Diego, to stroll through the boutiques, enjoy a leisurely lunch, and explore the sights and sounds of the village.

Participants of a post-seminar optional tour on Friday, August 25, traveled to the world-famous San Diego Zoo, where many took an initial tour bus ride or an overhead tram to get an overall introduction to all of the exhibits before walking to specific enclosures to find their favorite animals. A buffet lunch was served in a private rotunda dining room.
Investigations—Do They Really Make a Difference?

By Dylan Grymonpré, 2017 Kapustin Scholarship Recipient

Aircraft accident investigations are critical processes that provide findings, recommendations, and statistics that can enhance safety in an industry that thrives on the rewards of assuming ever-greater risk. Although investigations have been extremely valuable in reducing the accident rate over the past century, much of the vigor of the old days has been lost. The recent investigations of the past few decades have not been able to instigate the changes required to significantly improve aviation safety; the declining occurrence rate has plateaued. Investigations are no longer making a significant difference.

So what needs to change? Air accident investigators work hard, really hard; and in multiple instances they place their societal duties ahead of their families. This effort and dedication deserve showcasing and public exhibition—not for fame or glory, but in order to stimulate greater action toward improving aviation safety. Episodes of “Air Crash Investigation” [1] or “Mayday” [1] are simply not enough. There is an urgent requirement for accident investigators and their overarching safety boards to develop methods that better invoke government and industry action. This “need to act” can be instigated through five key transformations in the investigation process: enhanced communication of existing statistics, standardization of statistics across borders, emphasizing the need to implement recommendations, quantifying the costs of an accident, and marketing prevention.

Enhanced communication of existing statistics

Statistics are important; in many circumstances they are relied upon as the only objective evidence to enforce an argument for change. Unfortunately, the current method of communicating accident statistics is ineffective in producing change. The statistics do not invoke the urgent requirement to immediately address an issue; instead, the statistics do the opposite and encourage passivism. For example, a common method used to present accident statistics is a graph, similar to Figure 1, accompanied by a statement such as “Over the past decade, there has been a significant downward trend in accident rates.” This does not portray an issue; this actually sounds good. Why would any action be required? The problem seems to be solving itself.

Instead, investigators should communicate statistics in a manner that highlights an issue. The previous data could equally be presented using a more holistic perspective, such as the graph in Figure 2 accompanied by the statement “While history has indicated a significant reduction in accident rates, the progress within the past two decades has plateaued despite vast improvements in the...
knowledge and technology available to defend against such events.” This viewpoint highlights an actual problem and even identifies the presence of a solution. When presented in a more compelling context, statistics provide much stronger evidence for taking the actions required to improve aviation safety.

Standardization of statistics across borders

When analyzing and addressing safety, a common question is how does our performance compare with others? [3] If one nation has a low occurrence rate, it is likely that other nations (and their industry organizations) will be interested in examining this high performance so they can emulate best practices and reduce their own occurrence rate. This cannot take place if each nation is unable to effectively compare occurrence statistics (admitted as an issue by the Transportation Safety Board of Canada [3]). To facilitate the process of comparative growth, investigators should strive to establish an international standard for documenting and reporting aviation occurrence statistics. This would not impose restrictions on the statistics that nations can collect and report, rather it would simply establish a requirement to report a set of statistics that can be commonly understood across all borders. As an additional benefit, developing an international standard would expand the population of data available for statistical examination, presenting opportunities to improve accuracy and explore new analytical territory.

Emphasizing the need to implement recommendations

A key outcome of any accident investigation is the recommendations addressed to various parties. Nonetheless, these recommendations are virtually useless if not acted upon. To encourage action, investigators must take all steps possible to emphasize the importance of effective and efficient recommendation implementation. To address this, one common method is to develop a “Watchlist” [4] or “Most Wanted List” [5] and then lobby both industry and the government accordingly. However, “watching” or “wanting” does not create a sense of urgency to act. Instead, urgency to act can be stimulated through the development of a public alarm mechanism. This “alarm” would sound based on the varying implementation status of recommendations. Examples of such mechanisms include the “Doomsday Clock” [6] and the Defence Readiness Condition of the United States Army (aka “DEFCON”) [7]. These easy-to-understand and media-hyped mechanisms are effective in alerting the public about important information, such as the probability of an impending aviation occurrence. The outcome of such heightened public awareness is an increased pressure on industry and government to take action (eventually downgrading or resetting the alarm). As an experienced and objective third-party, investigators and their associated safety boards are in an excellent and informed state to regulate and implement such alarm mechanisms.

Quantifying the costs of an accident

One of the main reasons that available technological- and knowledge-based solutions are not implemented by industry, or mandated by government, is due to an inadequate understanding of the financial costs associated with an accident. It is quite possible that multiple solutions would be implemented if there was greater awareness of these costs. To assist in this effort, investigators and their safety boards should take steps to document and publicize objective information regarding the costs associated with an accident. Such data can include the costs to the state (including emergency medical services, search and rescue, public relations, official visits to the crash site, accident investigation, and cleanup).

Figure 2. Accident rate 1959 to 2001 [2].
as well as the costs to the operator (including capital loss, increased operating expenses, occurrence expenses, and lost revenue).

Estimates of these costs can be obtained through examining historical data, requesting accounting information from accident operators, and by using reasonable approximations. Once analyzed, the financial data can be categorized according to aircraft type and presented alongside accident statistics. If government and industry understand that there is a multimillion dollar bill associated with accidents, it will be much more difficult to argue that safety-based changes are “too costly” to implement. The cost of an accident is always more than the cost of its prevention.

Marketing prevention
One of the saddest findings of an accident is the inadequate presence of countermeasures that are currently available with modern knowledge and technology. This should not continue to be the case. To arouse action, a new statistic should be developed that clearly classifies whether or not an occurrence was reasonably preventable. This should be identified as an objective conclusion, within each accident report, accompanied by a suitable evidence-based explanation. This is not an occasion to assign blame, but rather a blunt and forceful opportunity to instigate action and achieve the “sole objective of [an] investigation” [8]: prevention.

Conclusion
The docile nature of implementing the changes recommended from recent accident investigations has been rumbled. Five key transformations are suggested to give the investigation process back its strength (i.e., the ability to inspire significant improvements in aviation safety):

- Enhanced communication of existing statistics advocates to the public that there are problems with aviation safety that compel immediate action.
- Standardization of statistics across borders facilitates the comparison of safety records and the emulation of best practices while also allowing for increased statistical accuracy and the potential innovation of new analytics.
- Emphasizing the need to implement recommendations, accomplished through “ alarming” the public of an impending aviation occurrence, pressures industry and government to effectively and urgently address safety issues.
- Quantifying the costs of an accident enables an improved understanding of the cost savings associated with proactive occurrence prevention.
- Marketing prevention (i.e. objectively reporting evidenced based conclusions regarding the preventability of accidents) reinstalls the vigour required to instigate action and reintroduce a significant decline in the accident rate.

So investigations, do they really make a difference? Well, it is up to investigators to decide.

References


The International Society of Air Safety Investigators bestowed Chan, Wing Keong of the Air Accident Investigation Board (AAIB) of Singapore with the Jerome F. Lederer Award, the Society’s highest honor for air safety investigation achievement. The award presentation came during the banquet that culminated the very successful ISASI 2017 seminar held in San Diego, California.

ISASI President Frank Del Gandio told banquet participants that Chan held positions of increasing importance within the Singapore Civil Aviation Authority (CAA), including chief inspector of accidents from 1992 to 1998. The AAIB of Singapore became an independent agency within the Ministry of Transport—separate from the CAA—in 2002, and Chan was the AAIB director until 2016. Under his leadership, the AAIB has grown to become one of the leading investigation agencies in the world.

The Singapore AAIB became an ISASI corporate member in 2003, and despite being new and having few personnel, the agency successfully hosted the annual ISASI seminar in 2007 under Chan’s leadership. Following that seminar, Chan and the AAIB approached other Asian ISASI members to become charter members of the Asian Society of Air Safety Investigators (AsiaSASI), which was formed in 2009. As part of Chan’s international initiatives, the AAIB began a series of triannual events beginning in 2010 that are now known as the International Accident Investigation Forum. The AAIB hosted subsequent forums in 2013 and 2016. With the support of the Ministry of Transport, the AAIB, under Chan’s leadership, has promoted international networking, investigation training, and the sharing of knowledge and experience.

