“JERRY LEDERER WAS LIKE A FATHER TO TOBY, WHO HAS SPENT A LIFETIME WORKING SELFLESSLY TO ENHANCE AVIATION SAFETY AND HAS DONE SO WITH THE UTMOST PROFESSIONALISM AND INTEGRITY. THERE IS NO ONE MORE DESERVING OF THIS PRESTIGIOUS JERRY LEDERER AWARD THAN TOBY.”

—ISASI PRESIDENT FRANK DEL GANDIO
FEATURES

5 ISASI 2016: Air Accident Investigators Examine Links to Safety Networks
By J. Gary DiNunno, ISASI—Delegates to ISASI 2016 meet in Reykjavik, Iceland, on October 18–20 for the Society’s annual international accident investigation and prevention conference to listen to technical presentations and participate in discussions with the overall theme of “Every Link Is Important.”

11 Advancing Safety Through Multiple Means
By Kristi Dunks, Ph.D., Office of Aviation Safety, U.S. NTSB—After an aircraft accident occurs, safety issues are identified and safety recommendations are issued to prevent future similar events. As investigations evolve, so, too, must methods for addressing safety issues.

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By Esperison Martinez, Editor—The Society’s highest honor goes to one of its most exceptional investigators

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22 Crash Scene Hazard Management: An Updated Approach
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ABOUT THE COVER

ISASI President Frank Del Gandio, left, presents the prestigious ISASI Jerome F. Lederer Award to Eugene “Toby” Carroll, the 2016 recipient (see page 14) before a banquet audience of more than 250 ISASI delegates and guests.

Photo: Esperison Martinez
Welcome to ISASI 2016 and to Iceland, a fabulous country to visit. First, some basic geography: Iceland is an island about the size of Indiana, and its population of 333,000 people is about that of a modest city in many countries. It’s home to multiple glaciers and multiple active volcanoes; the former is owed to its latitude, the latter to its location on the fault line between the North American and Eurasian tectonic plates. You actually rode over the edges of those two plates on your trip from the airport.

Today we are here to discuss and learn about aviation safety, investigative techniques, and the challenges and lessons from some recent or ongoing investigations. The good news is that year 2015 and thus far in 2016 mark the safest era in air transport history. Measured by fatal accidents in revenue airline operations, and “accident” is a key word here, aviation safety has reached a remarkable level. Only 10 fatal accidents occurred worldwide in revenue airline service since the AirAsia crash in Indonesia in December 2014. The 10 fatal crashes in two years, including four cargo flights, accounted for 278 onboard fatalities and 36 ground fatalities, while the world’s airlines moved nearly 8 billion people, including crew. In those same two years, all the OECD (the Organization for Economic Cooperation and Development) countries, plus the large economies of Asia, accounted for just one fatal accident, a cargo operation in a CRJ with two fatalities.

In 1996, airlines had 90 hull losses in revenue passenger and cargo service, with 40 fatal accidents and more than 2,000 fatalities, while the world’s airlines were moving less than half as many people. Yet, those numbers already were a major improvement over preceding years. In short, comparing these past two years to where we were 20 years ago really suggests that the system is safer than ever.

However, measuring only fatal accidents can understated the overall risk to passengers, as nonfatal hull losses can easily lead to multiple fatalities. An example is the recent Emirates crash in Dubai in which all 300 people exited a burnt-out Boeing 777-300. Add to this significant impact while landing short of runways plus substantial numbers of runway excursions.

There is also the challenge of an increase in political-criminal acts against civil aviation, such as the bombing of a Russian A321 over the Sinai, killing 224; the near-disastrous bombing in an A321 near Mogadishu in which the person carrying the bomb was ejected at 12,000 feet but everyone else survived; and the shoot down of MH17 in July 2014. Then, add suicide-murder with Germanwings in March 2015 (150 fatalities) and perhaps the disappearance of MH370 in March 2014—though that remains to be seen. And let’s not forget fatal attacks on airports.

Although the system is incredibly safe compared to any time in the past, we’re still a long way from zero risk, which highlights the significance of this year’s seminar theme: “Every Link Is Important.” This theme is perfect when we try to understand most of our recent accidents, risks that continue to challenge us, and newly emerging risks. Let’s start with existing risk. Of the 10 fatal accidents and the multiple nonfatal approach-and-landing accidents or high-speed runway excursions, only the EgyptAir case may include a scenario that we haven’t seen hundreds of times before.

For example, both fatal passenger CFIT accidents involved flying VFR in the clouds in mountainous terrain, with one crew having ignored multiple GPWS alerts. Another passenger accident involved a third attempt to land in severe winds. Fatal cargo accidents appear to have included loss of control on approach, a takeoff accident involving excessive weight, and several with aircraft that were clearly not airworthy, operating in countries with marginal or no functioning regulators. In addition, nonfatal approach-and-landing accidents and high-speed runway excursions involved the usual suspects of losing control or stalling on approach, landing long, landing in tailwinds, failure to go around, etc. Factors also include poor preflight planning, poor inflight decision-making, a lack of airport and weather infrastructure in some regions, basic weaknesses among operators, a lack of adequate procedures or crews who fail to follow procedures, a lack of flying skills, multiple ground fatalities with housing just off runway ends, and inadequate regulatory oversight or simply the absence of oversight.

We have made huge progress, but such old and familiar problems continue to demand attention, especially in certain regions, and they reinforce the idea that “Every Link Is Important.” We must continue to focus on and monitor a wide range of known safety precursors, but we also must manage new challenges. I believe two of the biggest challenges will be the growing shortage of qualified pilots and mechanics and the continued integration of unmanned aircraft systems (UAS) into civil aviation.

As the industry continues its explosive growth, labor shortages may be the biggest long-term problem. These shortages can be attributed to pay struc-
As you are my editors, I mark this message with this symbol because after having been privileged to serve as editor of ISASI Forum for the past 80 issues, a total of 20 years, this is the final issue for which I will serve you in that capacity. In that time, I have had the pleasure of working with hundreds of authors whose articles have brought enlightenment and knowledge of the accident investigator profession to ISASI members, to the international air safety community, and to the public.

Forum as it exists today is a product of former ISASI President Capt. Richard Stone’s foresight. In 1996, he envisioned that a change in the Society’s communications program would much better serve the membership in both performance and financial matters. The then-existing print program consisted of Forum as a quarterly technical newsletter, a bimonthly newsletter featuring council and chapter news, and published conference proceedings all distributed by mail to members on an individual basis.

ISASI’s International Council approved the conversion of the Society’s two newsletters geared solely at member interests to a feature-article-styled magazine aimed at members and the external public. The start-up of the new publication required the introduction of electronic publishing and new production and planning concepts.

In the January–March 1997 issue—the first edition of the newly conceived ISASI Forum—President Stone wrote, “With this issue of ISASI Forum, your International Council begins an important change in the communications program of our Society. Changes include a new look, new content, new format, and staff changes as well.”

Along with the issue’s launch, I pledged that Forum would strive to achieve the following: Promote air safety by the exchange of information. Help to broaden professional relationships. Increase the prestige, standing, and influence of air safety investigators. Project a favorable image of the Society.

To do this, I set the following editorial objectives: Be an authoritative source of material. Achieve credibility and respectability. Reflect the Society’s advocacy, positions, and values. Be reader friendly to internal and external audiences. Maintain budget constraints. And, most importantly, establish ISASI Forum as the voice of aviation accident investigators.

Has the pledge made so many years ago been met? One reader of an early edition wrote, “...excellent balance between news, organization affairs, future events and plans, and analysis of past accidents and hazards that continue within the industry.”

But only you, the Forum’s current readers, can judge if your magazine has attained its objectives. I certainly hope you have enjoyed its contents as much as I have enjoyed guiding its publication over the years. I thank the authors for the liberties they afforded me in editing their material and the same thanks to every reader who leafed through Forum pages and found the articles sufficiently informative to continue returning to its pages.

I’m sure that Gary DiNunno, your new editor, will continue to provide you with a highly respected, well designed, and very readable ISASI Forum. ◆

Sincerely,

Esperson
(Marty)
Martinez
More than 250 ISASI delegates, 47 companions, and 18 guests—representing 43 countries—descended upon Reykjavik, Iceland, Oct. 18–20, 2016, for the Society’s 47th annual international accident investigation and prevention conference to listen to technical presentations and participate in discussions with the overall theme of “Every Link Is Important.”

As delegates arrived and picked up their conference packets and name badges, discussions about their air safety investigations and other work-related matters commenced and continued throughout the week’s events. ISASI’s annual conference is a great networking opportunity and a chance for younger air safety investigators to meet and learn from more experienced peers.

Tutorial Workshops
On Monday, October 17, prior to the official opening of ISASI 2016, two all-day tutorials were offered—one looking at “Military Aviation Accident Investigations” and another with a theme of “Extending the Networks.” These tutorials were separate from the seminar program and required an additional entrance fee. There were 113 participants who attended the two tutorials.

Jim Roberts, Boeing ASI/ASE, and Wing Cdr. Neil Bishop, UK Defense AIB, led the military tutorial discussions. Various topics were examined.

- Ronald Smits, Dutch Safety Board, discussed accident investigation in the middle of a state border conflict—MH17. Issues included working in a hostile and dangerous environment, not being allowed access to the crash site, and the need to adjust the investigation plan to meet changing requirements.
- Agne Widholm, Statens haverikommission (SHK) Sweden, covered 10 years of experience in Swedish military accident investigation. He noted that there are common investigative techniques between commercial and military accidents. He discussed how the Swedish accident board is organized and that the organization changes as military members rotate.
- Brig. Gen. Bruno Caïtucoli, BEAD-Air, France, talked about lessons learned during an investigation of a Hellenic Air Force F-16D mishap. He discussed protocols that France and Greece require for investigations and that a Spanish judge was also involved as part of a judicial investigation. He suggested that moving forward slowly and ensuring that everyone was “happy” with each stage of the investigation was important to being able to proceed without creating conflict among the numerous parties.
- Maj. Stephen Turner, UK Defense AIB, observed that having fewer aircraft accidents is good, but this offers fewer opportunities for investigators to practice and improve their skills. He suggested that military accident investigators could share experiences across investigative organizations, modes, nations, and domains. He urged closer relationships with civilian agencies and industry as they face the same challenges. He also pointed to the use of virtual and synthetic training as a means to hone and update investigative skills.
- Fahad Masood, squadron leader in the Pakistan Air Force, discussed a different method of learning/education for “knowledgeable” adults—the K-CAASE methodology, which includes Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. He suggested that this approach emphasizes how to think, not what to think.
- Piotr Ptak, Lappeenranta University of Technology, Finland, presented a novel, low-cost method of tracking aircraft using the Doppler Effect phenomenon.
- Dr. Albert Moussa, BlazeTech Corp.,
OPENS
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Southwest Airlines
NetJets

EXHIBITORS
The following organizations were exhibitors for ISASI 2016:

Aerobytes
Cranfield University
Plane Sciences
TU Delft University

and cost factors of using a UAS as an investigative tool.

Olivier Ferrante, ESASI, led the tutorial "Extending the Networks," which covered a variety of communication, education, and cooperation techniques that can enhance air safety investigations. Existing networks such as the Nordic Accident Investigator Group and the European Network of Civil Aviation Safety Investigator Group were discussed. The tutorial also looked at regional cooperation that ICAO promotes.

• Marcos Costa, ICAO, discussed ICAO’s Manual on Regional Accident and Incident Investigation Organization.
• Olivier Ferrante, ESASI, talked about efforts and activities of the European Network of Civil Aviation Investigation Authorities.
• Thorkell Agustsson, director of the Icelandic Transport Safety Board, presented efforts of the Nordic Accident Investigation Group.
• Caj Frostell, ISASI international councillor, outlined the work of the Banjul Accord Group Accident Investigation Agency. Frostell is the group’s commissioner.
• Chong Chow Wah, AAIB Singapore, examined regional cooperation with accident investigations in the Asia and Pacific regions. He noted, for instance, that investigators from Taiwan had to travel to other regions that have mountainous terrain to train for accident investigation at high altitudes.
• Daniel Barafani, director of investigations, Junta de Investigaciones de Accidentes de Aviación Civil, looked at the AIG Regional Cooperation Mechanism of South America.
• Rob Carter, AAB, UK, discussed being in accident investigations “for the long run” from Lockerbie to Ethiopian 787.
• Marion Choude, ATR, and Mike Gamlin, Roll-Royce, discussed about investigation cooperation among manufacturers.
• Matthew Greaves, Cranfield University, demonstrated how universities and research institutions are expanding networking opportunities for air accident investigators.
• Keith Conradi, chief investigator, Healthcare Safety Investigation Branch, UK, discussed how successful air safety investigation tools and techniques can transfer to healthcare organizations.

Seminar Ceremonies
Tuesday, October 18
From the Hotel Grand Reykjavik, the largest hotel in Iceland, moderator Peter Swaffer, SRK, Sweden, introduced ISASI’s Site Committee chairman, Thorkell Agustsson, Islandic TSB director, who opened the event with a warm welcome to the international crowd from the Icelandic ISASI members. Agustsson urged all present to pay attention to the technical papers presented (see “Speakers and Technical Papers Presented at ISASI 2016,” page 10) and to meet and mingle with the air safety investigative professionals attending the conference.

Capt. Geirirhurud Alfësdottir, chairman of the Icelandic TSB, welcomed the ISASI delegates to Iceland’s capital city and looked forward to attending the technical sessions.

Interior Minister Ragnhildur Hjaltadottir, permanent secretary, also warmly greeted the gathering and emphasized that the seminar theme, “Every Link Is Important,” was “very descriptive of your profession.” She said, “You must find answers and explanations to accidents and incidents you are investigating. They may be caused by different contributing factors, which when linked together can lead to the incidents or accidents.” She noted that “your investigations are of vital importance for international air safety and security...because with your conclusions and recommendations the industry, regulators, and the public can correct any possible weaknesses and thereby min-

ESASI’s Olivier Ferrante discusses the agenda for the tutorial “Extending the Networks.”
ISASI 2016 Chairman Thorkell Agustsson welcomes the ISASI delegates to Iceland.
ISASI President Frank Del Gandio delivers an address to open the annual conference.

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imize the risk of further accidents and incidents.”

ISASI President Frank Del Gandio gave an opening address (see “President’s View,” page 3). He noted that, despite an increase in political-criminal acts against civil aviation, global aviation safety has reached a remarkable level in recent years. And yet, he observed, “we’re still a long way from zero risk.” As air safety investigators, he said, “We have made huge progress,” but problems continue to demand our attention, especially in certain regions—emphasizing that every link is important for our global air safety efforts. Acknowledging that “we must continue to focus on and monitor ...known safety precursors, but we also must manage new challenges,” Del Gandio said two of the biggest new challenges that investigators face will be the growing pilot and mechanic shortages and more UAS in civil aviation airspace.

Keith Conradi, chief investigator of the Healthcare Safety Investigation Branch, UK, gave the Tuesday keynote address. Until recently, Conradi was the chief inspector of air accidents with the UK AAIB. In September 2016, he joined the UK’s Healthcare Safety Investigation Branch and became immersed in the health-care industry with a whole new set of acronyms and meeting with groups and people with very different titles and backgrounds. He believes that “there are five key areas where accident investigation in aviation can make a real difference in health care.”

• A no-blame investigation should become a part of the culture. When something goes wrong in health care, often the information flow is instantly shut down. The current culture is more about fear that punitive action will be taken and jobs and careers are on the line. The health-care industry must move toward confidential reporting and openness, and this can be enhanced by having an investigation process that works on the same principles.
• Annex 13 is extremely valuable to air accident investigation. Healthcare investigations are currently conducted by a mismatch of people, not necessarily selected on merit but more on their availability, with little training. In air safety investigation, Annex 13 can bring some 190 states into a similar investigative process that we can all recognize.
• Protection of sensitive information during an investigation is important. This is a hugely contentious issue in health care. That a statement from a clinician might not be made available to a family member or patient seeking retribution is a highly emotional experience. Gaining the confidence of the health-care staff that a statement can be made to an investigator in confidence will take a great deal of time. Understanding that a healthcare safety investigation can occur parallel with other investigations, for example, judicial, has helped to begin unlocking this dilemma.
• Investigation independence is necessary. Most investigations in health care are conducted by colleagues or those who are close to the event. Adopting the aviation investigation model and the impartiality that underpins it should be a major improvement for the health-care industry.
• Safety action and safety recommendations in health care are often not effective. Current health-care investigations take place in an isolated, siloed, combative environment. Health-care investigations should include the concept of working together with individuals, hospitals, and the industry—as does aviation—to arrive at solutions and then reporting results as safety actions are taken to fix the problems.

Wednesday, October 19

Paulo Soares Oliveira Filho, investigation manager, air safety, Embraer, was the keynote speaker for the second-day session. He said challenges facing air safety investigators include the size, complexity, and diversity of investigations. Filho suggested the key to defeat these challenges is effective management of an investigation. He pointed to two successful management programs—crew resource management and safety management systems (SMS)—that have greatly contributed to air safety since their inceptions. Effective coordination of people among the various safety investigative teams is the best management tool an investigator-in-charge can employ. An investigative management strategy that recognizes every link is important among individual professionals, investigation
teams, and available resources will ensure collaborative results.

**Thursday, October 20**

Kathy Fox, chief of the TSB Canada, gave the keynote address. She said, “I think we can be very proud of the valuable work performed by air accident investigators. We've become very good at understanding how accidents unfold, how one event links to another, and how—to invoke the theme of this conference—every link is important.

“We've become especially good at identifying the operational, technical, and human factors that contribute to accidents. Whereas in the 'old days' we sought only to explain what happened, today we also focus on why. For instance, it has now become standard to look at how people interact with automated systems and with one another, or whether a pilot or crew may have been task-saturated, or fatigued, or distracted—because all of these elements can play a role. But in order to keep improving, we need to continue to push the boundaries—of our knowledge, and of what we investigate—so that ultimately we can do a better job of advancing safety. And so today I'd like to highlight something else—two things—that we should be looking at. Specifically, I’m talking about the organizational factors that contribute to accidents and the regulatory environment in which those organizations operate.

“Let me elaborate. Many companies, for example, say that safety is their top priority. However, there is plenty of convincing evidence that, for many of them, the real priority is profitability. That's not to say they consciously choose to be reckless or deliberately unsafe. It's just that, in the real world, they often have to balance many competing factors: safety, customer service, productivity, technological innovation, scheduling, cost effectiveness, and return on shareholder investment.

“That's a challenge for any business, and even though companies generally recognize and accept that products and services must be 'safe' if they want to remain in business, those other priorities can exert a lot of pressure on management. And when that happens, when we find deficiencies in how organizations identify, prioritize, and manage their risks, we must ask ourselves: where was the regulator? Because, ultimately, it is the regulator that is the guardian of public safety. Because the regulator sets the rules, determines the playing field, and creates the framework under which air carriers operate. And then—ideally—it is the regulator that provides the balanced oversight—whether in the form of inspections or audits—to make sure organizations are abiding by those rules and by that framework.

“Over the past decade, [the regulators'] approach to oversight in Canada has moved away from a traditional 'inspect-and-fix approach.' The new, preferred model is a systems-level approach, whereby, in addition to verifying a company's compliance with regulations, its internal processes are examined to verify that there is also an effective system in place to proactively manage the risks associated with its operations. The theory is that, if this is done properly, such a transition should result in improved safety—addressing not only any identified problems, but also the reasons behind them.

“And I agree—in theory. But that theory, and the move away from the traditional inspect-and-fix approach, only works if all companies have 1) the ability to proactively identify safety deficiencies, 2) the capability to rectify them, and 3) a top-down, organization-wide commitment to doing so. Does that sound like any operators you know? Sure. Some. Hopefully a lot. But not all. Because, again, there's a broad spectrum of capability, competence, and commitment when it comes to implementing SMS—despite its track record of success. Which brings me back to my question: when is enough enough? Should the regulator wait for an accident before stepping in? Should it wait for operators to fix the problems that have been identified, or should it adopt a firm hand before then? If so, at what point?

“Those are good questions—simple ones, yet perhaps confounding, too. But they need to be asked, and they need to be discussed. If they're not, we lose out on an excellent opportunity to do what I said at the beginning of this speech—to push the boundaries of what we know and of what we investigate. And this really is such an opportunity. Because the organizational factors I mentioned today, and the issue of oversight by the regulator, are appearing in our work with more and more frequency. They are, we have come to learn, important links in the chain—links that we need to pursue in order to better understand why accidents happen, and what needs to be done to make our skies, already very safe thanks to your good work, even safer.

**Companion Program**

Participants in the first ISASI Companion Program on Tuesday took a bus tour of Reykjavik that provided them a glimpse of Icelandic architecture and some history of the capital city. They also stopped at the Saga Museum to learn about Viking and Icelandic history.

Wednesday’s program originally included a plan to go out to sea on a whale-watching vessel, but it was cancelled due to weather conditions—rain and cold, high winds that created high waves. So, instead, they bussed to a whale museum in Reykjavik. There they viewed 23 to-scale models of whales that hung from the ceiling, giving participants the feeling that they were walking among swimming whales. Perhaps less dramatic than going out to sea, the museum provided an interesting (also warmer and dryer) look at all things whale related near Iceland. The tour guide, who has experience tagging whales for research, provided an interesting discussion of whale biology and ancestry. The companions also traveled away from Reykjavik to see the countryside and stop at a lake.

**Social Events**

**President’s Reception**

For many ISASI 2016 attendees and their guests, the president’s reception on Monday night was their first opportunity during ISASI 2016 to meet professional colleagues with whom they have corresponded and discussed work-related issues through telephone calls, e-mails, or Internet video connections. This is an occasion on a global scale to greet long-time friends and former co-workers who have moved or transferred to other positions—a time to catch up on events and life changes. There are hardy handshakes here, a hug there, a hand on a shoulder, and smiles all around. Passing among the clusters of people at the reception seems as though the participants are attending a school or family reunion.

**Blue Lagoon Reception**

After a long day of meetings, Tuesday’s seminar participants and companions bussed to the Blue Lagoon where many
First row top left: Stuart Hawkins, left, receives from President Frank Del Gandio the Award of Excellence for the ISASI 2016 best seminar paper. Seminar participants gather for the president’s reception.

Second row: An ISASI 2016 delegate presents a question to the conference speaker. Kapustin scholar Carly Shoemake, left, discusses her presentation with Technical Committee Chairman Brian McDermid, right. An ISASI 2016 delegate presents a question to the conference speaker.

Third row: Fabio Bonnett, Embraer, discusses investigating single-pilot accidents. An ISASI 2016 delegate presents a question to the conference speaker.
**Tuesday, 25 August**

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<td>09:00</td>
<td>Opening Ceremonies</td>
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<tr>
<td>• Moderator: Peter Swaffer, SRK, Sweden</td>
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<tr>
<td>• ISASI 2016 Committee Chairman: Thorkell Agustsson, Islandic TSB Director</td>
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<td>• Welcome: Geirthrudur Alfredsdottir, ITSB Chairman</td>
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<td>• ISASI President: Frank Del Gandio</td>
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<td>• Presentation of Kapustin Scholars</td>
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<td>• Welcome address: Ragnhildur Hjaltadottir, Permanent Secretary, Ministry of Interior</td>
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<td>09:30</td>
<td>Keynote address: Keith Conradi, Chief Investigator of the Healthcare Safety Investigation Branch, UK</td>
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<tr>
<td>• Sukhoi Superjet—Airborne Image Recorder Supported Investigation—Ragnar Gudmundsson ITSB</td>
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<td>• Protection of Investigation Records—Marcos Costa, ICAO</td>
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<td>• Reverse-Engineering the Causal Links Reveals Safety Analysis Issues—David Romat and Sebastien David, BEA, France</td>
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<td>• Investigating a MD-88 Runway Excursion—Joshua Migdal, Senior Air Safety Investigator, Delta Air Lines</td>
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<td>• Social Media in Crisis Communications—Carly Shoemake, Kapustin Scholarship Winner</td>
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**Wednesday, 26 August**

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<tr>
<td>09:00</td>
<td>Moderator: Jim Roberts, Boeing.</td>
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<td>• Keynote address: Paulo Soares Oliveira Filho, Manager Air Safety, Embraer</td>
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<td>• MH17 Safety Investigation—Kas E. Beumkes, Dutch Safety Board</td>
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<td>• Safety Recommendations: A Foundational Building Block to ESA’s Safety Risk Management Process—Marion Colavita, Aviation Safety Officer, European Aviation Safety Agency</td>
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<tr>
<td>• Aviation Safety Improvements: Advancing Safety Through Multiple Means—Kristi Dunks, Transport Safety Analyst, NTSB</td>
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<td>• Accidents During Non-Precision Approaches—Still a Recurrent Issue—Thomas Legagnon, Airbus</td>
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<td>• Real-Time Data Transmissions—Jaiqi Cao, Kapustin Scholarship Winner</td>
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<td>• ISASI Business Meeting, Frank Del Gandio, President; Ron Schleede, Vice President, Bob MacIntosh, Treasurer</td>
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<td>14:00</td>
<td>Moderator, Anthony Brickhouse, Professor, Embry-Riddle Aeronautical University</td>
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<td>• Using a Drone and Photogrammetry Software to Create Orthomosaic Images and 3-D Models of Aircraft Sites—Stuart Hawkins, Senior Inspector of Air Accidents (Engineering), UK AIB</td>
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<td>• Extend the Network and Exploit Available Resources: Lessons Learned from Two Major Investigations—Michael Guan, Investigation Lab, Aviation Safety Council, Taiwan</td>
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<td>• Cabin Safety Aspects in Accident Investigations: A Crucial Link—Martin Maurino, Safety, Efficiency, and Operations Officer, ICAO</td>
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<td>16:10</td>
<td>ISASI Working Group Meetings</td>
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**Thursday, 27 August**

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<th>Time</th>
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<tr>
<td>09:00</td>
<td>Moderator: Rob Carter, AIB, UK</td>
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<td>• Keynote address—Kathy Fox, Chief, TSB, Canada</td>
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<td>• Germanwings Safety Investigation—Romain Bevillard, Senior Safety Investigator, BEA France</td>
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<td>• An Additional Approach to Establishing the State of Operation of a Turboprop Engine During an Aircraft Accident—Douglas Zabawa, Accident Investigator, Pratt &amp; Whitney</td>
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<td>• The Effect of Commuting on Pilot Self-Assessment of Stress and Performance—Thomas Frisacher, Ph.D. Candidate, Cranfield University</td>
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<td>• Investigating Linkages Between an Occurrence Event and an Organization’s Safety System Performance—Heather Fitzpatrick, Senior Transport Safety Inspector, Australian TSB</td>
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<td>• AirAsia 8501: Echoes of Air France 447?—Andre Woenardi and Yasmeen Syed, Kapustin Scholarship Co-winners</td>
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<td>• Overview and Images of the MH17 Crash, Ronald Smits, Investigation Manager, Dutch Safety Board</td>
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* This was a presentation given during ISASI 2016, not a submitted paper.
ADVANCING SAFETY THROUGH MULTIPLE MEANS

By Kristi Dunks, Ph.D., Office of Aviation Safety, U.S. National Transportation Safety Board

(Adapted with permission from the author’s technical paper entitled Aviation Safety Improvements: Advancing Safety Through Multiple Means presented at ISASI 2016 held in Reykjavik, Iceland, Oct. 17–20, 2016, which carried the theme “Every Link Is Important.” The full presentation, including cited references and omitted images to support the points made, can be found on the ISASI website at www.isasi.org under the tag “ISASI 2016 Technical Papers.”—Editor)

On Sept. 17, 1908, the first powered airplane passenger fatality occurred. During a test flight for the U.S. Army at Fort Myer, Virginia, U.S.A., a wooden propeller blade split, and pilot Orville Wright was unable to control the airplane. Lt. Thomas Selfridge sustained a skull fracture as a result of the accident and died hours later. Although aviation history has been full of amazing achievements, when accidents occur, industry pauses to investigate the circumstances and learn from these events. After the 1908 accident, U.S. Army pilots were required to wear helmets to prevent injuries similar to the one sustained by Selfridge. Even from these early days of aviation, the prevention of similar accidents through safety improvements was of primary importance.