Chan served as the first vice chairman of the International Civil Aviation Organization’s (ICAO) Accident and Incident Investigation Divisional Meeting in 2008. He currently chairs the Asia Pacific Accident Investigation Group (APAC-AIG) within the ICAO APAC Regional Office. He has been an instructor at the Singapore Aviation Academy’s accident investigation courses for 15 years and has supported the courses by assigning additional instructors from the Singapore AAIB.

At the award presentation, Del Gandio noted, "During his close to 30 years in aviation safety, including 14 years as head of
Chan has been a strong visionary and supporter of international cooperation for air safety investigation. Chan has developed the Singapore AAIB into a world-class and high-tech professional accident investigation agency that is respected by colleagues all over the world,” said Del Gandio.

Observing that Chan has always preferred to work quietly in the background, Del Gandio concluded, "his achievements, encouragements, and support of others have been tremendous and outstanding on an international scale. ISASI is proud to have such a truly internationally spirited, worldwide recognized accident investigation expert among our membership. And Chan, Wing Keong is a most deserving recipient of the Society’s Jerome F. Lederer Award.”

Accepting the Lederer Award, Chan thanked those present at the banquet. He said, “This is a great honor for me. I am still awed by the news that I was to receive this prestigious award. I never imagined I would ever be associated with the famous name of Jerome Lederer. I regret I did not meet Mr. Lederer personally, but I am glad I at least saw him in person. That was in 2003, during the ISASI annual seminar in Washington, D.C., six months before Mr. Lederer passed away at the age of 101.”

Chan noted that he sounded like he was copying what ISASI International Councilor Caj Frostell said when he received his Lederer Award in 2003. "I still wish to say that this award is not only an honor for me, it is also an honor for my country Singapore, a small country with 5.8 million people,” he said. "Caj said at the time that Finland was a small country," Chan acknowledged, adding that many who attended the ISASI annual seminar in Singapore in 2007 know that Singapore is an even smaller country.

But even though Singapore is small, Chan stated, "We knew that accident and incident investigation was an important safety feedback link in the system of air transport operations. So we established the Air Accident Investigation Bureau of Singapore, or AAIB, which became the Transport Safety Investigation Bureau on Aug. 1, 2016, to include marine safety investigation.

"We have been fortunate to have the resources to allow us to expand our setup properly. But we knew right from the beginning that when we do need to undertake an investigation following a significant or major accident, we will not be doing the job alone. We need to work together with safety investigation experts in other countries, be they from the government investigation agencies or from the aviation or aeronautical industry. And many of the experts are members of ISASI, and many of them are here tonight. Therefore, we made the decision to join ISASI as a corporate member almost immediately after the AAIB was formed. And that was why I was in Washington in 2003 to receive the corporate membership plaque from Frank, ISASI’s president, and that was where I saw Mr. Lederer.

"I regard this award as also an encouragement to our AsiaSASI members and to our fellow investigator colleagues in the Asia Pacific region. Many of them are now striving to implement the new Standard 3.2 in ICAO’s Annex 13, which, as you know, requires countries to set up an accident investigation authority that is independent from the aviation authorities and other entities that could interfere with the conduct or
objectivity of an investigation. But they are often handicapped in this endeavor because of resource limitations, especially in investigation specialist manpower. In my capacity as the chair of the Asia Pacific Accident Investigation Group, I always tell them that ISASI is the only international grouping of air safety investigation professionals and that investigation assistance may be sought from ISASI members.”

Chan said, “I have been encouraging them to join ISASI. The network that they build up through ISASI could prove invaluable when they are looking for external expertise to help them in an investigation.” He noted that he was “confident that our fellow members will be forthcoming with their assistance. The Asia Pacific Accident Investigation Group has included the ISASI annual seminar in the group’s annual activity plan. I told my counterparts in the region that in addition to being a networking platform, the ISASI seminar is an occasion for them to keep abreast of developments in the technical aspect of investigation, because of the excellent sharing of experiences and knowledge that takes place at the seminar.

“Mr. Lederer embraced the sharing of experiences and knowledge,” Chan observed. “I understand one of the programs that Mr. Lederer developed that continues today is the Flight Safety Foundation’s annual International Air Safety Summit. Frank mentioned the International Accident Investigation (IAI) Forum in Singapore. This is a triennial program that brings together the world’s government investigation officials and experts. This IAI Forum program focuses less on the technical aspect and more on the sharing of experiences and knowledge in matters relating to the organization, infrastructure, and management of an accident investigation authority. I hope the forum program will emulate the International Air Safety Summits, and I hope to still see the forum running when and if I live to be 101 years old.”

Chan concluded, “I have benefited tremendously from the experiences and knowledge of my many ISASI friends and experts in this very special field of accident investigation. I thank you all for all this, and for your friendship and advice. On this note, I wish to thank ISASI and the Award Committee for giving me the honor of receiving the Lederer Award and to thank all of you for your encouragement during the last few days.”

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2017—Chan, Wing Keong

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On Nov. 6, 2014, Jazz Aviation Flight 8481 departed Calgary International Airport for Grande Prairie, Alta., Canada, with 71 passengers and four crewmembers. During takeoff, the number 3 tire failed. The flight diverted to Edmonton International Airport due to strong crosswinds at Calgary. Once at Edmonton, the crew was to change aircraft and continue to Grande Prairie. In subsequent flight crew conversations with maintenance personnel, it was recommended that the flight crew perform a “soft” landing due to the tire failure. No emergency was declared, nor was aircraft rescue and firefighting equipment requested. However, the equipment did roll out to meet the aircraft during the landing. Preparations were then made for a normal landing, as there was no reason or cause for concern to land with one flat tire. However, 2.3 seconds after initial touchdown, at 2030 mountain standard time, and at 2,435 feet from the threshold, the right main landing gear (MLG) collapsed. Upon contact with the ground, all of the right-side propeller blades were sheared, and one blade piece penetrated the right side of the cabin wall. The aircraft came to rest about 3,200 feet later, off the right (east) edge of the runway surface. Thankfully there were only a few minor injuries.

This paper discusses the many challenges that were experienced during the investigation, and the solutions that were put in place. The investigation had participants from the operator, Bombardier Aerospace Commercial Division, UTC Aerospace Systems, Transport Canada, and the Transportation Safety Board of Canada (TSBC).

The aircraft was recovered to a hangar the next morning for testing and initial inspection. In the meantime, the TSBC asked the aircraft manufacturer, Bombardier, to assist in the initial investigative phase. A senior air safety investigator was dispatched along with a Bombardier in-service engineer. Additionally, the operator (Air Canada Jazz) dispatched an investigator as did the landing gear.
manufacturer (UTAS) United Technology Aeronautical Systems (Goodrich Landing Gear). The initial investigation did not reveal any substantial findings, and it was evident from the first few days of the investigation that there appeared to be nothing wrong with the landing gear system as it operated normally on jacks. And all components appeared to be within all design specifications.

After approximately one week, it was decided to convene a second team, which included the manager, Bombardier Air Safety Investigations Office. Four additional Bombardier engineering representatives also attended—an electrical engineering specialist, a hydraulic specialist, a landing gear specialist, and a Q400 engineering specialist. Also assisting was the operator, UTAS, and Transport Canada.

During the second team visit, all associated wiring components were tested in detail, and the proximity sensor electronic unit (PSEU) was checked for all faults recorded. Numerous components where removed from the aircraft for additional testing, which included an electrical connector (P23) located in the fuselage to the wing attachment area that supplies 28 volts direct current to the landing gear solenoid sequence valve (SSV). In addition, the main landing gear cockpit selector handle assembly, the PSEU, and the landing gear assembly—including the landing gear drag brace, landing gear main strut, and main landing gear yoke—and the horizontal stabilizer brace, including the proximity sensors and the hydraulic unlock actuator, were tested.

Data from the aircraft’s digital flight data recorder (DFDR) were analyzed at the TSBC engineering laboratory. The focus of the analysis was on the takeoff roll, when the tire failed, and on the subsequent collapse of the right MLG on landing. The DFDR had recorded triaxial accelerations, which provided information on the aircraft vibrations when the tire failed. The landing gear data consisted of a number of discrete signals that indicated the status of the up-locks and down-locks for the nose landing gear and MLGs, the landing gear handle position, and the weight-on-wheels (WOW) state. A momentary MLG WOW was recorded at 118 knots, with the recorded vertical load factor at approximately +1.05 g’s. Approximately 1.5 seconds later, full MLG WOW recorded a vertical load factor of +1.07 g’s. This is an indication of very light touchdown forces and a soft landing, which we found would somewhat come into play later.