Title 49 United States Code 1131 authorizes the U.S. National Transportation Safety Board (NTSB) to investigate transportation accidents and “establish the facts, circumstances, and cause or probable cause.” The NTSB may also issue safety recommendations aimed at preventing future similar accidents.

Safety recommendations are defined as a formal request issued as a result of investigations or safety studies. Recommendations address a specific issue identified during an investigation or a study and specify actions to correct the issue. Letters containing the recommendations are sent to the most appropriate public or private organization to address the safety issue. By regulation, the U.S. Federal Aviation Administration (FAA) is required to respond to NTSB recommendations. Since the NTSB’s inception in 1967, and as of July 13, 2016, the agency has issued 14,434 safety recommendations, with 5,561 aviation-related safety recommendations.

Once a response to a recommendation is received, the NTSB corresponds with the recommendation recipient until the recommended action (or an acceptable alternate action) is completed. However, in some cases the recipient determines that it will not take any actions to address the identified safety issue. When this situation occurs, the NTSB cannot compel the recipient to take action regarding the recommendation because the NTSB is not a regulatory agency. All safety recommendations issued by the NTSB and the related correspondence and classifications are available on the agency’s website http://go.usa.gov/xKt6k.

The NTSB typically issues safety recommendations at the conclusion of an investigation, but recommendations are issued sooner when warranted, especially if an urgent safety issue has been identified. Although the NTSB’s safety recommendations have been the impetus for extensive aviation safety improvements, a formal recommendation is not always necessary or the most advantageous approach to improve aviation safety, especially if the public and industry call for improvements immediately after an accident. Other tools that the NTSB uses to resolve safety issues and prevent future accidents include safety accomplishments and safety results.

A safety accomplishment is defined as a positive measurable change within the transportation environment that is brought about through some direct action of an NTSB employee. Some safety issues identified during investigations, due to their nature, may be resolved through direct action of the entity involved. Through meetings and correspondence between the investigator and the entity, ideas for resolving the safety issue are identified and then acted on.

A safety result is defined as a positive change within the transportation environment that is brought about simply by the NTSB’s investigation of an accident or incident. The investigator does not make a suggestion to improve safety because the affected party acts on its own to resolve the identified safety issue.

Following are case studies of three accidents in which the NTSB issued safety recommendations. These investigations also led to safety accomplishments or safety results.

UPS Flight 1354, Birmingham, Alabama, U.S.A.

On Aug. 14, 2013, about 0447 central daylight time, UPS Flight 1354, an Airbus A300–600, N155UP, crashed short of Runway 18 during a localizer nonprecision approach to Runway 18 at Birmingham–Shuttlesworth International Airport, Birmingham, Alabama. The captain and the first officer were fatally injured. The airplane was destroyed by impact forces and postcrash fire (see Figure 1, page 12). The scheduled cargo flight was operating under the provisions of 14 Code of Federal Regulations (CFR) Part 121 on an instrument flight rules flight plan. Dark night visual flight rules conditions prevailed at the airport, and variable instrument meteorological conditions with a variable ceiling were present north of the airport on the approach course at the time of the accident.

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Dr. Kristi Dunks

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The NTSB determined that the probable cause of the accident was the flightcrew members' continuation of an unstabilized approach and their failure to monitor the aircraft's altitude during the approach, which led to an inadvertent descent below the minimum approach altitude and subsequently into terrain. Contributing to the accident were (1) the flight crew's failure to properly configure and verify the flight management computer for the profile approach; (2) the captain's failure to communicate his intentions to the first officer once it became apparent the vertical profile was not captured; (3) the flight crew's expectation that they would break out of the clouds at 1,000 feet above ground level due to incomplete weather information; (4) the first officer's failure to make the required minimums callouts; (5) the captain's performance deficiencies likely due to factors including, but not limited to, fatigue, distraction, or confusion, consistent with performance deficiencies exhibited during training; and (6) the first officer's fatigue due to acute sleep loss resulting from her ineffective off-duty time management and circadian factors.

As a result of the investigation, the NTSB made 15 recommendations to the FAA, two recommendations to UPS, two recommendations to the Independent Pilots Association, and one recommendation to Airbus. The safety recommendations to the FAA addressed fatigue reporting and assessment. The safety recommendation to Airbus addressed the need to provide a direct cue to flight crews when the flight management computer for applicable Airbus models is programmed incorrectly.

In addition to these safety recommendations, safety improvements were made outside of the formal safety recommendation process. The Birmingham airport authority and the Birmingham control tower replaced the emergency phone system and updated procedures to provide timely notification to emergency response personnel. Also, controllers received refresher training about entering remarks data into ATIS reports and updating those reports. Thus, the safety recommendations addressed the broad safety issues identified during the investigation, and the safety results implemented at the Birmingham airport and control tower addressed local procedures and training.

Sundance Helicopters, Las Vegas, Nevada, U.S.A.

On Dec. 7, 2011, about 1630 pacific standard time, a Sundance Helicopters, Inc., Eurocopter AS350-B2 helicopter, N37SH, operating as a "twilight tour" sightseeing trip, crashed in mountainous terrain about 14 miles east of Las Vegas, Nevada. The pilot and four passengers were fatally injured. The helicopter was destroyed by impact forces and postcrash fire. The helicopter was registered to and operated by Sundance Helicopters as a scheduled air tour flight under the provisions of 14 CFR Part 135. Visual meteorological conditions with good visibility and dusk light prevailed at the time of the accident, and the flight was operated under visual flight rules.

The NTSB determined that the probable cause of the accident was Sundance Helicopters’ inadequate maintenance of the helicopter, including (1) the improper reuse of a degraded self-locking nut, (2) the improper or lack of installation of a split pin, and (3) inadequate postmaintenance inspections, which resulted in the inflight separation of the servo control input rod from the fore/aft servo and rendered the helicopter uncontrollable. Contributing to the improper or lack of installation of the split pin was the mechanic's fatigue and the lack of clearly delineated maintenance task steps to follow. Contributing to the inadequate postmaintenance inspection was the inspector's fatigue and the lack of clearly delineated inspection steps to follow.

As a result of the investigation, the NTSB issued three recommendations to the FAA. These recommendations addressed establishing duty-time regulations for maintenance personnel, implementing best practices for conducting maintenance under 14 CFR Parts 135 and 91 Subpart K, and human factors training for maintenance personnel.

During the investigation, several safety improvements were completed. Sundance Helicopters was a member of the Tour Operators Program of Safety (TOPS). Investigators determined that Sundance Helicopters did not meet the TOPS audit requirements but had successfully passed the audit. After discussions with the NTSB, TOPS formed a committee to evaluate its auditing process. TOPS then revised its audit sampling procedures, added the revised information to its annual auditor training and orientation, and modified its audit-related checklists.

In addition, due to the maintenance errors and issues identified during the investigation, the NTSB worked with the FAA to (1) publish a general aviation maintenance alert on its website to highlight recent helicopter maintenance errors and (2) distribute the information through the FAA Safety Team (FAAST) e-mail registry. The NTSB also provided accident case study data related to maintenance errors that the FAAST included in its inspection authorization renewal training for mechanics.
Empire Airlines Flight 8284, Lubbock, Texas, U.S.A.

On Jan. 27, 2009, about 0437 central standard time, an Avions de Transport Régional Aerospatiale Alenia ATR 42–320, N902FX, operating as Empire Airlines Flight 8284, crashed short of the runway while on an instrument approach to Lubbock Preston Smith International Airport in Lubbock, Texas. The captain sustained serious injuries, and the first officer sustained minor injuries. The airplane was substantially damaged (see Figure 2). The airplane was registered to FedEx Corporation and was operated by Empire Airlines, Inc., as a 14 CFR Part 121 supplemental cargo flight. Instrument meteorological conditions prevailed at the time of the accident, and an instrument flight rules flight plan was filed.

The NTSB determined that the probable cause of the accident was the flight crew’s failure to monitor and maintain a minimum safe airspeed while executing an instrument approach in icing conditions, which resulted in an aerodynamic stall at low altitude. Contributing to the accident were (1) the flight crew’s failure to follow published standard operating procedures in response to a flap anomaly, (2) the captain’s decision to continue with the unstabilized approach, (3) the flight crew’s poor crew resource management, and (4) fatigue due to the time of day during which the accident occurred and a cumulative sleep debt, which likely impaired the captain’s performance.

As a result of the investigation, the NTSB issued nine recommendations to the FAA. These recommendations addressed (1) improving first officer assertiveness, (2) prohibiting operations in known freezing rain or freezing drizzle (unless the airplane manufacturer has demonstrated that the airplane model can safely operate in those conditions), (3) flight training on the dangers of operating in freezing precipitation, (4) improving airport emergency response communications, (5) ensuring airport emergency response access, (6) retrofitting aircraft performance monitoring systems, (7) annunciating flap asymmetries, (8) developing minimum simulator model fidelity requirements for airplane ice accretion, and (9) providing simulator training (once the simulator fidelity requirements are in place) for flight crews of all aircraft certified for flight in icing conditions.

Numerous safety accomplishments resulted from the work of the investigative team. In the months after the accident, Empire Airlines issued training guidance on flap anomalies, issued flight bulletins addressing airspeed bugs and prohibitions on operating in freezing rain or freezing drizzle, and implemented special emphasis icing training. FedEx held a safety summit to its feeder operators to address the circumstances of this accident and facilitate improved training, developed “no-go” weather items that prohibit takeoff or landing operations in known or reported freezing rain or freezing drizzle, and installed ice probes on all company ATR aircraft. The FAA issued an Aviation Information Service Advisory Circular (AISAC) with Icing Technical Instructions to its pilots to help the team develop unique solutions to complex safety issues and determine the best manner to collaborate with potential recipients on ways in which the safety issues could be addressed.

Documenting and sharing safety improvement information is another important aspect in improving aviation safety. Although official safety recommendations are well documented and tracked, comprehensive documentation of all related safety accomplishments and safety results is also needed. Safety improvement information is typically included in the NTSB’s final report of an investigation, similar to the documentation of safety actions by other accident investigation boards. Such documentation provides those outside of the investigation with knowledge of the safety improvements that have occurred so that all interested parties may learn from the event.

Each safety improvement resulting from an investigation is important in preventing future accidents and incidents. Investigative agencies and teams should understand and consider the full array of safety improvement options and, based on the needs of the investigation, choose the most effective method for conveying this information to bring about the desired change. Whether a local change is instituted by an airport manager or a significant regulatory change is made within the industry, each safety improvement implemented is a step forward for aviation safety.

Figure 2. Empire Airlines accident site.
The Jerome F. Lederer Award is the highest honor the International Society of Air Safety Investigators bestows upon an individual. So it is no surprise that the presentation crowns the Society’s annual three-day international conference on air accident investigation at its award banquet. Eugene “Toby” Carroll, a longtime accident investigation professional with more than 400 investigations to his credit, is the 2016 recipient of the award. ISASI, an organization dedicated to enhancing aviation safety through the continuing development and improvement of air accident investigation techniques, only considers for its highest award candidates who have careers of making outstanding lifetime contributions to technical excellence in furthering aviation accident investigation and achieving ISASI objectives.

In introducing the award winner to the banquet guests, President Frank Del Gandio said, “I have known Toby personally for approximately 35 years and have investigated numerous accidents with him with AMSI, the NTSB, and Continental Airlines. I always considered him my ‘go to’ person for answers to airline questions. While we attended many military functions together, we did not get to know one another until we met on accident sites. Toby is undeniably an exceptional aviation safety professional and colleague. Moreover, he is an invaluable mentor to aspiring safety investigators and has been a renowned safety advocate for many decades.”

Outlining Toby’s background, Del Gandio noted that Toby’s path in aviation safety began as an ROTC distinguished military graduate from Marquette University, followed by completion of the Army fixed-wing flight school program and then a tour in South Vietnam. After Vietnam, Toby was then assigned to the Army Aviation School as a committee chief/senior instructor.

After completing active duty, Toby remained in the military serving in the Reserve and National Guard as a company commander and operations officer. His last assignment was as brigade aviation safety officer of the 50th Aviation Brigade, where he established the newly formed Brigade’s aviation and ground safety programs in support of approximately 175 fixed- and rotary-wing aircraft spread out over four U.S. states. Toby has served as president of three military accident investigation boards and as a member of the aviation standardization board. During his military career, Toby was awarded the Distinguished Flying Cross, an Air Medal with 14 oak leaf clusters, the Bronze Star, and an Army Commendation Medal with cluster.

In 1985, Toby began his long-lasting position as the manager, then director, of flight safety at Continental Airlines, in which he was extremely influential in aviation safety and accident investigation. Toby was always eager to share his
expertise, and he instilled an appreciation of the significance of safety within the organization. He worked with numerous interns over the years and took a vested interest in providing them with mentorship and direction in their respective careers. He was also active in the career development of his colleagues by providing opportunities for them to refine and expand their skills and by enabling them to strategically pursue their interests in aviation safety.

At Continental Airlines, Toby was instrumental in implementing the FOQA, ASAP, IEP, VDRP, and LOSA programs. He is a great proponent of proactive safety programs and was appointed the industry co-chair of the Aviation Safety Information Analysis and Sharing (ASIAS) program. He also chaired the Issues Analysis Team (IAT) and the Air Transport Association's (ATA) Aviation Safety Exchange System. Furthermore, he served as chairman and vice chairman of the ATA (now A4A) Flight Safety Committee and as an alternate representative to the ATA safety council. Additionally, for more than 26 years, Toby served as the Continental Airlines “party coordinator” during NTSB investigations and/or as a technical advisor to the NTSB accredited representatives on International Civil Aviation Organization Annex 13 investigations. Overall, in his more than 45 years of aviation experience, he has participated or was in charge of more than 400 accident or significant incident investigations.

Concluding his remarks, President Del Gandio addressed Toby’s ISASI role: “Toby has also been a significant contributory member of ISASI since he joined in October 1982 and has attended every ISASI annual conference except two during that time. He is a former vice president and treasurer of the Dallas/Ft. Worth Regional Chapter and has served as the ISASI U.S. councillor and U.S. Society president since 2009.”

“Jerry Lederer would be extremely proud that Toby is receiving this award. Jerry attended many seminars, and Toby always arranged his travel. Jerry Lederer was like a father to Toby, who has spent a lifetime working selflessly to enhance aviation safety and has done so with the utmost professionalism and integrity. There is no one more deserving of this prestigious Jerry Lederer award than Toby.”

During the first-day opening ceremonies of ISASI 2016 in Reykjavik, Iceland, President Frank Del Gandio, in a surprise move, called Toby Carroll to the speaker’s platform. Some years earlier, Toby had responded to such a call and had been caught unaware, so he wondered “What now?” Once on stage, he stood aside the lectern; “Come closer,” said the president. And as he stepped forward, Del Gandio faced him and announced, “Meet the ISASI 2016 Lederer Award winner.” Stunned, Toby blurted, “Oh my God!”

As he stepped forward on the award banquet night to accept the Jerry Lederer Award plaque, his nervousness was still apparent, but he cradled the award in his hands and accepted the well-deserved, long applause from his peers. When the room quieted, he moved to the lectern and said: “On Tuesday morning when Frank announced that I would receive the Jerome F. Lederer Award tonight, I thought, ’Wow, what a great honor.’ Later, it hit me that I would have to make a speech, and I told myself, ’Keep it short but meaningful.’ So here it is.

“From the time I was a child, I knew that I wanted a career in aviation. My plan was to graduate from college, get my pilot ratings, fly in the military, and when my military obligation was fulfilled, I would go on to be a pilot at a major airline. Things were working out according to my plan until while serving as an Army fixed-wing pilot in Vietnam I was asked (in military fashion) to participate in an accident investigation. That opened my eyes to a whole new career path that I thought would be interesting and challenging. I have often told people that I became an accident investigator by accident.

“Upon completing active duty, I had the opportunity to work for a company that investigated aviation accidents for several manufacturers, and the rest is, as they say, history. I feel very fortunate that for more than 45 years I have worked not only in a field that has enabled me to make contributions to accident investigation, but also to have been involved in the development and promotion of proactive safety programs such as FOQA, ASAP, IEP, VDRP, and LOSA. Once these programs were up and running, the Aviation Safety Information Analysis and Sharing program began in 2007. ASIAS initially began with airlines and unions sharing de-identified information with the FAA to identify trends that led to significant training, operational, and maintenance improvements. The program to date has really grown.

“I cannot end tonight without saying a few words about Jerry Lederer. Those of us who were lucky to know Jerry realize what a special person he was. Jerry was humble, he was funny, and, more importantly, he had a wealth of aviation safety information that he was willing to share with everyone. He knew many of the most important people in aviation in the 20th century. Jerry truly deserved the title of ‘Father of Aviation Safety.’ These are some of the reasons why I feel so privileged to receive this award that has been named in his honor.

“Finally, I would like to thank the person who nominated me; the committee that selected me; Kathy, my supportive wife of 47 years; and my daughter, Erin—and all of you for making this an evening that I will always remember. Thank you.”

PAST LEDERER AWARD WINNERS
1977—Samuel M. Phillips
1978—Allen R. McMahon
1979—Gerard M. Brugink
1980—John Gilbert Boulding
1981—Dr. S. Harry Robertson
1982—C.H. Prater Houge
1983—C.O. Miller
1984—George B. Parker
1985—Dr. John Kenyon Mason
1986—Geoffrey C. Wilkinson
1987—Dr. Carol A. Roberts
1988—H. Vincent LaChapelle
1989—Aage A. Roed
1990—Olof Fritsch
1991—Eddie J. Trimble
1992—Paul R. Powers
1993—Capt. Victor Hewes
1994—UK Aircraft Accidents Investigation Branch
1995—Dr. John K. Lauber
1996—Burt Chesterfield
1997—Gus Economy
1998—A. Frank Taylor
1999—Capt. James A. McIntyre
2000—Nora C. Marshal
2001—John W. Purvis and the Transportation Safety Board of Canada
2002—Ronald L. Schleele
2003—Caj Frostell
2004—Ron Chippindale
2005—John D. Rawson
2006—Richard H. Wood
2007—Thomas McCarthy
2008—C. Donald Bateman
2009—Capt. Richard B. Stone and the Australian Transport Safety Bureau
2010—Michael Poole
2011—Paul-Louis Arslanian
2012—Curt L. Lewis
2013—Frank Del Gandio and Myron Papadakis
2014—David King
2015—Ladislav (Ladi) Mika

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Understanding the damage to the engines involved in an aircraft accident can provide insight into their state of operation at the time of impact. In the majority of investigations, an evaluation is performed at the accident scene by assessing the condition of the blades in the compressor and turbine sections of the engine. This classic approach to determining the state of operation of an engine has been used successfully for many years and has been widely taught as a fundamental investigative tool to generations of aircraft accident investigators. The fundamental premise is that if the blades are bent against the direction of rotation, the rotors were rotating. And if the rotors were rotating, the engines were operating.

However, a recent accident involving a large commercial airplane highlighted that this type of assessment has limitations. The on-scene evaluation of one of the engines proved to be misleading, and the evaluation was changed following additional assessment. This adapted article will discuss the method of that assessment. Secondly, it will also describe what information the engines yielded about the aircraft ground impact sequence, given an absence of the majority of the aircraft.

Accident background
A twin-engine commercial passenger jet was reported to have crashed in a remote area with thick vegetation similar to what would be found on the edges of a jungle. A team of investigators was dispatched to the scene to begin the investigative process. The team arrived on scene and observed that significant looting of the wreckage had already occurred. The majority of the aircraft had been removed—including the flight data recorder, which was later recovered but was not in a useful condition. All that remained were the two engines midway along, and on opposite sides of, the wreckage path.

Based on observations both on the ground and from aerial surveys, it was determined that the aircraft came in at a shallow angle and at a significant bank angle with the right wing down (see Figure 1). The detailed examination of the accident site identified both engines. Figure 2 shows the engine found on the left-hand side of the wreckage. (Figure 7, page 20, is of the engine found on the right-hand side of the wreckage. In describing the wreckage path, left and right are referenced looking in the direction of flight).

On-scene examination of both engines identified significant differences in the distress to the fan blades from one engine to the other. The engine on the right-hand side of the wreckage path exhibited very little distress to the fan blades, while the engine on the left-hand side had just the opposite appearance. Further examination of the engine on the right-hand side of the wreckage path identified the same lack of distress to the rear-stage turbine blades. The on-scene investigation concluded with a recommendation that the engines be examined further to understand the differences in their observed levels of distress.

Figure 1: View looking against the direction of flight depicting aircraft bank angle with right wing down.
**Basics of jet engine construction**

In simplified terms, a jet engine induces air into an intake, compresses the air in compressor stages, mixes this compressed air with fuel and then ignites that mixture in the diffuser/combustor section, and then exhausts the combustion gases through turbine stages that extract work to drive the compressor and other ancillary systems. In a typical turbofan engine, the forward most compression stage(s) is/are called the fan stage(s).

The mechanical construction of the compressor and turbine sections involves the close proximity, usually in an alternating pattern, of hardware that rotates and hardware that remains stationary. The diffuser/combustor section, which does not contain any rotating hardware, separates the compressor and turbine sections from one another. Surrounding all of the static and rotating hardware are cases that provide the positioning of the rotating hardware relative to the static hardware. Figure 3, page 18, is a cross-section of an exemplar turbofan engine.

It is this construction, specifically the close proximity of rotating to stationary hardware, that provides the accident investigator with a potentially valuable source of information regarding the state of rotation of the rotating parts of the engine during the impact sequence.

**Classic approach to understanding accident engines**

Due to the dynamics of an accident sequence, it is typical for an aircraft engine to impact the surroundings as opposed to coming to rest in a graceful or soft manner. The dissipation of the energies involved in an aircraft wreckage result in the generation of significant forces that can distort and compromise the structures involved, including the engines. This could mean ground impact, water impact, or impact with any other obstructions (e.g., trees, buildings, etc.) that were encountered along the wreckage path.

Relating back to the discussion on the basics of jet engine construction, the distortion of the engine structure itself due to the impact forces brings the rotating and stationary hardware into contact with each other. This contact leaves signatures on that hardware that can then be interpreted by the accident investigator.

As engine cases distort and intrude into the rotating blades of the compressor and/or turbine sections, the blade distress is directly related to the rotational speed of the engine rotors at the time of the excursion. As a general rule, the higher the level of damage, the faster the rotating hardware was rotating. Said differently, the faster a rotating part is rotating, the more energy there is that needs to be dissipated. This energy dissipation takes the form of hardware deformation and distress and thus can provide a measure as to the state of operation of the engine at the time of impact.

Taking this concept and putting it to practical application, it is worthwhile to examine a couple of examples. Figure 4, page 19, is an example of a fan rotor from an engine that was not rotating/windmilling at the time of impact. (Windmilling is a condition of unpowered free rotation/spinning, e.g., an unpowered engine.) Note how the majority of the blades exhibit very little, if any, deformation. They are straight and full length. Note also how a sector of the blades is buckled. This is interpreted as meaning that the rotor was not rotating at the time of its impact, allowing only the blades that were in the area of the deformed case to become deformed.

Figure 5, page 19, is an example of a compressor rotor from an engine that was rotating at high speed at the time of impact. The blade rows from this example have been liberated completely, folded over against the direction of rotation or fractured off leaving only stubs of blades still attached to the underlying disk. The explanation for this is that the rotor, with blades attached, was rotating fast enough that all of the blades rotated past/into the

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**Doug Zabawa**

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levels of distress between the extremes depicted in Figures 4 and 5 can also be used to infer the state of rotation. Figure 6, page 20, is an example in which 75 percent of the blades are fractured but the remainder are full length and straight/underformed. The energy level of this impact was somewhere between no rotation of the engine and high-speed rotation. In this example, the engine was rotating but at the low (relative to high-power takeoff) rotational speed of idle.

Using the concepts described above to evaluate the accident initially described, one could come to a potential scenario in which, at the time of impact, the engine located on the left side of the wreckage path was operating while the engine on the right side of the wreckage path was not.

With the information available from the on-scene portion of the investigation, and the lack of other definitive data, a decision was made to disassemble and examine the engines.

**Detailed examination of the engines**

During the examination of the engines, serial numbers permanently marked on certain engine components were used in conjunction with the operator’s records to determine the installed positions of the engines on the accident aircraft. This evaluation identified the engine on the left-hand side of the wreckage path as being the No. 2 engine (installed on the right-hand side of the aircraft) and the engine on the right-hand side of the wreckage path as being the No. 1 engine (installed on the left-hand side of the aircraft).

**Examination of the No. 2 engine:** Examination of the No. 2 engine identified first-stage fan blades that were both fractured and bent against the direction of engine rotation. Additionally, the second-stage fan blades that were observable were all bent against their direction of rotation. Splintered wood was also observed between the blades in both the first- and second-stage fans.

Circumferential scoring was observed on the aft side of the intermediate case. The forward side of the sixth-stage bleed cavity was caked with organic vegetation debris consisting of dirt and finely chopped wood particles. In general, it was observed that the blades in the high-pressure compressor (HPC) were either fractured or exhibited damage against the direction of rotor rotation. This damage consisted of blade bending, leading edge and trailing edge breakouts and smearing, and tip curls. The distress within a given rotating stage was consistent around the entire circumference.