Investigators initially travelled to the wheel manufacturer’s facility to determine the level of imbalance on the wheel. The number 3 wheel and tire assembly had an imbalance of 1,248 ounce-inches, or 6.5 pounds, 12 inches from the wheel center. The team then met later at the landing gear manufacturer’s facility to conduct full measurements of the main components that may have allowed the collapse to occur. At this time, there was a lot of second-guessing by some to suggest the impossibility of the failure of various components.

There was still an ongoing resistance when some engineers were stuck on the idea that this could not happen, when in fact it did. A meeting was convened in January 2015 at the aircraft manufacturer’s facility located in Toronto, Ont., Canada. This is when a determined effort had to be put forth by the investigator-in-change (IIC) and the manager of Bombardier Commercial Air Safety Investigations. Both pushed the fact that the failure had occurred and that the root cause had to be found. This was the purpose of the TSBC investigation, and the sole reason for all of the team to be there. The IIC had to manage all of the various individuals’ issues and ensure that the goal of the investigation was accomplished. The Bombardier manager pushed hard on his organization’s management to ensure that this goal was understood and to have full cooperation of the Bombardier investigation team members. Some had participated in the design acceptance during the airframe planning stages. This also required the buy in of all team members from UTC Aerospace, which had designed and manufactured the landing gear. Upper management of UTC then stepped forward with the full use of its personnel and facility to conduct the testing. An investigation plan had to be developed that encompassed all parts of the landing gear system and its control.

The schedule was moving forward at a reasonable pace, and we believed testing could begin in summer 2015. However, on March 8, 2015, things changed.

Bombardier Air Safety Investigations Office received a report that a SpiceJet Q400 experienced a runway excursion after landing in darkness and rainy conditions. The aircraft was reported to have hit a runway light and departed the left side of the runway, and the nose landing gear and left MLG collapsed. The aircraft was substantially damaged. There were no injuries to crew or passengers. The location of the accident was Hubli, India. We knew that this was the first flight into Hubli Airport after the facility had undergone improvements to the airport and runway, including a new runway lighting system.

Bombardier dispatched a field ser-
vice representative (FSR) to assist in the aircraft recovery. Bombardier Air Safety Investigations contacted the FSR and requested detailed photos of the damaged aircraft and specifically the landing gear. The aircraft was off the left side of the runway and was substantially damaged but accessible.

Upon receiving the photos, it was immediately noted that the left MLG aft doors were open. All other doors were closed and in their proper position for a normal landing. This was not expected. The manager immediately forwarded this information to the TSBC.

This second event suddenly put extreme pressure on the investigation team. Internal to the manufacturer, the team faced additional pressures from upper management, aircraft operators, and the regulator. The team needed to answer why, after 15 years of production and 12 million flight hours, two unexplained landing gear collapses had occurred after otherwise “normal” landings. Having a blown tire and hitting a lighting light are not unforeseen events. Aircraft experience these events in normal service life so why now?

Following an again-revised plan involved a full examination of the horizontal stabilizer brace for dimensional correctness as per the design. It was found to be correct and within acceptable wear limits. It was set aside to test some of the smaller components and to allow time to design a test rig for the brace.

The SSV was bench checked and found to be within design parameters. A test rig was then designed to test its function during dynamic vibrations. This was a full two days of testing at increasing vibration levels and at decreasing voltages to ascertain when the SSV would release hydraulic pressure to the aircraft lock actuator. This type of testing had not been done during development. The component was first tested for function, put through vibration sequences, and then function tested again. Throughout all this, there were discussions and speculation about the ultimate outcome as it related to the effect(s) on the landing gear collapse.

There had to be a concerted effort by the lead investigators to keep the end result in mind and on target.

Next the horizontal stabilizer brace underwent the same sequence of testing to see if vibration could induce a loss of the locked state. As the vibration frequencies and amplitude approached what was seen on the accident aircraft, some of the investigation group could see a noticeable vibration. Many members could not see or admit to this happening. Most of these were from various design groups. Once again, the difficulties in leading a complex investigation with many differing priorities came to life. The lead investigators had some convincing to do to move forward with full-scale landing gear tests.

Bombardier and UTAS then agreed to develop a full-scale landing gear test rig to examine the behavior of the landing gear, the SSV, the horizontal stabilizer brace, and the PSEU during concurrent vibrating and dynamic conditions. This process and testing were also not certification requirements and had never been done before. Exploration of possible investigative techniques and allowances to simulate the actual landing conditions were examined at length. Testing models of all the involved components were developed and agreed to by all attached to this part of the investigation. The imbalance and resulting vibration that had occurred had to be factored in and test run protocols established. A full landing gear test rig had to be designed and agreed to by all the principal team members. This was a challenge; however, everyone pulled together and channeled their efforts into the one goal.

The MLG assembly test rig included:
- a modified A380 test cell structure.
- a hydraulic system that enabled independent pressurization of MLG retract and unlock actuators.
- proximity sensors inductance acquisition card.
- two- and three-axis accelerometers.
- a data acquisition system.
- high-speed and standard cameras and video systems.
- a spin-up machine.

Testing was designed to be slow and progressive. No one was certain how the test rig would perform. After the initial tests with a very light imbalance weight, most team members were shocked regarding the amount of twisting and movement of the gear. Concerns were raised about the possibility of catastrophic breakage of some of the components. The engineers went back to their modelling programs based on the initial runs.

There were four more test sessions conducted at UTC in Oakville, Ont., Canada, during summer 2015. Each was three to four days in duration. There were a couple of times when testing had to be stopped due to the breakage of components in the test structure or the need to modify some parts of the test rig. The breakage was thought to occur due to the stiffness of the rig versus being mounted in a nacelle “on wing,” which would have been less rigid but impossible to do. One such time, due to the rigidity of the structure,
the upper (forward) drag brace fixture fractured.

After the upper drag brace fixture was repaired, the team repeated the same test with hydraulic system pressure (3,000 psi) on the unlock actuator. High-speed cameras and videos were all in place, and the test began. This test revealed that when normal hydraulic pressure was applied at the unlock actuator, the stabilizer brace would remain down and locked.

There were more than 70 runs conducted. In the end, and as it turned out, the gear unlocked under the same conditions (no hydraulic pressure on the unlock actuator) as were encountered during the landing phase of the accident. There was a great amount of jubilation when we found that we had accurately replicated the accident conditions and achieved the same result.

The team determined that to accommodate for a highly imbalanced tire or a single-impulse event hydraulic pressure would need to remain on the unlock actuator at all times. This could be solved by a simple modification to the current PSEU logic.

Early PSEUs could be modified by a software upgrade, and new aircraft starting at production serial number 4554 would be equipped with a new -602 PSEU. Airworthiness Directive CF-2016-31 was introduced, and PSEUs were modified.

The TSBC investigation encompassed more than just the landing gear and imbalance testing that had taken place. Operations personnel verified that the flight crew had done everything correctly. The failure mode of the tire itself had to be ascertained. The operator’s maintenance records and cabin crew training were reviewed. Cabin egress was looked into and reported on. Edmonton International Airport emergency response programs were looked at and the handling of the passengers post-egress. This required bringing together an investigation team with various and diverse backgrounds, such as electrical, avionics, design and manufacture, tire design and failure modes, maintenance, and operations. All of these links were from different organizations and departments within those organizations.

The team had explored and accomplished many possible and different investigative techniques, including

- involvement of many different engineers from numerous manufacturers, and
- a never-before-done vibration analysis and testing methodology.

Technical review: Results and dissemination to the aviation world. In spite of the complexities and time required, the investigation resulted in worldwide changes to the Q400 fleet landing gear. The investigation really did make a difference.
By Roger Cox, U.S. National Transportation Safety Board Operational Factors Group Chairman During the Colgan Flight 3407 Investigation

(Adapted with permission from the author's technical paper entitled Making a Difference in Aviation Safety: Colgan Flight 3407 Eight Years Later presented during ISASI 2017, Aug. 22–24, 2017, in San Diego, California. The theme for ISASI 2017 was “Investigations—Do They Really Make a Difference?” The full presentation can be found on the ISASI website at www.isasi.org in the Library tab under Technical Presentations.—Editor)

Colgan Flight 3407, a Bombardier DHC-8-400 (Q400), crashed near Buffalo, New York, on Feb. 12, 2009. The accident attracted wide attention and became one of the landmark investigations done in recent years. As a result of the accident, the U.S. Congress took the unusual step of enacting a new aviation safety law in 2010, building on and adding to the U.S. National Transportation Safety Board’s (NTSB) recommendations from its investment. Nine years after the accident, more than half the NTSB’s recommendations are still open, and some of the actions mandated by the law remain incomplete. Significant safety issues addressed by the NTSB in its report included flight crew monitoring failures, pilot professionalism, fatigue, remedial training, pilot training records, airspace selection procedures, stall training, Federal Aviation Administration (FAA) oversight, flight operational quality-assurance programs, use of personal portable electronic devices (PEDs) on the flight deck, the FAA’s use of safety alerts for operators to transmit safety-critical information, and weather information provided to pilots. Congress further addressed regional airline oversight and disclosure, Safety Management Systems (SMSs), screening and qualification of pilots, pilot records, and new requirements for ATP certification.