All gas path surfaces within the HPC were coated with organic vegetation that consisted of dirt and finely chopped wood particles. The domes of the burner cans exhibited a deposited coating of organic vegetation that consisted of dirt and finely chopped wood particles. A significant amount of organic vegetation debris, consisting of finely chopped wood particles, was caked around the holes for the burner cans in the combustion chamber support assembly.

The blades in the HPT and LPT stages of the engine were observed to be in place and intact. No blade fractures in the turbines were identified. There were no findings that indicated a pre-accident malfunction of the engine.

**Examination of the No. 1 engine:** Examination of the No. 1 engine did not identify any significant distress to the blades of the first- or second-stage fans. All of these blades were observed to be intact and straight with no significant deformation or distress. Figure 7, page 20, depicts the observed condition of the fan from the No. 1 engine on scene. All of the primary gas path surfaces in the HPC were coated with organic vegetation debris that consisted of dirt and finely chopped wood particles. All of the HPC blades were observed to be in place, intact, and straight.

The combustion chamber outer case was noted to be dented inward, consistent with an external impact, from 6:00–9:30 o’clock (clock locations are aft looking forward with 12:00 at top dead center in the installed orientation). The domes of the burner cans exhibited a significant deposit/caking of organic vegetation consisting of dirt and finely chopped wood particles. Organic vegetation consisting of a mixture of dirt and finely chopped wood particles was deposited on the largest diameters along the entire lengths of the individual burner cans. Figure 8, page 21, depicts the deposited debris on the burner cans.

The inside of the burner cans exhibited a thin coating of organic vegetation debris consisting of dirt and finely chopped wood particles. A significant amount of organic vegetation debris, consisting of finely chopped wood particles, was caked around the holes for the burner cans in the combustion chamber support assembly.

The blades in the HPT and LPT stages of the engine were observed to be in place and intact. No blade fractures in the turbines were identified. There were no findings that indicated a pre-accident malfunction of the engine during the examination of the No. 1 engine.

**Engine analysis findings**

**Analysis of No. 2 engine findings:** The condition of the fan and compressor stage blades in the No. 2 engine were consistent with the rotors rotating at the time the engine received its impacts. Furthermore,
the distress to the fan and compressor blades as compared to the lack of distress to the turbine blades indicated that the forward portions of the engine were where the initial engine impacts occurred, which in turn arrested the rotation of the engine rotors.

The circumferential scoring observed on the aft side of the intermediate case was consistent with the HPC still rotating at the time the relative axial positioning of the high-pressure rotor to the intermediate case was lost. This was consistent with the engine rotors rotating while the cases were being deformed during the impact sequence.

With no findings of pre-impact failure of the No. 2 engine and signs of rotation of the engine rotors at the time of impact of the No. 2 engine, the conclusion was drawn that this engine was operating during the portion of the accident sequence when the engine impacted the trees/ground.

*Analysis of No. 1 engine findings:*

The No. 1 engine did not exhibit the blade distress that is typically associated with an engine that is rotating at the time of its impacts during the accident sequence. The blades also did not exhibit a localized area of distress, such as a quadrant of buckled blades, that could be explained by an engine that was not rotating at the time of its impacts. Both of these points could be explained by the condition of the engine cases. The only significant deformation noted to the engine cases was to the combustion chamber outer case, which does not have any blades in close proximity to it to leave indications as to the state of rotor rotation.

With the lack of blade damage to help establish the state of rotor rotation, the investigation focused on understanding the organic debris deposits in the engine. As noted, the debris contained finely chopped wood that was found deep within the engine past all of the compression stages. It was determined that for the wood to have been chopped in the manner...
it was, something had to have done work on it, specifically
the compressor blades. For this to have occurred, the engine
rotors had to have been rotating at the time the engine
encountered the trees. It is not feasible to have branches
rammed into the front of the engine and still get chopped in
the same manner as observed unless that engine was operat-
ing under power at the time it encountered the trees.

Substantiating further that the engine was operating
was the manner in which the debris was deposited on the
raised surfaces of the burner cans. The debris was deposit-
ed in a manner that was consistent with it being entrained
in airflow and then being caught on the high points of the
surfaces that the airflow encountered. Again, this pointed to
the engine operating and pumping air at the time the wood
was being ingested.

Finally, as was noted previously, there were some find-
ings of finely chopped wood in the No. 2 engine, although
significantly less than what was found in the No. 1 engine.
A qualitative comparison of the wood from both engines
assessed that the wood in each engine had been chopped
to the same degree. With the mechanical damage to the
blades of the No. 2 engine establishing that it was rotating
at the time it sustained its impacts, the finely chopped wood
in this engine was determined to be characteristic of what
wood would look like when ingested by an engine that was
operating. This provided further substantiation that the No.
1 engine was operating at the time it encountered trees.

Understanding engine condition differences
The determination of the engine installed positions, based
on the operator’s records and positive identification of seri-
alized components in the engines, provided further insight
into the conditions of the engines and the aircraft impact sequence.
The relative positions of the engines at the accident site were consist-
ent with the engines crossing the wreckage path during the accident
sequence. In other words, the engine installed on the left-hand side of
the aircraft (the No. 1 engine) ended up on the right-hand side of the
wreckage path, while the No. 2 engine came to rest on the left-hand
side of the wreckage path.

The knowledge that the engines had crossed the wreckage path was
important in further understanding the differences in the observed
levels of mechanical damage within each of the engines. Recalling
that the orientation of the aircraft was right wing down as the aircraft
entered the trees at the accident site, it was recognized that the No.
1 engine traveled through the thin treetops, while the No. 2 engine
encountered the more robust tree trunks that were closer to the ground.
The tree trunks pro-
vided a more substantial threat to the No. 2 engine
in addition to that engine
encountering the ground
earlier than the No. 1 en-
gine during the accident
sequence. By contrast,
the No. 1 engine traveled
through the thin treetops
ingesting vegetation as it
got along for a relative-
ly longer period of time
before it came in contact
with the ground. This
time allowed for the No. 1
engine to ingest the thin
debris at the tops of the
trees, chop that debris,
and deposit it deep within
the engine without the
engine sustaining the me-
chanical damage typically
associated with an engine that is determined to have been operating
at the time it was impacted during the accident sequence.
Finally, the dented combustion chamber outer case indicated a significant impact to the No. 1 engine in an area where no blades were present. Thus, there was no incursion of static hardware into rotating hardware within the engine to provide an indication of engine rotation, or lack thereof, during the accident sequence.

On-scene observation combined with the examination of the engines helped to explain how the engines came to rest on opposite sides of the wreckage path from their installed locations on the aircraft. With the right wing down orientation of the aircraft, it was determined that the No. 2 engine impacted the ground and separated from the aircraft early in the accident sequence. After separation of this engine, it continued to travel in a straight trajectory as the remainder of the aircraft turned to the right and passed the engine. This allowed the No. 2 engine to come to rest on the left-hand side of the wreckage path. The No. 1 engine separated later in time with the aircraft turning right and came to rest on the right-hand side, completing the process of the engines crossing the wreckage path.

Conclusions
The initial on-scene work during this accident investigation identified differences in the level of mechanical damage between the No. 1 and No. 2 engines. This difference in mechanical damage suggested the possibility that the No. 1 engine was not operating at the time of the accident. A disassembly and examination of both engines was accomplished to understand the conditions of the engines.

The examinations confirmed, via the traditional technique of evaluating the mechanical damage to the compressor blades, that the No. 2 engine, located on the left-hand side of the wreckage path, was operating at the time of its impacts. Furthermore, finely chopped wood deposited within this engine was identified during the examination.

The examination of the No. 1 engine, located on the right-hand side of the wreckage path, did not identify the mechanical damage signature typical of an engine that was operating during the accident sequence. The examination of this engine did not identify impacts or distress to the static structure of the engine that would produce blade distress that could be used to establish the state of rotation of this engine. Detailed examination of this engine did identify finely chopped wood deposited in the burner area of the engine. A qualitative assessment of this wood, including a comparison with the wood found in the opposite engine, led to the assessment that the engine was operating at the time it encountered trees at the accident site.

The positive identification of the installed positions of the engines combined with the survey of the accident scene further enhanced the understanding of the condition of the engines. With the understanding that the engines had crossed the wreckage path during the accident sequence and the observation that the aircraft entered the trees in a right wing-down attitude, an understanding was reached that the No. 1 engine (exhibiting no blade damage) entered the tree tops and ingested relatively thin vegetation while the No. 2 engine encountered heavier vegetation and impacted the ground earlier in the accident sequence. The No. 1 engines thus had time to process and accumulate debris before coming to rest at the accident site. The manner in which the debris in the engine was processed was consistent with having work (e.g., chopping) performed on it that was consistent with an engine that was operating at the time it encountered trees at the accident site.

This accident investigation highlighted that the traditional method of understanding the state of operation of an engine during an accident sequence can be misleading. An engine that was initially suspected of not rotating at the time of its impacts was later determined to have been operating through a further examination. This examination utilized the finding of chopped wood within the engine to establish that is was operating at the time it encountered trees at the accident site. Furthermore, the documentation of the accident scene and positions of the engines were instrumental in understanding why the two engines exhibited different appearances and aided in the explanation of the damage observed.

(The author thanks his colleagues and friends in the Pratt & Whitney Flight Safety Office for their help and support in writing this paper. Their contributions have been truly valued and invaluable.)
CRASH SCENE HAZARD MANAGEMENT: AN UPDATED APPROACH

The Canadian Armed Forces (CAF) Directorate of Flight Safety (DFS) has developed an updated approach to crash scene hazard management and welcomes the opportunity to collaborate with other organizations to share best practices and lessons learned.


On Jan. 21, 2016, an updated approach to crash scene hazard management was presented to representatives of the major air investigator communities in Canada: the Canadian Society of Air Safety Investigators (CSASI), Transport Canada (TC), the Transportation Safety Board of Canada (TSB), and DFS. The updated approach is rooted in the risk-management (RM) process recommended by the International Civil Aviation Organization (ICAO) and is designed as a comprehensive yet straightforward evidence-based approach to managing crash scene hazards.

Background

From the early 2000s, crash scene hazard management in Canada focused largely on biohazard protection. This was the logical consequence of changes in the late 1990s to workplace health and safety guidelines aimed at protecting the worker from exposure to infectious diseases such as Human Immunodeficiency Virus (HIV), Hepatitis B, and Hepatitis C. To emphasize the perceived risk, the annual “Personal Protection” training for aviation accident investigators was specifically called “Blood-Borne Pathogen (BBP)” training.

Unfortunately, the emphasis on biohazard protection sometimes overshadowed other potential hazards at aviation crash scenes. Anecdotally, there was concern at the DFS (the independent investigator of CAF aircraft accidents) that some CAF flight safety personnel were emerging from training with the impression that infectious diseases were the primary hazards at a crash scene. Over time, the DFS attempted to supplement BBP training with instruction on other hazards, such as chemical, explosive, and radiological hazards. But this led to ever-growing “shopping lists” of specific hazards that were difficult to remember and not contextualized in terms of the actual risks they posed.

In 2015, the DFS began a review of its crash scene hazard training package, ultimately leading to this updated approach that is believed to benefit not only Canadian air investigators but also international air investigators.

Method

The DFS reviewed the ICAO guidance provided in Circular 315, “Hazards at Aircraft Accident Sites,” which discusses specific crash scene hazards and groups them into categories. The DFS adopted this consolidated hazard categorical approach but made slight modifications to the individual ICAO categories after broad consultation with the DFS accident investigators and CAF aviation medicine and occupational medicine experts. Thus, the previous shopping lists of hazards were reorganized into five easy-to-remember categories: 1) Physical, 2) Chemical, 3) Environmental, 4) Psychological, and 5) Biological.

The DFS then conducted a risk analysis of the five hazard categories using an RM process. ICAO Circular 315 recommends applying a RM process to crash scene hazards involving the cycle of 1) identifying hazards, 2) identifying exposure routes, 3) assessing risk, 4) introducing controls, and 5) reviewing and revising the risk assessment. Rather than applying RM at the time of a crash, the DFS decided to take the ICAO recommendations one step further and pre-assess the likely hazards.

With primary focus on the CAF aircraft fleets, the DFS gathered evidence from scientific and medical literature, hazardous material safety data, and expert consensus to assess the overall risk of each hazard category. The pre-assessment was intended to give investigators a “head start” when confronting a crash scene, allowing faster and more accurate risk assessment, safer scene hand over, and improved safety measures.

Applying this RM process, the DFS ultimately assessed that there was a low risk associated with biohazards (e.g., HIV, Hepatitis B, and Hepatitis C) at a crash site. This assessment was based on reassuring information from the U.S. Centers for Disease Control and Prevention, the Public Health Agency of Canada, and a thorough literature search for documented cases of disease transmission from aircraft accident sites. Moreover, consideration was given to advances in medical science since the creation of health and safety guidelines in the 1990s. For instance, Hepatitis B transmission can be prevented with vaccination, HIV transmission can be prevented with post-exposure prophylactic treatment, and Hepatitis C can now be medically cured. Thus, the relatively low risk of biohazards can
be put in proper context for accident investigators.

**Crash scene hazard matrix**

In the end, the DFS produced the following matrix describing the minimum expected risk level of each of the five crash scene hazard categories. The matrix is intended to serve as a quick reference and simple starting point for crash scene hazard management. At the same time, investigators remain free to modify the risk levels when necessary based on specific crash site circumstances. The DFS has re-written the chapter on “Crash Scene Hazard Management” (previously entitled “Blood-Borne Pathogens”) in its Airworthiness Investigation Manual (the investigation standards manual for the CAF). The new approach is being taught in the CAF flight safety course for aircraft accident investigators and the medical course for aviation medicine providers.

**Collaboration**

The DFS felt that the entire Canadian air investigative community could benefit from its work and, as stated earlier, presented it to the CSASI, the TC, and the TSB in January 2016. Coincidentally, each group was considering a periodic review of its own crash scene hazard management and BBP training packages. Each group subsequently agreed to collaborate with the DFS to further develop the proposed approach and to determine how to best incorporate it as the basis for crash scene hazard management within their respective organizations.

**Conclusion**

This common approach is expected to enhance interoperability and allow collaboration on future work, such as the rationalization of PPE. To promote a greater understanding of crash scene hazard management, the DFS welcomes the opportunity to collaborate with other organizations, both nationally and internationally, that would like to share their best practices and lessons learned. Hopefully our shared knowledge will give our accident investigators a better idea of the risks that they may encounter at a crash scene and will result in them being better prepared to protect themselves and others at the site and afterwards.

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Exposure Route</th>
<th>Risk</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Broken structures</td>
<td>• Cuts</td>
<td>HIGH</td>
<td>• Control access</td>
</tr>
<tr>
<td>• Carbon fiber (CF)</td>
<td>• Punctures</td>
<td>Likely probability</td>
<td>• Avoid/cordon</td>
</tr>
<tr>
<td>• Stored energy</td>
<td>• Crush</td>
<td>Critical severity</td>
<td>• Disarm</td>
</tr>
<tr>
<td>• Explosives</td>
<td>• Inhalation/ingestion</td>
<td>• Severe injury and/or</td>
<td>• Apply fixant (CF)</td>
</tr>
<tr>
<td>• Radiological†</td>
<td>• Contact/x proximity</td>
<td>• Significantly degraded</td>
<td>• Decontaminate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>operational capability</td>
<td>• No eating on site</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Wear PPE</td>
</tr>
<tr>
<td><strong>Chemical</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Petroleum, oil</td>
<td>• Inhalation</td>
<td>MEDIUM</td>
<td>• Control access</td>
</tr>
<tr>
<td>• lubricants/liquids</td>
<td>• Ingestion</td>
<td>Likely probability</td>
<td>• Avoid/cordon</td>
</tr>
<tr>
<td>• Metals/oxides</td>
<td>• Contact</td>
<td>Moderate severity</td>
<td>• Neutralize</td>
</tr>
<tr>
<td>• Viton (rubber)</td>
<td></td>
<td>• Minor injury and/or</td>
<td>• Decontaminate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Degraded operational</td>
<td>• No eating on site</td>
</tr>
<tr>
<td></td>
<td></td>
<td>capability</td>
<td>• Wear PPE</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td>Variable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Cold/heat</td>
<td></td>
<td>MEDIUM</td>
<td>• Control access</td>
</tr>
<tr>
<td>• Fatigue</td>
<td>• Direct exposure</td>
<td>Likely probability</td>
<td>• Implement site security</td>
</tr>
<tr>
<td>• Insects/wildlife</td>
<td>• Indirect exposure</td>
<td>Moderate severity</td>
<td>• Apply work/rest cycles</td>
</tr>
<tr>
<td>• Enemy/security</td>
<td>(vicarious trauma, narratives)</td>
<td>• Minor injury and/or</td>
<td>• Monitoring</td>
</tr>
<tr>
<td>• Political situation</td>
<td></td>
<td>• Degraded operational</td>
<td>• Limit exposure and control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>capability</td>
<td>information release</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Wear PPE</td>
</tr>
<tr>
<td><strong>Psychological</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Traumatic exposure††</td>
<td></td>
<td>MEDIUM</td>
<td>• Control access</td>
</tr>
<tr>
<td>• Direct exposure</td>
<td>• Cuts</td>
<td>Likely probability</td>
<td>• Implement site security</td>
</tr>
<tr>
<td>• Indirect exposure</td>
<td>• Punctures</td>
<td>Moderate severity</td>
<td>• Apply work/rest cycles</td>
</tr>
<tr>
<td>(vicarious trauma, narratives)</td>
<td></td>
<td>• Minor injury and/or</td>
<td>• Monitoring</td>
</tr>
<tr>
<td></td>
<td>• Via mucous membranes</td>
<td>• Degraded operational</td>
<td>• Limit exposure and control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>capability</td>
<td>information release</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Wear PPE</td>
</tr>
<tr>
<td><strong>Biological</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Blood-borne pathogens</td>
<td></td>
<td>LOW</td>
<td>• Vaccinate††</td>
</tr>
<tr>
<td>• HIV</td>
<td>• Cuts</td>
<td>Unlikely probability</td>
<td>• Control access</td>
</tr>
<tr>
<td>• Hepatitis B/C</td>
<td>• Punctures</td>
<td>Critical severity</td>
<td>• Decontaminate</td>
</tr>
<tr>
<td></td>
<td>• Via mucous membranes</td>
<td>• Severe injury</td>
<td>• Wear PPE</td>
</tr>
</tbody>
</table>

†† Although the injury sustained from radiological hazards could be severe, the probability of exposure is considered improbable, and therefore the risk is considered low.

††† The potential for severe traumatic exposure may increase the assessed risk level to high in certain circumstances.

†††† Advance vaccination is encouraged and could be mandatory for all personnel who attend a crash scene.

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**Authors’ Comment**

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Barbara Dunn, the CSASI; Nora Vallée, Occurrence Response Analyst, Flight Operations, the TC; Leo Donati, Director Operational Services, the TSB; Susan Greene, Manager Multi-Modal Training and Standards, the TSB; Beverley Harvey, Senior Investigator International Operations and Major Investigations–Air, the TSB; Dr. Joan Saary, Occupational Medicine Specialist, Canadian Forces Environmental Medicine Establishment, the CFEME; Maj. Rachel Morrell, Military Medicine, the CFEME; Maj. Nathan Nugent, School of Operational Medicine, the CFEME; Col. Pierre Morissette, Royal Canadian Air Force Surgeon, CF Health Services Group HQ; Lt. Col. Helen Wright, 1 Canadian Air Division Surgeon, the CAF; Maj. Tarek Sardana, SO Aerospace Medicine, the CAF; Maj. Carmen Meakin, Clinical Leader for Mental Health, the CAF; Lt. Col. Martin Leblanc, Chief Investigator, the DFS, the CAF; MWO Gary Lacoursiere, Technical Investigator, the DFS, the CAF; Capt. Roger Dib, Director Aerospace Equipment Program Management (Fighters and Trainers) 3-2-2, the CAF; WO Wil Tyhaar, Director Aerospace Equipment Program Management (Transport and Helicopters) 2-3-2-3, the CAF.
FIVE RECEIVE ISASI SCHOLARSHIPS

THE ISASI RUDOLF KAPUSTIN MEMORIAL SCHOLARSHIP PROGRAM HAS SELECTED FIVE STUDENTS TO RECEIVE ITS BENEFITS.

By Esperison Martinez, Editor

This year’s ISASI Rudolf Kapustin Memorial Scholarship marks a new chapter for this program, which was established in 2002 to memorialize all deceased ISASI members. The scholarship was named in honor of Rudy Kapustin, the former ISASI Mid-Atlantic Regional Chapter president, who died in 2002. Throughout his long career, Kapustin was always a strong safety advocate.

After 14 years of dedication to the program and the selection of 40 Kapustin scholars, Richard Stone and Ron Schleede have handed the baton to a new selection committee, chaired by Chad Balentine, ISASI’s secretary. Balentine, along with Alicia Storey and Erin Gormley, reviewed the 14 applications submitted and selected the authors of four essays, one with dual authorship, to be the 2016 recipients of the scholarship. The new Kapustin Scholars are:

- Andre William Woenardi, University of Southern California, Los Angeles, California, USA, and Yasmeen Syed, University of Southern California, Viterbi School of Engineering, Los Angeles, California, USA, dual authors of the essay AirAsia 8501: Echoes of Air France 447?
- Taylor Beall, Delft University of Technology, the Netherlands, author of the essay New Materials, New Challenges?
- Jiaqi Cao, Cranfield University, UK, author of the essay The Challenges for Air Safety Investigators: Exploring Potential Link to Achieve Real-Time Data Transmission.
- Carly Christian Shoemake, Embry-Riddle Aeronautical University, Daytona Beach, Florida, USA, author of the essay Social Media in Crisis Communication.

Balentine noted, “It is truly amazing to have received so many outstanding applications for this prestigious scholarship that is solely funded through the generous donations of ISASI members. Designed to encourage and attract college students in the areas of aviation safety and investigations, previous winners have ultimately found careers as college professors and manufacturer and accident investigation board investigators. This program truly is working, and I look forward to seeing the remarkable contributions that this year’s recipients will bring as they finish their education and begin their careers.”

In addition to a new selection committee, this year also set forth new scholarship application criteria. Per the new criteria, an applicant:

- needs to have demonstrated a genuine interest in aviation safety and accident investigation/prevention. This includes being an active member of his or her student chapter (if one exists). Verification will be conducted by the professor signing the application.
- will be required to obtain a letter of recommendation from his or her professor, academic tutor, or faculty mentor.
- needs to be a student member of ISASI to apply for the scholarship (the membership application may accompany the scholarship application submission).
- will be required to submit a professional résumé that includes activities associated with ISASI’s aims.
- will be required to sign the application, acknowledging that the essay is his or her “original” work.
- is required to submit an essay of 1,500 words (+/- 10%).

In addition, the requirement remains that an applicant must be enrolled as a full-time student in an ISASI-recognized education program, which includes courses in aircraft engineering and/or operations, aviation psychology, aviation safety and/or aircraft occurrence investigation, etc., with major or minor subjects that focus on aviation safety/investigation.

An award of US$2,000 is made to each student who wins the competitive writing requirement, meets the application requirements, and who registers to attend the ISASI annual seminar. The award will be used to cover costs for the seminar registration fees, travel, and lodging/meal expenses. Any expenses above and beyond the amount of the award will be borne by the recipient. ISASI corporate members are encouraged to donate “in kind” services for travel or lodging expenses to assist student scholarship recipients. Member contributions have provided an annual allocation of funds for the scholarship. Contributions are tax-deductible in the U.S. and may be made in the name of a specific deceased member payable to the ISASI Rudolf Kapustin Memorial Scholarship fund and sent to the ISASI main office.

Application and scholarship availability notices are posted in some 50 colleges and universities worldwide. ISASI members are encouraged to promote the scholarship to individuals, student groups, parents, and applicable departments at their alma maters. Members are also encouraged to assist in securing and completing applications for any appropriate student(s).

The deadline for applications is April 15 of each year. Full application details and forms are available on ISASI’s website, www.isasi.org.

AirAsia 8501: Echoes of Air France 447?
An Examination of the Factors that Led to the Fatal Crashes and Their Effects on Aviation Safety
By Andre Woenardi and Yasmeen Syed

On June 1, 2009, Air France Flight 447 bound for Paris, France, crashed into the Atlantic Ocean, taking the lives of 228 passengers. Despite the consequent improvements to the Airbus automation system and pilot training, the issues in aviation safety magnified from the Air France crash manifested once again nearly four and a half years later in the tragic accident of AirAsia Flight 8501. This essay seeks to explore the critical issues shared by both aviation disasters and their subsequent impact on the future of aviation safety. Although many factors were prevalent in both accidents, the following research will focus on the loss of situational awareness and its contribution to the downfall of two state-of-the-art commercial Airbus aircrafts.

On Dec. 28, 2014, Indonesia AirAsia Flight 8501, traveling to Singapore, disappeared into the Java Sea after pilots responded incorrectly to a malfunction in the rudder travel limiter (RTL). Shortly after the first officer, the pilot flying (PF), requested permission to climb to avoid storm clouds, four master cautions activated signaling the failure in the RTL. The crew performed standard procedures in response to the first three cautions but deviated from procedure after the fourth alert by removing and reinserting the circuit breakers of the flight augmentation computer (FAC). This action disengaged the autopilot and stall protection by shutting off part of the fly-by-wire system mid-flight. As a result, flight control shifted from normal law to alternate law; and for nine seconds, nobody was flying the plane. According to the aircraft accident investigation report released by Komite Nasional Keselamatan Transportasi (KNKT², Indonesia’s accident investigation authority), “Subsequent flight crew action leading to inability to control the aircraft in the alternate law resulted in the aircraft departing from the normal flight envelope and entering prolonged stall condition that was beyond the capability of the flight crew to recover.” The missteps of the flight crew exposed their loss of situational awareness after the sudden onset of automation failure.

Over the past few decades, advances in aircraft automation have dramatically improved airline safety, enhanced efficiency and performance, increased fuel economy, and reduced pilot workload. Conversely, the advent of cockpit automation has also evolved the role of the pilot “from manually flying the aircraft to spending a majority of their time monitoring flight deck systems.” Yet, paradoxically, pilots are still expected to fly extraordinarily in the face of a crisis, given little direct experience or nonsimulator practice to do it. Another consequence of the advancement of cockpit automation is its increasingly complex cockpit interface. Pilots, in their new role as system operators, struggle to fully understand the intricate system they work with—the “problem” no longer as transparent as it once was in older mechanical cockpits.