This paper summarizes the progress made toward improved aviation safety as a result of that investigation and discusses actions still needed. The paper contrasts pilot certification, records and selection issues, pilot training issues, safety management issues, and FAA oversight and design standards issues before and after the investigation and attempts to realistically assess how much difference the investigation really made.

Introduction

The reduction in the U.S. commercial airline accident rate and the increasing flow of operational data available to airlines and the FAA have led some observers to declare that actual accident investigations are of less and less value to air safety. For example, in a 2016 press release about the Commercial Air Safety Team (CAST), the FAA declared in part: “CAST has evolved and the group is moving beyond the ‘historic’ approach of examining past accident data to a proactive approach that focuses on detecting risk and implementing mitigation strategies before accidents or serious incidents occur.”

The implication was that data are replacing accident investigation analysis and recommendations as a rationale for changing policy and regulation. While there is no doubt that Aviation Safety Action Programs (ASAP), Flight Operational Quality Assurance (FOQA) programs, and the Aviation Safety Information Analysis and Sharing (ASIAS) program are providing an enormous amount of operational data that hold great potential for safety improvements, investigations are still a vital part of understanding and preventing accidents. Given sufficient emphasis and resources, accident investigators can find out not only what happened, but can delve deeply into why it happened. Safety deficiencies that have been dormant for many years come to light. Accident investigations can then provide a catalyst for action that masses of operational data cannot.

The Colgan 3407 accident investigation was one of those catalyst investigations. Company officials were often defensive, news media coverage was relentless, and there was strong pressure from within the board to complete the report in one year or less. Nonetheless, the investigative team was able to build on the work of previous investigations and probe deeply into the reasons why the accident occurred. The emergent facts during the investigation and the power of the final report energized the public, gained the attention of Congress, and drove the FAA and the industry to make substantive changes to practices they had resisted changing for years.

Only a few months after the NTSB issued its final report, the U.S. Congress acted, enacting PL 111-216, “The Airline Safety and Federal Aviation Administration Extension Act of 2010,” on Aug. 1, 2010. This intervention by Congress into air safety issues was fairly rare. Normally aviation regulations are written by the FAA under authority granted to it by Congress. The passage of laws directing creation of specific regulations usually only happens following one or more major accidents. For example, the FAA was created in 1958 following several midair collisions, one of which took place between two airliners over the U.S. Grand Canyon. Several other air safety actions were taken by Congress following accidents. A Department of Defense Commercial Airlift Review Board was created by Congress after a military charter plane crash in Gander, Newfoundland, in 1985. The Aviation Disaster Family Assistance Act was passed in 1996 following the US Air Flight 427 accident in Pittsburgh, Pennsylvania, and its provisions were added to foreign carriers following the Korean Airlines accident in Guam in 1997.

Many of the Colgan accident victims were from the Buffalo, New York, area. The Buffalo News provided extensive coverage of the accident investigation, and soon an ad hoc group of victims’ families formed. Calling themselves “Families of Continental 3407,” they became a strong and effective lobbying group supporting changes to air safety rules. The NTSB’s public hearing, held only three months after the accident, drew a full house in the agency’s boardroom, and the testimony of the airline’s officials under questioning from investigators and board members drew surprise and anger from public observers.
Table 1. Regional Airline Accidents 2003–2008 (Scheduled Passenger Flights)

<table>
<thead>
<tr>
<th>Year</th>
<th>Carrier</th>
<th>Date</th>
<th>Flight fatalities</th>
<th>Ground fatalities</th>
<th>Crew a factor</th>
<th>Regional code share</th>
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Even with the imposition of new law on the FAA and the aviation industry, progress in some areas has been slow. Rulemaking was required by many of the law’s provisions, and rulemaking is an inherently time-consuming process. Advisory groups and commenters can bring progress almost to a halt. Nonetheless, almost all the provisions of the airline safety act have been completed. The phasing in of congressionally mandated changes will go on for another two years. Eight of the NTSB’s new and reiterated recommendations have been implemented; five have been closed unacceptable or no longer applicable, and 15 remain open. Of the remaining open recommendations, most are getting close to resolution.

**Background**

Colgan Air was a regional airline. It contracted with major airlines, including United and Continental, to carry those airlines’ passengers from hub airports to smaller cities. By 2009, the regional airline industry had evolved from flying light reciprocating-engine-powered airplanes to flying jet and turboprop aircraft at sizes and speeds almost comparable to mainline airlines. In that year, regional airlines carried almost one quarter of the commercial passengers in the U.S. even though most of them were not known to the public under their own name, but under a mainline “express” name. The practice of selling passengers a ticket for a flight on a mainline carrier while providing part of the travel on a regional airline, known as code sharing, was not widely understood by the public. Regional airlines typically hired entry-level pilots, paid them relatively low wages, and expected to see many of them leave for better-paying jobs within a few years.

Colgan was certified under 14 CFR Part 121, the same rules that pertain to major airlines. Investigators approached the Colgan accident with the same objectivity they employed with any investigation. However, the safety standards of regional airlines compared with major airlines was a subject of interest to the investigators. All but two of these accident flights involved companies with code-sharing agreements with larger airlines. Flight crew actions, sometimes involving unprofessional behavior, were a factor in every accident but one. These accidents are shown in Table 1.

In the six years before the Colgan accident, U.S. scheduled passenger airlines experienced the lowest number of fatalities in their history, with the exception of one segment—regional airlines. Regional passenger airlines had 10 major accidents during that period, six of which involved fatalities. All but two of these accident flights involved companies with code-sharing agreements with larger airlines. Flight crew actions, sometimes involving unprofessional behavior, were a factor in every accident but one. These accidents are shown in Table 1.

In addition, a cargo turboprop flight, Empire 8284, crashed just two weeks before the Colgan accident, and it was another crew-involved accident. The Colgan captain’s extensive record of certification and training failures, which was revealed early in the investigation, and the casual atmosphere in the cockpit during the Colgan accident, which was revealed when the docket was opened, added to concerns of a negative trend in pilot performance standards and professional conduct at regional airlines.

At the time of the Colgan accident, many aspects of airline regulation had not changed substantively in decades. New airline first officers were only required to have an FAA commercial certificate, which could be obtained when a pilot had 250 flight hours or in some cases less. The airline transport pilot (ATP) certificate could be obtained without any airline training. Airline pilot training records varied widely in quality and were rapidly being replaced by electronic systems that eliminated many details. Safety programs also varied widely in quality, and the data collection programs that enabled better analysis were optional. Pilot flight and duty-time rules designed to ensure pilots were properly rested were arbitrary and largely unchanged since before the advent of the jet age. Airline stall training was based on the idea that practicing recovery from actual stalls was unnecessary. Flight simulators lacked the ability to simulate full stalls. Pilots at regional airlines were confused about when an ice contaminated tail stall would occur; airlines provided videos on tail stall but no actual training.

Airline pilot professionalism was generally taken for granted. The FAA and the industry assumed captains would be highly observant of rules and procedures. Crew compliance with the ban on use of PEDs and with the sterile cockpit rule were assumed by the FAA. Proper monitoring of a flight’s progress by the pilot not flying was a skill the FAA thought was understood and done by all pilots. Pilots who travelled long distances from home to begin their flights were assumed to ensure they would be fit and ready for flight.

Colgan Air and the regional airline industry bore the brunt of scrutiny during the Colgan investigation. Colgan itself was merged into its corporate parent airline and disappeared. However, regional airlines as a whole continued to grow, and most of the recommendations and laws from the investigation pertained not just to regional airlines but to the entire airline industry.
Actions and results
The NTSB’s final report, which was adopted on Feb. 2, 2010, was an omnibus report. The analysis addressed 13 main issues and 24 sub-issues. Recommendations from previous reports that had not been acted on by the FAA were revived and reconsidered in the light of the facts of the Colgan accident. The NTSB recommendations, which are not binding, were scrutinized carefully by congressional staff as they drafted the new law. The new airline safety act mandated the main ideas of some of the NTSB recommendations and added major changes to rules on pilot certification, pilot hiring, pilot training, pilot records, pilot fatigue, airline safety programs, and FAA oversight. The resulting regulations were a product of new and old NTSB recommendations, FAA-sponsored Aviation Rulemaking Committees (ARCs), FAA internal analysis, and the provisions of the new law.