In the event of an automation failure, they experience difficulty fixing a problem they cannot identify, especially under extreme stress and pressure. Pilots’ skill degradation, coupled by the complexity of a highly automated cockpit, results in the loss of situational awareness—defined by Airbus as “having an accurate understanding of what is happening around you and what is likely to happen in the near future.” The challenges that overreliance on automation and the resulting degradation of situational awareness create for aviation safety have been prevalent and catastrophic since the birth of cockpit automation. Yet, the issue continues to be portrayed time and time again in aircraft accidents such as AirAsia 8501, posing enduring obstacles for air safety investigators.

The pilots’ loss of situational awareness in Flight 8501 was

Andre Woenardi
21, born in Singapore, calls Jakarta, Indonesia, his hometown, where his parents still reside. He is presently living in Los Angeles, California, U.S.A., and attending the University of Southern California. His present course of study, which he expects to complete in 2017, is industrial system engineering. He holds a bachelor of science undergraduate degree. Andre plans to graduate and gain working experience in the U.S. before returning to Indonesia to make a real difference in his country as he works to become a professional in the field of management consulting, specializing in human factors and work design.

Yasmeen Syed
20, was born in Burbank, California, U.S.A., and resides in Glendale, California, where her parents continue to live. She attends the University of Southern California’s Viterbi School of Engineering in Los Angeles and is pursuing a master’s degree in industrial and systems engineering. She holds a bachelor of science degree in industrial and systems engineering. Yasmeen is currently interning at the NASA Jet Propulsion Laboratory for the Asteroid Redirect Redirect Mission. Asked about her aspirations and future plans, she said, “I would like to continue developing a deep, comprehensive understanding of technological systems to better identify and mitigate the risks they pose. Given my passion for rock climbing and forensic novels, I’ve always had an interest in solving challenging problems. But it wasn’t until I took a USC course in human factors engineering and work design that I realized I could apply my interests toward a career in aviation safety and accident investigation. After immersing myself in the research, I was immediately drawn to a field where my investigative skill set could be showcased and my work would have a lasting impact. Going forward, I hope to use my ISASI Kapustin experience as a platform to pursue work in the aviation industry as a system engineer to bridge the gap between human operators and technological interfaces.
most clearly reflected by the confusion and disunity bred by the cockpit design. Radar data showed that the Airbus A320 was climbing at 6,000 feet/minute, more than three times the climb rate commercial airplanes are designed for, before its crash. The abnormally steep ascent was explained by the first officer’s operation of the control stick at extreme pitch attitude, climbing at a rate of up to 11,000 feet/minute and triggering stall warnings. In response, the captain, the pilot monitoring (PM), repeatedly instructed the PF to “pull down!” when he actually intended for the first officer to push the stick forward (pushing the nose down) to regain speed and recover from the stall.

The miscommunication may have been a consequence of high stress and the obligation of the pilots, both of different nationalities, to use English—a second language for both. Confused, the first officer continued to pull up and urged the captain to grab his own control and push forward. However, the captain overlooked the fundamentals of CRM and failed to communicate his action to the PF, resulting in the pilots’ opposing inputs neutralizing each other. With an extreme angle of attack and inadequate airspeed, the aircraft continued to stall and descend until the aircraft disappeared from the radar.

While miscommunication was a crucial factor, the cockpit design prevented the captain from gaining situational awareness of the aircraft’s operation, leading to the stall. Despite reducing pilots’ responsibility by allowing them to let go of the stick and focus on other tasks, automation also fosters error by keeping the second pilot’s stick neutral while the other is in use. Because the PF’s stick is held back for only a few seconds, “it’s not immediately apparent to one pilot what the other may be doing with the control stick, unless he makes a big effort to look across to the other side of the flight deck.” Unlike traditional yokes that are mechanically connected, this fly-by-wire design severs the connection between the pilots, perpetuating the loss of situational awareness, which diminishes any hope of recovery.

The same findings were concluded in the 2009 Air France 447 accident. The Airbus A330 crashed into the Atlantic Ocean following the pilots’ inappropriate response to unreliable airspeed data. Similar to AirAsia, the flight control system was misbehaving due to technical failures, and the flight crew struggled to understand what had gone wrong. Possibly under the assumption that he was operating at low altitude, the PF of Air France pulled the stick back into a steep climb for most of the flight—mirroring the actions of the PF on the Indonesian airline. From bad weather and inadequate technical maintenance to pilots’ extreme overcorrection, the similarities between the two Airbus tragedies ensued as the pilots of AirAsia failed to acknowledge the aircraft was stalling throughout the entirety of the aircraft’s descent, continuing to express confusion about its status until its final moments.

This trend of diminished situational awareness in aviation crashes is undoubtedly caused by the perpetual advancement of cockpit automation. Due to the reliability and convenience of automation, aircraft are now easier to fly and have, in turn, reduced the time and scope of pilot training programs. As computers replaced manual operations, training programs were curtailed from months to weeks. However, the shortened training time focuses on learning how to operate the automated system, neglecting to teach pilots how to manually operate aircrafts and work through emergencies and anomalous procedures. According to Capt. Douglas Moss, an A320 pilot and expert in aviation safety, “Most of the training relies on the pilots to look up the solution in a checklist, without giving them the time in the training program to actually practice all the various failure modes. In both Air France and AirAsia, there was not enough time to look up anything in the checklist. Their training probably didn’t include those types of scenarios.” Moss draws attention to shortcomings of pilot training programs and their inability to evolve with the rapid progress of automation—the implication of this finding suggesting that insufficient pilot training breeds the loss of situational awareness responsible for recent aviation accidents, including Air France 447 and AirAsia 8501.

A growing threat to the culture of aviation safety, degraded situational awareness is cited by the Australian Transportation Safety Board (ATSB) to be the cause of 85% of incident reports. The exorbitantly high statistic reveals a troubling trend of the rise of accidents involving human factors and pilots’ mismanagement of the situation, the most recent including the 2015 TransAsia crash, where pilots’ loss of situational awareness due to the complexity of the engine throttle system led to the flight’s collapse. With continual advancement of automation in the aviation industry, new hazards quietly emerge and jeopardize the safety and welfare of all those on board. The fatal accidents of Air France 447 and AirAsia 8501 urge the need for a harmonious relationship between pilot training and automation to overcome habits of the past and drastically improve passenger safety.

Special thanks to Mr. Daniel Scales and Mr. Tom Anthony of USC Aviation Safety and Security, Capt. Douglas Moss of United Airlines, and Capt. Abdulsalam Sardouk of Middle East Airlines for their insightful comments and support of this research.

References

1 “Normal law” is the flight control system that intervenes to protect against stalls, while “alternate law” eliminates stall protection and involves more manual operations.
5 Crew Resource Management, a philosophy centered on interpersonal communication, leadership, and decision making in the cockpit.
New Materials, New Challenges?
By Taylor Beall, TU Delft

As time progresses, so do the technologies used in support of the aircraft industry. One major shift in recent years is a migration towards new materials, particularly fiber reinforced polymer composites. The newest aircraft have large portions of their structure made from these novel materials; however, it is still not completely known how normal conditions, or in some cases abnormal conditions, will affect these lighter, stronger structures. Although the number of major air accidents has continuously decreased throughout the years, also not completely answered is what the effect of these new materials will be in an accident scenario. In the 1960s, the typical amount of composite material on an aircraft was 1% to 3% by structural weight. This amount slowly increased until there was a major jump in the percentage of composites used in the new Airbus A350 and Boeing 787, which contain more than 50% composite material. The continually shifting ratios of metals and composite materials, each with differing thermal and structural properties, might present unknown challenges.

Compared to the traditional metals used in aircraft construction, the research and knowledge about the long-term and catastrophic behavior of composites are still in the beginning phases. Work to fill in our knowledge gaps is being done in many areas, including the effect of fire and impact, as well as others.

The U.S. Federal Aviation Administration (FAA) has identified four areas of safety concern with using these novel materials: (1) limited information on the behavior of composite airframe structures, (2) technical concerns related to the unique properties of composite materials, (3) limited standardization of composite materials and repair techniques, and (4) level of training and awareness on composite materials. This recognized lack of information and lack of standardization presents both systemic and application-specific challenges to the aviation industry.

Improper repairs can cost lives, and the third concern begs a discussion of how composite airframe structures are currently repaired. Despite that fact that composites behave differently from metals, both are currently repaired in the same way; drilling and riveting a metal doubler patch is the certified repair for primary structure. This approved method seemingly accepts some higher level of risk due to composites not behaving ideally when drilled. There is a risk of delamination during drilling and the riveting process introducing areas of bearing stress, something that composites are not strong against. Additionally, since the thermal behavior of the doubler patch is not the same as the underlying material, changes in environmental temperature will introduce additional stresses into the structure that must be taken into account. However, even with the disadvantages of this method, maintenance groups are well versed in how to properly perform this established technique, albeit with possible problems when drilling composites.

As illustrated by both the Japan Airlines Flight 123 (JAL 123) and China Airlines 611 incidents, there have already been repairs that have caused loss of life. In the case of JAL 123, the repair was properly designed; however, it was incorrectly installed. As the aviation industry migrates to bonded repairs, a major challenge will be to ensure proper training and maintenance oversight to reduce errors in standardized and tightly controlled processes.

The advantage of bonded repair is that it closely matches the strength and properties of the original structure. Unfortunately, this method is still being evaluated for general use and is not yet certified. As well, in introducing a new repair method, new training and certified standards will need to be established to ensure that maintenance operations everywhere can perform a repair of the same quality.

Another issue with the bonded repair method is that it is not as easily applied in normal maintenance conditions. While a temporary repair can be a patch, the permanent repair usually requires a step-down grinding method, essentially followed by relaminating the composite in the affected area. This is not a simple approach to apply, as the grinding is done by hand and must be very precise, and strict environmental controls are required. Some repairs have already failed due to suboptimal application conditions, something if implemented on a wider scale might end up costing lives.

This leads to the question of what tolerance margins are acceptable for this type of repair. For example, some grinding activities require an accuracy of a tenth of a millimeter. It has not yet been firmly established how much error in grinding depth, or applying and feathering the patch, is permitted for the repair to still be effective. Similarly, the overall effect of different combinations of application variables is not well documented.

Once a repair has been applied, actively used aircraft, such as those in commercial aviation, have an increased probability of repeated impact and damage in the same areas. The effects of multiple impacts have not been extensively explored, particularly on areas that have been repaired. Riveted doublers on composite materials may actually make multiple impacts more problematic. The
rivets transfer impact forces to all layers of the underlying material, which works well with homogeneous materials such as aluminum, but may not be ideal for heterogeneous materials such as fiber composites. On the other hand, although the impact load transfer may be better for laboratory-quality “perfect” bonded repairs, the chance of slight misalignments or other small defects may reduce the effectiveness of the repair. Additionally, it is not known if the effect of normal aging of the material will induce problems, compounded by multiple impacts. With so many factors at play, with quite a few still not well studied, it is possible that currently accepted repairs to composites could cost lives due to these partially understood effects.

Another area of study is the effect of fire on composite materials. During the fires aboard the fledgling Boeing 787 aircraft, the composite material was charred, but the localized damage was not as extreme as with metal fuselages. The battery fire aboard the Ethiopian Airlines plane did not actually penetrate the composite material, despite a large amount of damage. However, this improved local performance of the composite material exposed to fire may not tell the entire story. There may be possible difficulties when repairing the aircraft, and future failures of the structure may result. Since carbon fibers are excellent conductors, the heat from the fire may not be localized and can potentially spread, melting or compromising the adhesive layers within the composite material in adjacent areas. For repair of fire-damaged aircraft, we need a better understanding of how far the heat damage can extend. In the case of the Ethiopian Airlines 787, the entire upper skin was replaced for the barrel section of the fuselage in front of the tail, an area much larger than the exterior visibly damaged section. While nondestructive techniques are very important in determining the extent of fire damage, there could be an as yet unknown effect or damage type combining short-term damage (fire, impact) with longer-term damage (fatigue, aging of materials) where the nondestructive techniques used will be very important. Using the incorrect method due to the unknown type of damage expected could cause damage to grow unchecked and could cause catastrophic failure.

To determine if there is damage within a structure and material, nondestructive inspection techniques are used. These techniques vary in their effectiveness, depending on the specific situation and type of damage. Further research and development of improved standards are needed. Also, since composite damage is not always visible, particularly in the case of physical impacts, more rigorous standardization of techniques to determine possible damage will most likely need to be pursued. Since an impact normal to the fiber is in the weakest strength direction for composites, a relatively minor impact for an aluminum skin might produce less visible damage for a composite structure, although the composite structure might be significantly more compromised. This can be due to delaminations and other internal interply damage between composite layers, something that can be very problematic but invisible to the human eye. A relatively minor impact may ultimately require a large repair due to the number of plies in the material, with each added ply requiring the area of the patch to be increased, to provide a sufficiently gradual step-down feathering area to reach all the damaged plies in the material. However, most likely the nondestructive inspection techniques will be invaluable in reducing risk and confirming that repairs are functioning properly.

In theory, and in the ideal situation, the benefits of increasing composite material use vastly outweigh any negative challenges. However, there is not yet enough empirical data about the behavior of the new composites in all possible situations, particularly following repair. How the materials will age, and the effect of normal wear, including minor impacts, requires much more research. With such a large increase in the use of composite materials across the aviation industry, some of these unknowns will be established through actual use case studies, and associated certifications can expect to be updated accordingly. As information is steadily gathered, the challenge for air safety investigators will diminish. During this initial phase of widespread composite material implementation, it is unfortunately likely that there will be incidents and accidents that will improve our understanding. Hopefully through experimentation, inspection, and data collection, the possibility of these incidents occurring will decrease over time, and our understanding and effectiveness and quality of repairs will vastly increase. Improper repairs can cost lives, but through further research the behavior of these repairs will be better understood, and the challenge for air safety investigators to accurately determine cause and effect, at all levels, will be improved.