The following is a summary of the major safety changes made as a direct or indirect result of the Colgan investigation, including remaining implementation concerns. A detailed examination of every change made as a result of the Colgan investigation is beyond the scope of this report. Further information about the recommendations can be found on the NTSB website, www.ntsb.gov. The current status of the NTSB recommendations is shown in Table 2 and the provisions of the airline safety act in Table 3 (see page 24). (The first letter of the recommendation status indicates if the recommendation is open or closed; the second letter indicates acceptable or unacceptable; the remaining letters are qualifiers, such as “response,” “action,” or “alternate action.”)

Pilot certification, records, and selection
ATP certification and airline hiring
The airline safety act required that both the pilot-in-command (PIC) and second-in-command (SIC) at Part 121 airlines have an ATP certificate and multiengine flight experience. The act also mandated that ATP applicants have 1,500 flight hours and required the FAA to write more-stringent rules for the ATP certification training process. The NTSB’s report provided details of the captain’s certification difficulties but did not recommend changes to airline hiring standards or FAA pilot certification. The report did reiterate an open 2005 recommendation urging all operators to check a pilot’s flight check failures prior to employment. Sections 216 and 217 of the airline safety act addressed these subjects. It mandated extensive

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<td>A-10-15</td>
<td>Professionalism guidance using media</td>
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<td>Document pilot training records</td>
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<td>Use training records for remediation</td>
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Reiterated

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<td>A-07-13</td>
<td>Teach monitoring skills</td>
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Table 2. Colgan Recommendations Status as of March 2017
preemployment screening for pilots by airlines and, in section 203, created a new pilot records database to facilitate this screening.

The FAA published the “Pilot Certification and Qualification Requirements for Air Carrier Operations” final rule in July 2013. The rule required ATP applicants to complete a certification training program (CTP), standards for which were set by the FAA. All CTP programs are now reviewed by FAA headquarters. So far, 75 colleges have been approved to provide training for the restricted ATP certificate, and 21 organizations, including 10 airlines and 11 simulator-equipped training schools, have been approved to complete the CTP. Minimum standards for CTP instructors were also established, including at least two years of experience as a Part 121 airline pilot.

The new pilot certification rules were the result of far more than just the events of the Colgan accident. The FAA took into consideration recommendations of the First Officer Qualification ARC, analysis of 58 pilot-involved accidents, and 23 previous NTSB recommendations, including two from the Colgan report. However, the circumstances of the Colgan accident, including the captain's unusually numerous certification failures and the lack of adequate screening, training, and supervision of pilots at the airline, were a significant driver of the new rules. Investigators traced both of the accident pilots' performance histories back to their previous employers, and even further back to their original training, and showed how they developed over time. This helped the FAA and Congress understand how the training and certification process needed to be strengthened.

The most controversial element of the new airline regulations was the “1,500-hour rule.” Historically, major airlines have hired pilots with flight experience far in excess of 1,500 hours, even though the minimum FAA requirement for an SIC was only a commercial certificate (250 hours or less). Earning low pay working in marginal, even hazardous, conditions was a rite of passage for most airline pilots. Typically, pilots who did not serve in the military gained experience flying at air charter companies, commuter airlines, supplemental airlines, or served as flight instructors. As regional airlines have grown into a major segment of the airline business, their low pay and limited career opportunities have made it more difficult for them to recruit entry-level pilots. Their perceived need is to go back to hiring pilots with 400 to 600 hours, as Colgan did. Their trade association, the Regional Airline Association, has lobbied Congress to relax the 1,500-hour rule, so far without success.

The airline industry will need to find a way to recruit and develop adequate numbers of new pilots to serve in the future without sacrificing the standards now in effect.

**Pilot records**

There were four recommendations in the NTSB report about pilot records. They addressed the need for better accuracy and completeness of records, and the need to use these improved records for remedial training and pilot hiring. Investigators were able to obtain detailed training records from the accident captain's previous employers that Colgan had never obtained, and these records clearly showed he had major proficiency issues before he ever was hired at Colgan. Investigators also showed Colgan retained only minimal records of the captain's training events even though he either failed or barely passed his first three company checkrides. The NTSB report showed records had to be better kept and better used, and Congress agreed.

Airline, has lobbied Congress to relax the 1,500-hour rule, so far without success. The airline industry will need to find a way to recruit and develop adequate numbers of new pilots to serve in the future without sacrificing the standards now in effect.

The NTSB did not call for the creation of a new FAA pilot records database (PRD), but Section 203 of the airline safety act did. To date, the database is not fully operational. The Department of Transportation Office of Inspector General told Congress in 2016 that “a robust, centralized database for pilot records remains years away.” While a PRD notice of proposed rulemaking (NPRM) has not yet been published, the FAA did establish a three-phase PRD deployment plan in December 2016. In the current phase-one period, the FAA provides airline access to pilot information so far available while maintaining the existing requirements of the older Pilot Records Improvement Act (PRIA) rule.

The difficulty the FAA has had in implementing the PRD reflects in part conflicts within the industry. Pilots and airlines, concerned about privacy and liability, want to minimize the data maintained in the database. Safety advocates, including the NTSB, want to see more robust data. A major problem caused by the FAA’s failure to move more quickly is that large amounts of historical data may be lost as time passes. Other safety improvements,

**Table 3. Status of Provisions of PL 111-216 as of March 2017**

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including training, remediation, and pilot hiring rules and practices, depend on the quality of the PRD. The FAA will need to move more quickly to establish the PRD.

**Training**

**Airline stall and stickpusher training**

A significant change to airline training recommended by the NTSB was the requirement for airline pilots to do periodic training on full aerodynamic stall recognition and recovery. Three recommendations in the NTSB report addressed aerodynamic stalls. One was a simple procedural change that was quickly adopted by Q400 operators. Two others were more challenging. One called for a significant change in the way air carrier pilots train to recognize and recover from aerodynamic stalls. Another called for stickpusher simulator training for pilots flying stickpusher-equipped airplanes. Section 208 of the airline safety act made this training mandatory. Both the stall and stickpusher training required significant improvements in simulator fidelity.

The FAA published the "Qualification, Service, and Use of Crewmembers and Aircraft Dispatchers" final rule in November 2013. This included new 14 CFR Part 121.423, which will require the stall training recommended by the NTSB. An advisory circular (AC) on stall and stickpusher training was published by the FAA in August 2012. 14 CFR Part 121 carriers have until March 2019 to comply. Part 135 and 91K operators are not directly affected by these rules.

The main impetus for these changes was the finding by the NTSB that the Colgan captain reacted improperly to the stall warning, took actions that induced an actual stall, and then failed to properly react to the stickpusher activation. The report tied the FAA's long-standing stall training policy to the captain's actions. The FAA had required pilots to maintain altitude during "approach to stall" recoveries during training. The captain appeared to place a priority on maintaining altitude instead of recovering from the stall. The new stall training requires airline pilots to perform recoveries from a full stall, rather than an approach to stall, which has been the standard since airline simulators were first introduced. Maintaining altitude is no longer a requirement. The full stall training will be instructor guided, not graded.

The Colgan crew was not alone among airline crews in experiencing an aerodynamic stall. There were at least four large turbojet accidents resulting from stalls between 1996 and 2008. Turboprop airliners experienced even more stall accidents during this period. Many of the turboprop events took place in icing conditions. These accidents are shown in Table 4 (see page 27).

Certain airlines, in particular Alaska Airlines, have been very proactive in getting the necessary improvements made to their simulators and in developing the new training curriculum. Other organizations, notably the European Aviation Safety Agency and Airbus, have expressed reservations about doing this training, in part because of the belief that fly-by-wire airplanes with envelope protection obviate the need for the training. However, the Air France Flight 447 and AirAsia Flight 8501 accidents show that even these airplanes are vulnerable to aerodynamic stalls.

As airline flight simulators are remodeled and recertified and airlines begin training pilots in stall recognition and recovery, it will be essential for training department managers and instructors to fully understand the airplane's post-stall behavior and the nuances of proper recovery techniques. The pilot community will need to understand and accept the need for these changes to their training.

**Tail stall training**

One Colgan recommendation addressed the need for operators to identify any airplanes in their fleet susceptible to icing contamination tail stall (ICTS) and to provide appropriate training. Equally importantly, it insisted that any reference to tail stall procedures be removed by operators if their airplanes were not susceptible to ICTS. The impetus for this recommendation was the fact that the Colgan crew had seen a video about ICTS and may have been influenced by it during the accident stall even though the manufacturer told the NTSB during the investigation the airplane was not susceptible to ICTS.

The FAA compiled a list of all airplanes used in 14 CFR Part 121 and broke the list into three categories. These were airplanes not susceptible to ICTS; airplanes with risk mitigated by design changes, operating limitations, and/or operating procedures; and airplanes not evaluated. The FAA published a notice to its inspectors on the subject in June 2014 directing principal operations inspectors (POIs) to see that operators complied with the guidance. Notably, POIs were directed to verify NASA's "Tailplane Icing" video was not part of the operators training if its airplanes were not susceptible to ICTS. Pilots working at air carriers should no longer be getting conflicting or unclear guidance about ICTS for the airplanes they fly. However, that list has not been made public. One of the problems identified in the NTSB's Colgan investigation was widespread confusion among pilots about ICTS. There have been multiple articles published recently in aviation magazines about tail stall, possibly adding to confusion about when a tail stall recovery is needed. FAA publication of the ICTS aircraft list would help to minimize confusion on the subject for all pilots.

**Monitoring training**

There were two recommendations on monitoring in the Colgan report, one of which was a reiteration of an earlier recommendation. The NTSB wanted to see FAA POIs at every airline review their airline’s procedures to ensure monitoring was being taught. The FAA did not agree to do that, but it published a final rule on qualification, service, and use of crewmembers and air traffic controllers in November 2013 that mandated air carrier pilot monitoring procedures. In January 2017, the FAA also did a major rewrite of its AC 120-71 on standard operating procedures (SOPs) and pilot monitoring duties. These actions met the spirit, if not necessarily the letter, of the recommendations.

Monitoring is an activity that takes place in cockpits by pilots. Mandates and training are valuable means to improve monitoring, but the ultimate responsibility lies with pilots. The FAA's final rule mandating monitoring does not go into effect until 2019, but there is no reason for pilots to wait. All pilots of multicrew aircraft should be improving their monitoring skills today.

**Remedial training**

The NTSB published a recommendation on remedial training in 2005, and it was reiterated in the Colgan report. A new recommendation addressed the need to use improved pilot records in conjunction with the remedial training program.

Colgan had no remedial training program to work with pilots who had training problems. The investigation discovered the company had not taken steps to correct the accident captain's known training deficiencies and had no effective system in place to do so. Remedial training was mandated by Congress in Section 208 of the airline safety act. 14 CFR 121.415, published in November 2013, requires this training.

The major rewrite of airline training that includes remedial training does not become effective until March 2019. Air carriers should be working now to ensure their training programs are robust and ready for implementation by that time. Improved pilot records—part of a new
pilot records database—should assist remediation when the database is fully in place.

**Professional development training**

The NTSB report addressed professionalism and leadership in three recommendations, asking the FAA to create a new AC, mandate training, and produce a multimedia presentation on the subject. In addition, the NTSB held a public forum on pilot and controller professionalism in May 2010 as a follow-up to the accident report. Section 206 of the airline safety act required that airlines establish mentoring programs, professional development committees, and additional leadership training. The law specifically addressed compliance with the existing sterile cockpit rule.

The NTSB’s analysis of the accident crew’s conversation concluded the crew was not following that rule and was distracted before the stall warning occurred. The investigation also found the accident first officer used her cellphone during predeparture taxi, a violation of 14 CFR Part 121.306. The NTSB asked the FAA to mandate use of checklists to ensure PEDs were not used during critical phases of flight, but the FAA did not agree.

The FAA issued a NPRM in October 2016 on pilot professional development. The new rule will add familiarization flights and leadership and mentoring training to air carrier training and will add pilot professional development committees to airline organizations. When the FAA-proposed rule is implemented, it should meet or exceed the NTSB recommendations on professionalism for operations under 14 CFR Part 121. The new pilot professional development rules will be in addition to previous rules and programs put forth to influence or direct pilot behavior, including the sterile cockpit rule, crew resource management (CRM) training, and programs such as pilot union professional standards committees.

The underlying purpose of the NTSB recommendations and public forum on professionalism was to reach every pilot with the message that disciplined, attentive, cooperative behavior is the standard pilots should aspire to. There are still too many accidents and incidents in which pilots do not meet these standards. It will take greater determination by crewmembers to achieve this end. Strong advocacy from institutional leaders will help.

**Safety management**

**Fatigue and commuter policies**

The Colgan report included a recommendation that specifically addressed fatigue caused by pilot commuting and placed responsibility for a solution on both pilots and air carriers. NTSB investigators surveyed the Colgan pilots and learned that almost 70% commuted into the base for their flights. The accident crew had done so and had poor rest as a result.

Section 212 of the airline safety act mandated that the FAA would issue new regulations on pilot flight and duty time based on the best available scientific information. These regulations were to include the effects of commuting. The FAA issued a final rule, “Flightcrew Member Duty and Rest Requirements,” in January 2012, establishing the new 14 CFR Part 117 governing fatigue management for passenger airline pilots. The rule became effective in December 2014. The new regulation included a provision, 117.5, “Fitness for Duty,” that placed responsibility for fatigue on both the operator and the crewmember. The FAA also mandated a fatigue risk-management system and issued an AC on the subject in 2013.

Although the FAA’s actions were a quantum leap forward for fatigue management, the NTSB thought there were two flaws. Part 117 only pertained to Part 121 passenger airlines, because the air cargo industry obtained what was known as a “carve out,” allowing them to remain under the existing Part 121 rules. In addition, airline responsibilities regarding pilot commuting were not addressed in specific detail.

Pilot commuting is probably still just as prevalent today as it was in 2009. The industry has to force companies to change their behavior, or else the FAA will have to change their rulemaking to force pilots to commute less. Airlines need to be encouraged to adopt FOQA programs, but it is the FAA’s responsibility to mandate these programs by law.

**FOQA and SMS**

There were three recommendations addressing the implementation of FOQA programs in the Colgan report. The NTSB wanted FOQA to be mandated for all commercial operators, subject to obtaining the necessary statutory or regulatory authority to fully protect the data. The board also recommended use of all available data sources—in part a reference to cockpit voice recorder data. The board had previously recommended SMSs for all operators. FOQA programs are typically a major part of an SMS program. Section 215 of the airline safety act mandated that Part 121 airlines adopt SMSs and consider including FOQA within these SMS programs.

The International Civil Aviation Organization (ICAO) mandates countries to require flight data analysis programs (FDAP) as part of an SMS. FOQA is an FDAP-type program. It is FAA policy to conform to ICAO standards and recommended practices to the maximum extent practicable.

FOQA and SMS

At the time of the accident, regional airlines did not have FOQA programs, and none were required. In June 2009, the FAA administrator encouraged airlines to set up FOQA programs; and by January 2010, 11 regional airlines had begun to do so. By February 2013, the FAA reported that 39 airlines (about half of Part 121 airlines) had set up FOQA programs. In January 2015, the FAA published a final rule requiring Part 121 airlines to have SMS programs. However, the agency did not require FOQA. Congress did not provide the statutory support the board wanted the FAA to obtain for mandatory FOQA. The FAA also felt FOQA was cost prohibitive or impractical for some smaller airlines and older airplanes.

As audio and video recording technology continues to improve, even flight schools and corporate operators are adopting flight data monitoring systems. As the cost of systems drops and becomes more miniaturized, FOQA-type programs become more and more feasible for all. While voluntary compliance is still the rule for airline FOQA programs in the U.S., the Colgan investigation showed that the public has a stake in airline safety, too. The public should know which operators have robust FOQA programs and which do not.
dation called for new simulator fidelity requirements that would support the new stall recovery training. The FAA put those requirements into effect in March 2016 with the publication of a new rule, “Flight Simulation Training Device Qualification Standards for Extended Envelope and Adverse Weather Event Training Tasks.” The new simulator standards also required the ability to simulate upset other than stalls, icing conditions, gusty crosswinds during takeoff and landing, and bounced landings. These requirements stemmed from earlier accident recommendations. Airlines have until March 2019 to put these standards into effect.

Simulator manufacturers depend on airplane flight test data to model simulator flight path and flight control response. In the new rule, the FAA allows for aerodynamic stall models to be developed and validated using engineering and analytical methods, and requires the post-stall airplane behavior to be type-specific and sufficiently accurate to be able to conduct the necessary training. Subject-matter experts, typically type-experienced test pilots, will validate the accuracy of the modified simulators performances.