References

Social Media in Crisis Communication
By Carly Shoemake

As the demand for air travel has grown over the last several decades, the aviation industry is forced to become more dynamic in order to keep up. The industry is compensating for this need in the form of more aircraft, companies, and also more refined regulations; however, one area that the industry has neglected to address has been that of communication—specifically, before, during, and after a crisis. While communicating with the public has always been a task for investigators or even the industry in general, social media outlets like Facebook and Twitter have now become more prominent in the everyday use of society. Social media is now a main source of news for much of the public so when a crisis arises, it is no surprise that many choose to post, share, re-tweet, and re-gram their and others’ experiences. The challenge for air safety investigators arises when the airline or participating party does not have an effective social media communication strategy included in their emergency response plan to combat the speed at which information spreads.

In order to understand how to respond to a crisis through social media accounts, it is first important to understand how quickly information spreads virtually now. On July 6, 2013, at 11:28 PDT, Asiana Airlines Flight 214 was flying the approach into San Francisco International Airport from Seoul, South Korea. The flight was carrying 291 passengers, 12 flight attendants, and 4 flightcrew members. The aircraft struck the seawall and collapsed, killing three and seriously injuring 49, resulting in the first fatal crash in the United States in more than four years.

Within 30 seconds of the accident, an onlooker in the terminal snapped a photo of the crash and posted it on Twitter. She was quoted more than 4,000 times in the media over the next 24 hours. Her post didn’t just travel through Twitter feeds either. That post was seen on Facebook but also made its way to Path and Sina Weibo as well as countless other sites. A passerby actually live-tweeted the event as it occurred. His posts were seen re-tweeted more than 32,000 times. Shashank Nigam, an analyst and writer from SimpliFlying, agrees that “the lesson learnt is that social media needs to be an integral part of any crisis management plan for an airline or an airport today. There is no longer the luxury to respond in two hours, or even 20 minutes.” (Nigam, SimpliFlying) After a crash, social media picks the story up before the airline even knows what is going on, making responding to a crash a difficult dance acknowledging the event, clearing up rumors, and updating with facts as they are found.

With so many social media outlets and so little time, the overwhelming nature of crisis communication can make it very tricky to get it right. It’s important to recognize that there is a wrong way to communicate to the public after a crisis.

Malaysia Airlines Flight 370 departed Kuala Lumpur, Malaysia, on Saturday, March 8, 2014, and was headed to Beijing, China. Contact was lost with the Boeing 777 at 2:40 AM somewhere over the Indian Ocean and was never regained. To this day, what became of the airliner and the 239 people on board is still a mystery.

News of the event became international news literally overnight, and by the time the sun rose over the Asian Pacific region, it was already too late for the airline to break their silence. For more than four hours, the airline was silent and failed to make an initial statement regarding the loss of contact. When the post finally did come, it fell on deaf ears as it was described as cryptic and confusing. Much speculation about the incident also occurred over that time that was taken for fact and skewed the airline’s chance to speak the truth.

For those following the investigation, more questions have been yielded than have been answered. The public response was that of disappointment heeding distasteful comments, including ones begging the airline to answer questions like “If the flight is about six hours. Why is the search taking longer to find that plane? [sic]” (Facebook). The lack of response led to public skepticism of the airline’s integrity and overall safety. However, the crash of Malaysia Airlines Flight 17 provided a perfect opportunity for the airline to try again.

Malaysia Airlines Flight 17 was due from Amsterdam, Netherlands, to Kuala Lumpur, Malaysia, on July 17, 2014, just a short four months after their company airliner vanished, when the flight dropped out of the sky killing all 295 people on board. This time, the airline came back with a much stronger social media presence admitting their loss of contact and, later in the day, establishing a hashtag so that followers could refer to one place to receive the most up to date information. Evidence of the airline’s faster response can be found all over news sites that covered the incident, unlike that of their sister flight MH370.

While Malaysia Airlines did finally catch on, it’s safe to say that no one did it better than Southwest. Southwest Airlines Flight 345 collapsed after their nose gear failed upon landing at LaGuardia Airport in New York on July 23, 2013. The plane skidded more than seven football fields before coming to a stop on the edge of the runway, injuring 10 passengers. While the virtual conversation began seconds after the crash, less than 30 minutes after the incident, Southwest already issued an official hashtag in a post recognizing the crash. The timeliness of the established hashtag, or the presence of one at all, is critical to controlling the information spread about the event.

While every crisis is different and responses should be catered to the event, waiting for an event to happen is already too late to have a social media crisis communication strategy established.
in a company’s emergency response plan. Seconds after any crisis, the conversation has already started on social media, so staying ahead of the spread of information matters most in those first moments. “You want to have backups and secondaries, and frankly you want to have people who can give other people relief,” explains Morgan Johnston, manager of corporate communication and social media strategist at JetBlue Airways. “A crisis isn’t going to only occur during normal business hours. You need to plan for an emergency response that can last for days, weeks, or even months.”

In order for a team to respond promptly, a plan of what a team is supposed to do or even who the team is needs to be established before an event and updated frequently as to grow with the needs and habits of society. Social media crisis communication should involve the response team owning the conversation.

With so many different social media platforms, owning the conversation can sometimes be difficult. Johnson of JetBlue suggests that crisis communicators need to focus on how to “limit the amount of places that people think they need to look” to find information and providing audiences valid information while staying empathetic.

A great way to limit the amount of places people go to receive information is by establishing a hashtag early on and encouraging people to check for updates. This customized tag provides one quick link for the audience to click on to follow the conversation online and find the most recent and factual information only regarding this event. The hashtag also allows the party to lead the conversation by posting updates and answering questions directly instead of people assuming or falsifying information, or in other words allowing for the spread of rumors. Even through different social media platforms, establishing a centralized location for information can help give crisis communicators the luxury of only posting to a few different places where followers can come to you to find answers.

Being linked together is as much a blessing as it is a curse, but the key for air safety investigators is to begin responding to an accident before it happens. Establish an emergency response plan that includes social media releases and identifies teams to create and manage sites. With much of the world connected through social media, don’t let social media drown out the truth or compromise the integrity of the company. Social media is and will continue to constantly change as will the aviation industry. Crisis communication can be very tricky, but the most important thing is to join the conversation.◆

Resources

(Continued from page 10)

AIR ACCIDENT INVESTIGATORS EXAMINE LINKS TO SAFETY NETWORKS

took a pre-dinner plunge into a large outdoor pool with relaxing, thermally heated water and enjoyed silica mud facials for which the site is famous. Bathers walked around in shoulder-high warm water and under waterfalls into smaller pools as the facial mud dried and cleansed their skin. After they finished and dressed, the entire ISASI group gathered in the resort’s restaurant overlooking the lagoon to socialize, make new acquaintances, and enjoy an excellent meal.

Awards Banquet
At the end of a long day of air safety presentations on Thursday, the hotel staff had only a few hours to transform the meeting room from a seminar setting to a fabulous banquet hall that seats even more people. The lights were dimmed and tables fashionably set. Meanwhile, seminar participants had a short time to catch their breath and then dress for the biggest event during the week—the ISASI awards banquet. As everyone found their seats, waiters poured white or red wine. Bread and salad were served, and the meal began. As desert reached the table, ISASI President Frank Del Gandio took the stage and suggested that the evening’s program should begin so that all the announcements and awards could be completed in a timely fashion.

Del Gandio thanked the Islandic team of Thorkell Agustsson and Ragnar Gudmundsson for being gracious seminar hosts and for their assistance with putting together all the programs. Recognition was also given to Brian McDermid and Simon Lie, Technical Committee; Olivier Ferrante, Tutorials; Alistair Mann, Technical Support; and Barbara Dunn, Registration. Recognition is also due for ESASI’s work on the seminar website and providing an electronic means to collect and categorize all of the papers and presentations submitted for ISASI’s consideration.

Del Gandio then presented new corporate membership certificates to the University of Balmand/Balmand Institute of Aeronautics—Capt. Mohammed Aziz; Asiana Airlines—ISASI Korean Society Director General Soon Cheol Byeon; Mitsubishi Aircraft Corporation—Senior Advisor Hideyo Kosugi; and the Junta de Investigacion de Accidentes de Aviation Civil—Director of Investigations Daniel Barafani. Other new corporate members, he said, included Petroleum Air Services, Aegean Airlines, and Delft University of Technology.

Stuart Hawkins, AAIB, UK, was awarded recognition for the best paper and presentation during the seminar. Hawkins’ discussion of drones as an investigative tool was riveting and informative with still images and videos of the technology in action. With a changing of the guard, Esperison (Marty) Martinez was recognized, with a standing ovation, for his 20 years of service to ISASI as editor of the ISASI Forum (see page 4). The Kapustin scholarship winners received certificates of recognition for their winning essays (see page 24).

The highlight of the awards ceremonies was the presentation
of ISASI’s highest award, the Jerome F. Lederer Award, to Toby Carroll, U.S. councillor (see page 14) as recognition of a lifetime of selfless work to enhance aviation safety.

Following ISASI tradition, at the end of the official seminar 2016 activities, Icelandic host Thorkell Agustsson passed the ISASI cowbell (used to open the gathering and call delegates to their seats) to the ISASI 2017 North American host, Barbara Dunn.

Post-Conference Tour
A day after the conference settled, two busloads of ISASI 2016 participants willingly became tourists and took the Golden Circle Tour to visit some of Iceland’s most stunning geography. The two busloads traveled the circle in opposite directions so that each site was not overwhelmed with visitors. Despite rain and thick clouds, the groups saw the Geysir geothermal area where the Strokkur geyser can shoot a column of boiling water up to 98 feet (30 meters) into the air every 4–8 minutes. And yes, this area is where the English word geyser originated. They then walked along the Mid-Atlantic Ridge where the European and North American tectonic plates separate about two centimeters per year. The guide noted as the group walked between walls of lava turned to stone that Iceland has hundreds of small earthquakes every day, but most cannot be felt. The next sight was Gulfoss waterfall, or Golden Falls, where the glacier-fed river, Hvitá, drops into a deep crevice. Finally, the group went to Fontana Wellness in the community of Laugarvatn, where natural, open-air steam baths are located near a much colder lake. By the time the group returned to the hotel, everyone was ready for a rest and dinner in nearby restaurants. ♦

President Frank Del Gandio, left, presents Toby Carroll the ISASI 2016 Jerome F. Lederer Award, which reads, “For Outstanding Contributions to Technical Excellence in Aviation Accident Investigation.”

ISASI 2016 participants visit the Strokkur geyser during a post-seminar optional tour.

Kapustin scholarship recipients receive their certificates. Shown from left, Jiaqi Cao, ISASI President Frank Del Gandio, Carly Shoemake, Taylor Beall, and Yasmeen Syed. Andre Woenardi was not available for the photo.

Thorkell Agustsson makes the traditional passing of the ISASI cowbell to Barbara Dunn, chairman of ISASI 2017 to be held in San Diego, California, U.S.A.
The University of Balamand Institute of Aeronautics

(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)

The University of Balamand is a Lebanese institution for higher education that’s located 75 kilometers north of Beirut. It was established in 1988 and resides on a picturesque historic hill that overlooks the Mediterranean.

The university is home to some 5,000 students in 11 faculties, follows an American system of education, and since its inception to date boasts more than 15,000 graduates who act as its ambassadors all over the globe.

The Balamand Institute of Aeronautics (BIA) was established in 2010 as a flexible academic entity within the faculty of engineering. It’s a unique and pioneering regional structure that has recognized that aeronautics is a multifaceted and multidisciplinary sector. Accordingly, the BIA was conceived with a mission to advance all aspects of aeronautics in line with the needs and priorities of the Lebanese and regional aeronautical sector.

Within this global approach to aviation and aeronautics, the BIA has managed to set up and consolidate a number of programs within the different faculties. Examples include the BS/MS aeronautical engineering programs within the mechanical engineering department and the B. Tech aircraft maintenance engineering programs (in airframes, engines, and avionics) within the faculty of technology. The BIA is currently working on the air transport management MBA to be anchored within the faculty of business and management.

The engineering and technology programs are supported by state-of-the-art labs and workshops that are intended to give students genuine opportunities for experimentation and maintenance practice. These labs include wind tunnels, water tunnels, materials testing machines, piston and gas-turbine engines, composite material facilities, as well as a number of fixed-wing aircraft and helicopters.

In addition to enhancing the students’ learning experiences, many of these labs are used in research and are augmented by modern computational facilities that are used for computational fluid dynamics, finite element analysis, or other numerically based activities. The BIA also has a number of flight training devices in addition to an advanced high-bypass jet engine simulator.

Despite the hardships imposed by regional instabilities, the standards set by the BIA have made it the focal point for aeronautical capacity building in Lebanon and the Middle East. The Lebanese Air Force, for instance, has entrusted the BIA with the formation of its technical officers as well as its recurrent training. Furthermore, many of the Balamand graduates are employed by airlines, MROs, training establishments, service providers, and national authorities across the Middle East. This has enabled the BIA to build and foster strong professional links with many of these establishments.

In an effort to expand its scope and international projects, the BIA has become a corporate member of ISASI. Through this step, it seeks to better itself in meeting its institutional objective and delivering quality programs to its students and its community. At the BIA, we strive for excellence in aeronautical education through dedication and commitment to provide our students with the best and most enjoyable learning opportunities.