For many years, the lack of simulator accuracy prevented the aviation industry from moving forward in stall training. Improper training using old, inaccurate simulator motion models contributed to several accidents, and the FAA had concerns about “negative training.” The Colgan accident report caused a breakthrough in the resistance to changing simulators to allow the needed stall training.

According to an official at Bihrle Applied Research, a stall simulation provider, only about five out of 100 flight simulators in the U.S. contain the data necessary for full stall simulation at the present time. In the two years that remain before the FAA requirements go into effect, airlines will have to make investments in simulators and new training curricula. Further delays in proper stall training could result in another stall-related accident.

Low-speed cautions
There were two recommendations in the Colgan report on the need for improved low-speed warnings. Investigators found the accident airplane, while properly certificated, had neither a low-speed amber band on the airspeed indicator nor a low-speed aural cue, and that both of these could have alerted the accident crew to a pending stall before the stall warning activated. The FAA changed the design standard for the amber band in January 2011 but so far has not taken action on the aural cue.

Surveillance
Colgan was experiencing rapid growth at the time of the accident. The accident Q400 airplane type had been in service at the airline for only one year, and the company’s pilots were relatively new to the airplane. Investigators found the FAA inspectors assigned to oversee the airplane were also new to the airplane and had a heavy workload. Even though there were Q400-qualified FAA inspectors elsewhere, they were not assigned to help. One NTSB recommendation asked the FAA to better address workload and experience discrepancies of this type, and the FAA agreed, issuing amended policy and procedure in fall 2014.

Congress agreed with the need to ensure better surveillance of airlines. It mandated the creation of an Air Carrier Task Force (Section 204 of the airline safety act), a review of FAA inspector staffing and workload (Section 205), and an annual inspection of regional airlines (Section 211). The FAA completed these actions between 2011 and 2012.

The FAA has long been aware of the safety challenges of new airplane introductions, rapid growth, and industrial issues such as strikes at airlines. The FAA will need to provide close scrutiny to airlines based on these considerations.

Safety and operational communications
The Colgan report included three recommendations pertaining to the FAA’s dissemination of weather information to...
Under the auspices of the Singapore Aviation Academy (SAA), an Aircraft Accident Investigation Techniques Course was held in November 2017 for safety personnel and officials of Royal Brunei Airlines (RBA). The instructors were David Lim and Bryan Siow of the Transport Safety Investigation Bureau of Singapore and ISASI International Councillor Caj Frostell. The program included an ISASI activity presentation. Twenty RBA safety officials participated. The RBA leads were Zairil Aswande Zainal, manager of emergency response, and Deogenes Oriel, manager of safety. The RBA has been successfully expanding its flight operations network using Airbus A320s and new Boeing 787s.

**ISASI Discussed with JIAAC in Argentina**

In early September 2017, ISASI International Councillor Caj Frostell and Chan, Wing Keong, an advisor to the Singapore Transport Safety Investigation Bureau, chairman of the International Civil Aviation Organization’s Asia Pacific Accident Investigation Group, and secretary of AsiaSASI, met with the Argentine Civil Aviation Accident Investigation Board (JIAAC) represented by Pamela Suarez, president; Juan Mangiameli, national director of management and development; and Daniel Barafani, national director of investigations. The reactivation of the ISASI Latin American Society was discussed as well as close cooperation and upcoming events. A few weeks earlier, Chan received ISASI’s Jerome F. Lederer Award at the ISASI seminar in San Diego, California.

The Singapore Aviation Academy provided an Aircraft Accident Investigation Techniques Course for the Latin American Civil Aviation Commission. JIAAC hosted the course in its facilities in Buenos Aires. The course was attended by 50 participants from Argentina, Bolivia, El Salvador, Guatemala, Nicaragua, Mexico, and Panama. The PowerPoint slides were translated into Spanish, and simultaneous interpretation to/from Spanish was provided. As part of the program, Chan and Frostell gave an ISASI PowerPoint presentation and urged support for reactivating the ISASI Latin American Society.

**ISASI Met with Safety Officials of Royal Brunei Airlines**

Under the auspices of the Singapore Aviation Academy (SAA), an Aircraft Accident Investigation Techniques Course was held in Brunei in November 2017 for safety personnel and officials of Royal Brunei Airlines (RBA). The instructors were David Lim and Bryan Siow of the Transport Safety Investigation Bureau of Singapore and ISASI International Councillor Caj Frostell. The program included an ISASI activity presentation. Twenty RBA safety officials participated. The RBA leads were Zairil Aswande Zainal, manager of emergency response, and Deogenes Oriel, manager of safety. The RBA has been successfully expanding its flight operations network using Airbus A320s and new Boeing 787s.

**CALL FOR PRESENTATIONS FOR ISASI 2018 SEMINAR**

The annual ISASI seminar will take place at the Intercontinental Hotel in Festival City in Dubai, the United Arab Emirates, Oct. 29–Nov. 1, 2018. This includes the tutorials on Monday, October 29.

The theme of the seminar is “The Future of Aircraft Accident Investigation.” Presentation topics to support the theme may include:

- Future of aircraft data capture and retrieval and protection of safety information.
- Development of new investigation techniques for aircraft, helicopter, and UAS accidents.
- Potential future developments in underwater wreckage recovery.
- Investigation of aerospace vehicle accidents.
- Future evolution of human factors investigation methods.
- Recent accidents/incidents of particular interest.
- Future investigator selection criteria and training needs.
- Implications for investigation of future developments in aircraft, engine, and avionics systems design, including manufacture and automation.
- Future evolution of family assistance.

Presentations must be in English and should be 25 minutes long. There will be an additional five minutes for questions at the end of each presentation.

Important dates:

- March 15, 2018—Last date for receipt of abstracts.
- May 1, 2018—Presenters informed of acceptance.
- May 15, 2018—The 2018 seminar technical program will be published.
- July 15, 2018—Last date for receipt of completed papers and presentations.

Important information:

The government of Dubai requires the following information for each presenter:

- Clear color scanned passport copy—first three pages (more than 500kb ≤ 1 MB).
- Passport size photograph—solid color background and not more than six-months old (more than 500kb ≤ 1 Mb).
- Brief biography. This information will be required before the July 15, 2018, cutoff date.

ISASI looks forward to welcoming participants to the annual seminar and tutorials in Dubai.
MENASASI Held Workshop and Seminar

The Middle East/North Africa Society (MENASASI) held its fifth annual seminar and workshop at the Elaf Jeddah Hotel in Jeddah in Saudi Arabia on Nov. 7–9, 2017. The seminar was hosted by the Aviation Investigation Bureau of Saudi Arabia.

The workshop’s (tutorial) first session was “Investigation Management” presented by David Miller. Sidney Hawkins presented the second session entitled “Accident Site Safety.” The workshops were attended by 85 members.

The two-day seminar was opened by Abdulelah Felemban, director of the Aviation Investigation Bureau. The welcome address was given by H.E. Abdulhakim Al Tamini, president of the General Authority of Civil Aviation of Saudi Arabia. A follow-up opening address was given by Khaled Al Raisi, director general of the Air Accident Investigation Sector of the United Arab Emirates and the acting president of MENASASI. Frank Del Gandio, president of ISASI, also gave a welcome address.

There were 145 attendees, including seven state investigation authorities, five civil aviation authorities, and six airlines.

Fifteen presentations covered search and recovery, operations, investigations, investigation tools, and safety recommendations. The presentations were well received and generated questions and discussion from the audience.

MENASASI became active on Aug. 22, 2013, and now has 46 members and nine corporate members. In addition, MENASASI will host the 49th annual ISASI seminar at the Intercontinental Hotel in Dubai Oct. 29–Nov. 1, 2018.

ISASI’s U.S. Southeast Regional Chapter (SERC) is planning its 2018 meeting for July 27–28, 2018, in Savannah, Georgia, at the Savannah Marriott Riverfront reports Chapter Secretary/Treasurer Alicia Storey. In addition to technical presentations during meeting hours, activities will include a tour of Gulfstream and other social events on Friday and Saturday evenings.

MARC Plans Annual Gathering in May

ISASI’s Mid-Atlantic Regional Chapter (MARC) will hold its annual meeting on May 3, 2018, from 6:00–9:30 p.m. at the Crowne Plaza Dulles Airport in Herndon, Virginia. Ron Schleede, ISASI vice president and MARC president, urges attendees to make hotel and meeting reservations early as space is limited for both. The hotel reservations deadline is April 12, and meeting/dinner reservations requested after April 20 will be granted on a space-available basis. Guest speaker will be Robert Sumwalt, U.S. National Transportation Safety Board chairman and ISASI member.

Dates for ANZSASI 2018 Seminar Set

The 2018 ANZSASI Australasian seminar will be held in Melbourne, Australia, at the Novotel Hotel, Collins Street, from Friday to Sunday June 1–3, 2018. The theme for this gathering is “Improving Safety.”

Australian Society President Rick Sellers notes that the joint Australia and New Zealand ANZSASI seminar was a great success last year and that the ASASI executive team has been working hard behind the scenes to ensure that the ANZSASI 2018 seminar is both informative and enjoyable for all participants. “We’re looking forward to a really great seminar in June,” says Sellers. “Being such a diverse group (across Australia and New Zealand) provides us a unique opportunity to get together and discuss new techniques, processes, and ideas.

“With this in mind,” Sellers notes, “I strongly encourage our members to consider submitting a paper for the upcoming seminar,” adding, “the Novotel Collins Street is ideally suited as it’s centrally located and adjacent to public transport. The seminar will follow our usual format with a welcome reception on Friday evening, two full days of presentations on Saturday and Sunday, and a dinner on Saturday night.”
pilots and one recommendation about the FAA’s use of nonbinding notices such as safety alert for operators (SAFOs) for safety-critical information. Most of the weather recommendations have been completed. The SAFO recommendation has not been closed. Investigators found the FAA had issued a SAFO addressing remedial training programs in response to an NTSB recommendation, but neither the Colgan POI nor Colgan officials were aware of it. This lack of awareness of SAFOs had been commonly noted by the NTSB in other investigations. The FAA had no process in place to ensure and document that the safety-critical information in much of its communications to airlines was actually read, accepted, and acknowledged.

Safety information is of no value if no one reads it. Establishing a feedback loop between the FAA and airlines would seem to be a simple task. However, it remains a problem not yet resolved.

Code sharing
Colgan 3407 was a Continental Airlines code-share flight. During the investigation, many observers, including families of the victims and journalists, expressed surprise that the accident airplane, painted in Continental’s colors and logo, was not actually a Continental flight. Investigators spoke with Continental officials and found that the company disclaimed any responsibility for the safe operation of Colgan Air. In contrast, Colgan staff told investigators Continental exercised significant control over their company, including setting of schedules and making decisions about cancellations. The accident report did not discuss code sharing, but the NTSB held a public forum on the subject in September 2010.

In Section 210 of the airline safety act, Congress required airlines to disclose the actual air carrier to be flown on airline tickets, and in Section 214 required annual FAA inspections of regional airlines.

Code sharing is not a recent phenomenon. The NTSB made reference to “code-sharing arrangements” in a 1994 safety study on commuter airline safety. That study helped to persuade the FAA in 1995 to place most commuter airlines into the same Part 121 regulatory regime as major airlines; the FAA called it creating “one level of safety.” The Colgan investigation showed that, even though it was certified under Part 121, the airline was clearly not operating at the same level of safety as major airlines.

Conclusions
Before the Colgan investigation, some airlines, particularly regional airlines, met only very low minimum standards for pilot hiring, pilot training, pilot records, and pilot professional standards. Those standards have been raised. Before the Colgan investigation, all airlines conducted “maintain altitude” stall training. The change to realistic stall training is now under way. Before the Colgan investigation, thousands of turboprop pilots were confused about tail stalls. This has changed. Airline pilot monitoring training, remedial training, and professional development training were minimal or nonexistent. These are now required. Standards for pilot fatigue management, SMSs, flight simulators, and low-speed cautions have improved.

Not every safety issue raised by the investigation has been fully resolved. Pilot records improvements have been very slow to develop. Most flight simulators still need to be modified for use in the new stall training. Voluntary compliance with rules and good judgment by pilots are still needed, as is the adoption of safety programs like FOQA by airlines. However, standards have been raised.

For today’s accident investigators, it should be clear that good investigations really do matter. Explaining not just what happened, but why it happened leads pilots, airlines, and the FAA to rethink the way they operate. Making recommendations is part of an investigation, and being willing to challenge the status quo is important. Even when recommendations miss their mark or fail to be accepted, they provide a reasoned argument for change. The findings and recommendations from many previous investigations influenced the changes made after the Colgan accident long after their reports were completed. For example, the air carrier stall-related accident investigations shown in Table 4 (see page 27) did not change stall training, but they provided strong support to the arguments that succeeded in making the change. Today’s investigators should recognize that every investigation is important, either now or later.

Finally, maintaining a reputation for fairness, integrity, thoroughness, and attention to detail as an investigative agency pays off in many ways. The Colgan investigation was not easy. Parties were fearful of liability, emotions ran strong, and there was strong pressure to produce a report within one year. Even so, the public, the victims’ families, and Congress placed faith in the NTSB’s process, findings, and recommendations, and this faith was what enabled change. •
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January-March 2018 ISASI Forum • 31
**WHO'S WHO: CRANFIELD UNIVERSITY**

Cranfield, an exclusively postgraduate university located on its own airport 50 miles north of London, is a global leader for education and transformational research in technology and management. Cranfield recently marked the 40th anniversary of its first aircraft accident investigation course, which was first run in conjunction with the Air Accidents Investigation Branch, with a two-day conference for accident investigators. Many of the university’s former students returned for the conference to hear the latest developments in the field of accident investigation.

Since 1977, Cranfield University has established itself as a center of excellence for aircraft accident investigation. Over the last 40 years, more than 1,000 investigators have been trained by the university using a unique combination of academic instruction, practical simulations, and the experience of investigation professionals.

In 2004, Cranfield’s Safety and Accident Investigation Center widened its scope to work with investigators from the rail and marine sectors through its Fundamentals of Accident Investigation Course and in 2005 launched the world’s first MSC program for air accident investigators. In 2017, it ran its first course for health-care safety investigators.

Today, the center consists of 12 academic staff with a focus that has widened to include all aspects of multimodal safety and accident investigation, including safety management, flight data, human factors, unmanned aerial systems, and airworthiness.

Professor Graham Braithwaite, director of Transport Systems at Cranfield University, noted, “It was fantastic to see so many familiar faces returning to Cranfield, and where for many their careers in accident investigation took off. As well as a chance to reminisce, it was also an opportunity to hear from industry leaders and to find about how technology such as laser site scanning, computer modelling, and drones are changing accident investigation.”

Cranfield’s distinctive expertise is in its deep understanding of technology and management and how these work together to benefit the world. The university’s education portfolio is recognized for its relevance to business and industry. Cranfield is the largest UK provider of master’s-level graduates in engineering and offers a flagship MBA, extensive world-class customized executive education, and professional development programs. The university works to inform government policy and leads the way in producing cutting-edge technologies and products in partnership with industry.

The research and consultancy carried out for industry, government, and business provide Cranfield students with a real-world learning environment, allowing them to develop as professionals and then transfer their knowledge to the global economy. This has always been the “Cranfield way,” but it has never been more important than in today’s world. New developments include a £35m joint aerospace integration research center with Airbus and Rolls-Royce and a £9m autonomous vehicle test environment. Cranfield recently was awarded £65m to develop a digital aviation research and technology center with partners including Thales, Raytheon, Saab, Monarch Aircraft Engineering, and Avellant. Recent safety research has included advanced HUMS systems for helicopters, triggered transmission of flight data, the development of safety culture tools, the human performance aspect of remote ATC towers, and a review of safety assurance for a major regulator.

The university’s work in aviation safety has been recognized at the highest level. Cranfield was awarded a Queen’s Anniversary Prize in 2011, the highest award a UK academic institution can receive, for research and training in aircraft accident investigation. In 2013, the university received the Richard Teller Crane Founders Award from the Flight Safety Foundation for sustained corporate leadership in aviation safety.

The Safety and Accident Investigation Center offers a wide range of courses for aviation safety professionals and accident investigators, ranging from its flagship six-week Aircraft Accident Investigation Course, which runs each January and May, to five-day modules in specialist skills such as advanced interviewing techniques, legal skills for accident investigators and material failures for accident investigation. The center also conducts tailored courses around the world for state investigation agencies, operators, and manufacturers.

The university’s intensely practical focus is supported by the people delivering our teaching and research. Cranfield works with both academics and industrialists, and its team has firsthand experience in managing airline and military aircraft operations, accident investigation, crashworthiness, design and certification, and students get the benefit of their extensive real-world knowledge. ♦

(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)